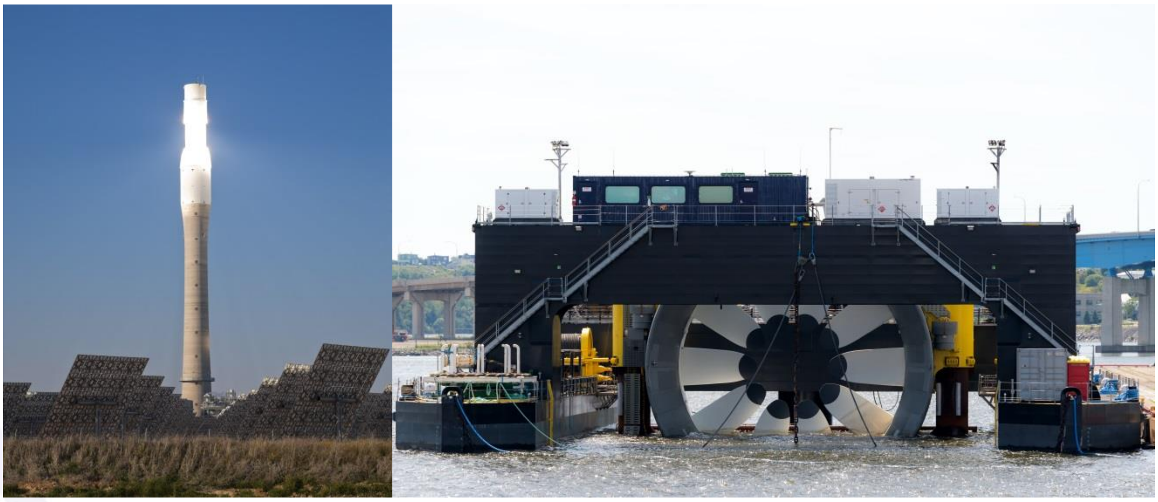


Innovative Financial Instruments for First-of-a-Kind, commercial-scale demonstration projects in the field of Energy

Written by ICF *in association with London Economics*

September 2016

Research and Innovation

EUROPEAN COMMISSION
Directorate-General for Research & Innovation
Directorate G — Energy
Unit G.1 — Strategy
Contact: Nuno Quental
E-mail: RTD-ENERGY-COM@ec.europa.eu
European Commission
B-1049 Brussels

EUROPEAN COMMISSION

Innovative Financial Instruments for First-of-a-Kind, commercial-scale demonstration projects in the field of Energy

2016 Directorate-General for Research & Innovation

EUROPEAN COMMISSION

EUROPE DIRECT is a service to help you find answers to your questions about the European Union

Freephone number (*):
00 800 6 7 8 9 10 11

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you)

LEGAL NOTICE

This document has been prepared for the European Commission however it reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

More information on the European Union is available on the internet (http://europa.eu).

Luxembourg: Publications Office of the European Union, 2016.

PDF ISBN 978-92-79-62115-4 doi: 10.2777/704393 KI-06-16-027-EN-N

Printed in the United Kingdom.

PRINTED ON RECYCLED PAPER

2016 Directorate-General for Research & Innovation

Contents

Glossary

AEN	Advanced electricity networks
ARENA	Australian Renewable Energy Agency
ARP	Advancing Renewables Programme, Australia
ARPA-E	Advanced Research Projects Agency-Energy, USA
BIO	Biomass conversion technologies, 2nd generation only, for bioenergy and biofuels – part of the EC's SET-Plan
BMUB EIP	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMUB) Environment Innovation Programme, Germany
CCS	Carbon Capture and Storage – part of the EC's SET-Plan
CSP	Concentrating solar power – part of the EC's SET-Plan
DECC	UK Department of Energy and Climate Change
DCO	Development Consent Order (i.e. for new electricity generation)
EC	European Commission
EDP	Energy Demonstration Project facility
EEEF	European Energy Efficiency Fund (EEEF)
EIB	European Investment Bank
EIF	European Investment Fund
EFSI	European Fund for Strategic Investments
ETI	Energy Technologies Institute (UK)
EU	European Union
FEED	Front-End Engineering and Design
FID	Final Investment Decision
FI	Financial Instrument (loans, guarantees, equity, etc.)
FOAK	First-of-a-kind
GEO	Geothermal energy – part of the EC's SET-Plan
GHG	Greenhouse gas
GIB	Green Investment Bank (UK)
ILP	InnovFin Large Projects facility (delivered by EIB, 2014 - 2020)

IPR	Intellectual Property Rights
KfW	German government-owned development bank, based in Frankfurt, formerly known as Kreditanstalt für Wiederaufbau
LCOE	Levelised Cost of Energy
LES	Large-scale energy storage solutions, including pumped-storage hydropower
LPO	Loans Project Office, USA
MFF	Multi-annual Financial Framework (European Union)
NEDO	New Energy and Industrial Technology Development Organisation, Japan
NREAP	National Renewable Energy Action Plan
OCN	Ocean energy (comprising tidal stream, wave energy and tidal lagoons) – part of the EC's SET-Plan
PE	Private equity
PIA	Programme Investissements d'Avenir (tr: "Investments for the Future"), France
R&I	Research and Innovation
RDI	Research, Development and Innovation
RSFF	Risk Sharing Finance Facility (delivered by EIB, 2007 – 2013), EC
RTO	Research and Technology Organisation
SET	Strategic Energy Technologies
SPV	Solar photovoltaics – part of the EC's SET-Plan
SPV	Special Purpose Vehicles
U.S. DOE	United States Department of Energy
VC	Venture Capital
WIN	Wind energy (comprising fixed onshore, fixed offshore and floating offshore turbines) – part of the EC's SET-Plan

Abstract

This study, commissioned by DG Research & Innovation, examined the role of financial instruments in the support of commercial-scale, first-of-a-kind (FOAK) energy demonstration projects focused on Sustainable Energy Technology (SET) sectors in Europe. It was carried out by ICF, in association with London Economics, between March 2015 and June 2016. Extensive research was undertaken to determine the current SET FOAK investment and funding landscape, as was consultation with three main stakeholder groups: technology sponsors, financial market participants, and public support schemes at the EU, Member State and international level.

FOAK projects are highly risky and the supply of equity and debt is at much lower levels than the financing of proven low carbon technologies. Market participants have very different appetites for risk, which in turn leads to complex financial structures being required to enable such projects to achieve financial close. Consequently, there is high demand for a suite of public sector funding mechanisms to be made available to fill the commercialisation, 'Valley of Death', funding gap.

Two EU financial instruments have been identified as being needed: equity provision and specialist loans (as the latter already being offered by the Energy Demo Projects (EDP) facility), both at a scale of around at least €250 million and ideally €500 million. These were subjected to an ex-ante assessment in line with the criteria laid down in the EU Financial Regulation. Although the equity fund option scored slightly higher than the EDP facility, both the equity fund and EDP facility are deemed to be of strategic importance and should be developed in parallel, as complementary interventions. Additionally, a clear need has been identified for an Advisory Service to help project sponsors navigate public support and plan better the critical steps in achieving financial close.

Résumé

Réalisée pour le compte de la DG Recherche et innovation, cette étude porte sur le rôle des instruments financiers dans le soutien aux projets européens inédits (« First of a kind » ou FOAK) de démonstration à l'échelle commerciale de certaines technologies du Plan stratégique européen pour les technologies énergétiques (Plan SET), dits les projets SET FOAK . Elle a été menée par ICF, en association avec London Economics, entre mars 2015 et juin 2016. Dans le cadre de cette recherche, trois types d'acteurs ont été consultés: promoteurs de projets, acteurs du marché, et responsables de dispositifs d'appui public de l'Union européenne, des Etats Membres), et des pays tiers.

Les projets innovants comportent un risque important, et leur financement par capitaux propres (equity) et leur financement par emprunt demeurent bien en dessous des financements dédiés à des technologies plus matures. L'attitude des acteurs du marché face au risque varie, ce qui entraine l'établissement de structures financières complexes, nécessaires pour permettre la clôture financière de ce type de projet. En conséquence, la demande est forte pour une gamme de mécanismes de financement public qui permettrait de combler le besoin de financement de projets SET FOAK afin qu'ils puissent traverser la dite « vallée de la mort » du financement et arriver au stade de première application commerciale.

Le besoin de deux instruments financiers s'est particulièrement fait ressentir : la provision de capitaux et de prêts spéciaux (ces derniers étant déjà offerts par le dispositif « Energy Demonstration Projects (EDP) Facility »), sur un volume d'au moins €250 millions et idéalement € 500 millions. Ces deux instruments ont ensuite été sujets d'une évaluation ex-ante, selon les critères fixés par la régulation financière européenne. Bien que l'instrument fonds-propres bénéficié d'un score légèrement meilleur par rapport à l'instrument emprunt, ces deux outils sont considérés comme étant d'importance stratégique pour garantir les besoins de financement des projets SET FOAK, et doivent être développés en parallèle, comme deux interventions complémentaires. De plus, le besoin d'un service de conseil aidant les promoteurs de projets à naviguer parmi les dispositifs de soutien publics et à mieux planifier les étapes critiques du financement s'est clairement fait ressentir.

Executive summary

ES1 Introduction

This study, commissioned by DG Research & Innovation, examined the role of financial instruments in the support of commercial-scale, first-of-a-kind (FOAK) energy demonstration projects focused on Sustainable Energy Technology (SET) sectors in Europe. The study was carried out by ICF, in association with London Economics, between March 2015 and June 2016. It aimed to:

- describe and quantify the investment needs and current financing bottlenecks related to the financing of SET FOAK projects;
- identify and analyse the market conditions, which affect the investment and lending to SET FOAK projects and the need for further public intervention at EU level; and,
- formulate appropriate policy options, including financial instruments (FIs), to remove identified investment and/or financing 'bottlenecks'.

Overall, the study sought to bridge the knowledge gap between technology developers and financial market participants, and to generate policy options, which support SET FOAK projects in the EU.

ES1.1 Scope of the study

The study focused on European first-of-a-kind (FOAK) commercial-scale demonstration projects at Technology Readiness Level (TRL)[1] 7 or 8 that use innovative low-carbon energy technologies from the following SET-Plan sectors:

- Advanced electricity networks (AEN);
- Biomass conversion technologies, 2nd generation only (BIO);
- Concentrating solar power (CSP);
- Carbon Capture and Storage (CCS);
- Geothermal energy (GEO);
- Large-scale energy storage solutions, including pumped-storage hydropower (LES);
- Ocean energy (comprising tidal stream, wave energy and tidal lagoons) (OCN);
- Solar photovoltaics (SPV); and,
- Wind energy (WIN) - comprising fixed onshore, fixed offshore and floating offshore turbines.

Applications covered energy generation (heat, power), biofuels production and innovative manufacturing (for example, bio-refineries and the production of SPV modules and wind turbines).

ES1.2 Study approach

Extensive research was undertaken to determine the current SET FOAK investment and funding landscape, as was consultation with three main stakeholder groups:

- European technology sponsors were selected from the EU and European Economic Area. From a pre-qualified list of over 200 sponsors, 52 completed e-survey responses were assessed for relevance and current financing needs. Of these, 41 projects were screened using criteria, which included the scale of funding need, a timetable to operations of four years or less, in addition to an assessment of six types of risk: organisational/shareholder; technological; market conditions / energy policy; environmental regulatory; construction & commissioning; and, operational. Finally, 35 FOAK exemplar projects covering all nine SET sectors between them were shortlisted to

[1] Technology Readiness Levels are defined in Section G of the Horizon 2020 Work programme for 2016-17 available at http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf , p.35

illustrate investment needs, typical financial structures for projects (i.e. combinations of grant funding, equity investment, debt finance, etc.), and market replication potential.

- Financial market participants were drawn from the EU, North America and Japan. Based on a pre-qualified list of 80 investors and/or financiers, who had either an established track record in SET areas or an emerging interest in SET FOAK projects, 80 organisations were shortlisted and approached for consultation. These included: venture capital and private equity firms, retail and investment banks, public banks, engineering and industrial firms, energy utilities, pension funds, insurance companies and sovereign wealth funds. Senior representatives from 29 organisations, many of whom were responsible for deciding on SET/FOAK strategy and decision-making within their organisations, were interviewed in July to October 2015.
- Technology and innovation support schemes at the EU and Member State level were shortlisted in order to identify and map different forms of public sector funding instruments focused on TRL 7-8. Comparable schemes in non-EU countries (e.g. Australia, Canada, Japan and USA) were also analysed to understand how they are delivered and to see whether any practices and experience could be replicated in the EU context. Managers across many schemes were interviewed to understand the effectiveness, efficiency and future development of their respective schemes.

This research was used to reflect on current EU financial support mechanisms and to identify gaps in their provision, so as to generate appropriate policy options. This led to two key financial instruments (FIs) being identified as essential to support grants: equity provision and specialist loans (delivered through the InnovFin Energy Demonstration Projects (EDP) facility).

Further consultations with 15 senior representatives from financial market participants were held in the final stage of the study in February to March 2016 to gain detailed perspectives on the desired scale and character of these two FIs. These consultations also helped to generate market sentiments on which SET sectors were most in need of such support. The two FIs were then subjected to an ex-ante assessment in line with the criteria laid down in the EU Financial Regulation. Although the equity fund option scored slightly higher than the EDP facility, both the equity fund and EDP facility are deemed to be of strategic importance and should be developed in parallel, as complementary interventions.

ES2 Conclusions

ES2.1 The SET FOAK funding challenge and rationale for intervention

Financing is a critical link between innovation and successful commercialisation. However, SET FOAK projects in Europe face tremendous challenges in raising sufficient funding to achieve financial close, achieve construction, become fully operational, and thereby prove to the market the efficient operational performance of leading-edge SET innovations. The scale of finance required for such projects has hitherto failed to be fully recognised by policy makers.

Investment needs to 2020 across all EU SET FOAK projects are substantial, estimated at between €4.0bn[2] and €28.5bn[3] (equivalent to around half of the current SET-Plan need[4]) – see Table ES2.1 – and sectoral investment needs differ widely. For example, the lack of any full-chain CCS FOAK projects in Europe, despite an ambition to have around nine CCS projects funded and operational by 2015, means that just one or two such successfully commissioned projects could help to fundamentally change market sentiment on CCS in the EU; while the deployment of four to five tidal stream arrays could also help to greatly lower risk perceptions for the ocean energy sector.

[2] A minimum size of SET FOAK plant combined with a minimum deployment scenario across all nine SET sectors

[3] For those SET sectors with the highest unmet funding needs, the equivalent figures are €3.0bn to €18.1bn

[4] To address the gaps in the financing of demonstration, deployment and market take up of emerging low carbon energy technologies in relation to the SET-Plan requires at least around €60bn in technology development over the period 2010-2020 across various SET sectors including bioenergy (€9bn); solar PV and concentrating solar power (€16bn), wind (€6bn), CCS (€13 billion) and the electricity grid (€2 billion). Source: JRC, 2013. Joint Research Centre Scientific and Policy Reports R & D Investment in the Technologies of the European Strategic Energy Technology Plan. Brussels, 2.5.2013 SWD(2013) 157 final. Available at: http://ec.europa.eu/energy/technology/strategy/doc/swf_2013_0157_en.pdf

In contrast to this significant future investment need, when measured across both EU support schemes (such as the NER 300 at €2.1 billion) and available through key Member State support schemes, ICF estimates that total current grant, debt and equity provision for FOAK projects at EU and Member State level is around €4 billion. This leaves a public funding shortfall of around €10 billion to achieve maximum levels of FOAK demonstration projects[5].The failure to prove technologies at commercial scale creates large negative consequences. It limits the opportunities to reduce the Levelised Cost of Energy (LCOE) for emerging low carbon technologies in the European energy supply market; it greatly reduces the potential for such technologies to help Europe achieve its climate and energy targets; it impacts on the potential demonstration effect that successful SET FOAK projects would have on the financial markets, both in the EU and globally; and it hinders the growth of a European industrial supply side that can generate economic and social benefits to the European economy. There are therefore clear and compelling reasons to resolve this funding problem.

Table ES2.1 Investment needs across SET sectors

SET sector	Indicative project sizes (EUR M)		EU SET FOAK project deployment needs to 2020		Indicative investment needs to 2020 (EUR M)	Estimate of current unmet funding needs
	Min size of project	Max size of project	Min no of FOAK projects per sector	Max no of FOAK projects per sector		
AEN	10	50	14	28	140 - 1,400	Medium
BIO (2nd gen biofuels)	150	600	5	10	750 - 6,000	High
BIO (energy)	8	100	10	20	80 - 2,000	High
CCS	500	1400	1	2	500 - 2,800	High
CSP	185	330	5	10	925 - 3,300	High
GEO	75	120	3	6	225 - 720	Low
LES	15	350	5	10	75 - 3,500	Medium
OCEAN	20	100	5	10	100 - 1000	High
SPV (generation)	35	50	5	10	175 - 500	Low
SPV (manufacturing)	45	250	3	5	135 - 1,250	Low
WIND (fixed)	50	300	5	10	250 - 3,000	Low
WIND (floating array)	125	300	5	10	625 - 3,000	High
Total			75	149	3,980 - 28,470	

Source: ICF

[5] Analysis is based on a bottom-up aggregation of major funding streams for FOAK project sponsors. Public sector intervention for FOAK projects could reasonably be expected to provide 50% funding, i.e. between €2bn and €14.25bn of the overall investment need range. Grant provision for FOAK is estimated at around €3bn through schemes dominated by NER 300 and France's PIA; loan provision is estimated at less than €500m (€150m via InnovFin's Energy Demo Project (EDP) facility as well as France's PIA's scheme and Germany's KfW provision); and equity provision is estimated at less than €500m (mainly via European Investment Fund into early stage cleantech companies during 2007-13 and now through InnovFin's SME Venture Capital scheme, and France's PIA scheme)

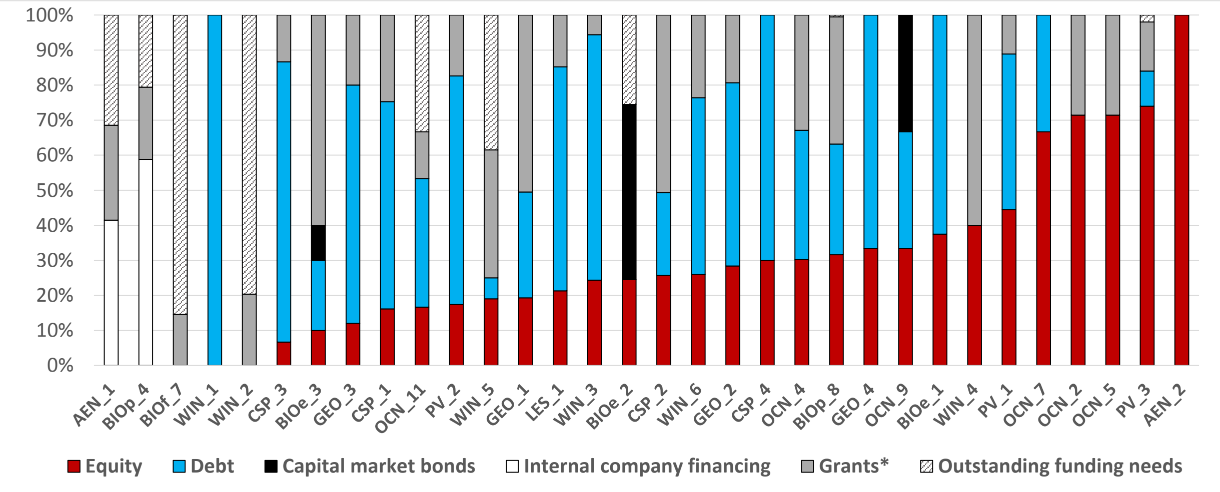
ES2.2 Blending of funding streams to achieve financial close

SET FOAK projects are a very high risk asset class in which there has been limited interest to date from the market, with the exception in some SET sectors of those corporate project sponsors who either have intrinsically linked business interests, such as energy utilities, or are used to investing in innovation as part of their business strategy (e.g. multi-national engineering companies). A major reason for the lack of interest is the vast array of commercial opportunities in the EU and globally to invest and finance proven SET innovations (for example, first generation solar PV, onshore wind, mass burn biomass, etc.). These opportunities are able to deliver required returns to institutions and private investors without carrying much risk, at least from a technological or business perspective[6].

ICF's interviews with banks (investment, retail, universal) found that the use of debt funding is not widely available for SET FOAK projects, i.e. prudent lenders are neither willing nor able to take exposures on projects of unproven debt carrying capacity. One reason is that increasing regulatory and capital adequacy requirements imposed on banks and insurance companies have reduced their willingness to take risk, impacting investment activities which might have otherwise been considered. This reinforces the need for public sector supply of debt.

SET FOAK projects have complex financing needs and large variations in financing structures exist, even within sectors, due to the different technology types, scale, track record of sponsors, etc. (Figure ES2.1)

Figure ES2.1 Forecasted financial structure of projects, organised by amount of equity in the project



Source: ICF survey of European project sponsors, 2015

Financial structures[7] from 32 different sponsors show that:

- grants (i.e. public sector risk capital) play a very important role overall in many SET FOAK deal structures, with projects typically forecasting between 10-30% or much higher amounts in some isolated cases (e.g. for bioenergy, bio-pyrolysis, CSP, geothermal, wind); grants are perceived as particularly important for ocean energy, generally making up the balance with equity and, infrequently, debt;
- equity investment is forecast between 10-30% in many projects, but is particularly high for several solar PV and ocean energy projects while being absent in other projects;
- debt requirements can be very large, varying from 10% of total funding to more than 70%. –Based on sponsor forecasts, the ease with which FOAK projects are perceived to be able to raise debt is highest in the most mature SET sectors, i.e. wind, solar PV and geothermal[8]; although it is also

[6] Markets for most SET innovations are still subject to potentially large political risks

[7] Note that the vast majority of projects when consulted had yet to reach 'financial close', i.e. the point at which contracts are signed and the financial structure of the project is confirmed. FOAK project structures should be therefore regarded as indicative and by no means confirmation that it is possible for the sponsor to actually achieve the stated breakdown of debt, equity, etc.

[8] Geothermal energy is characterised as mature given that the first commercial geothermal power plant started operation in Italy in 1911, although it is recognised that more innovative geothermal approaches are much less mature in the market

perceived to be possible to raise very high levels of debt for CSP projects – in contrast, two ocean energy projects made no reference to debt;

- bond finance is of limited relevance, being hardly mentioned by sponsors[9], as is true for internal company financing; and,
- outstanding funding needs either indicate shortfalls in funding which may stall a project or else non-disclosure of key aspects of the financial structure (such as expectations of feed-in tariffs).

ES2.3 Market conditions which impact on the SET FOAK funding "landscape" include resource availability, regulatory frameworks and supply chains

Several market conditions which generate positive framework conditions for funding FOAK projects were identified, including:

- Resource availability, such as a viable ocean energy resource in the North West of Europe and excellent solar radiation across the Mediterranean to benefit CSP.
- Well-designed planning and permitting systems, established supply chains, testing/demonstration centres and greater public acceptance, are more likely to be in place where high penetration rates already exist, as with Solar PV, (onshore) Wind and Bioenergy. This creates more optimal market conditions for FOAK projects.
- Stable and predictable systems of fiscal support have a positive signalling effect to potential investors/financiers of FOAK projects since they help to accelerate deployment of technically proven and early commercial technologies. Renewable energy plants are often given priority in terms of network access and dispatch of generated electricity where fiscal support is provided.
- Consistent and supportive policy framework, including ambitious future capacity targets in National Renewable Energy Action Plans (NREAPs), plays a crucial role in fostering new developments for sectors where limited or no market deployment exists (e.g. CCS, Geothermal, LES and Ocean energy) as well as for sectors with a high level of market deployment (e.g., biomass conversion technologies).
- New European state aid regulations for energy and R&D are likely to have a positive influence on FOAK funding. For example, Member States can provide support to new innovative production plants for novel biofuels or bio-refineries; and operating and investment aid are permitted to support industrial installations equipped with CO_2 capture, transport and storage facilities.

At the same time, substantial market failures and barriers are known to inhibit investment and financing of FOAK projects, either structurally, at a macro-economic level; and/or on the demand side, impacting on investment decisions; and/or within the supply side, especially in nascent and emerging supply chains where there is often insufficient incentive to invest in new innovations, not least because of uncertain returns.

Barriers also include sub-optimal investment situations, in which the market is not interested in supporting FOAK projects (despite there being a positive economic rate of return) or where projects that are in principle bankable (i.e. can generate a positive internal rate of return, IRR), find that the finance or investment is inadequate because of a project's inherent uncertainty or underlying risk structure.

Across the EU, market conditions for SET FOAK projects vary significantly by country and SET sector. This creates a complex landscape, making it challenging to analyse and draw meaningful conclusions about any one country's role in supporting FOAK projects, especially since the SET policy environment is constantly evolving. In general, across all SET sectors and countries, the outlook can be taken as generally neutral, although in several sectors such as bioenergy, ocean and wind energy there are a number of markets demonstrating a more positive outlook; and there is at least one Member State - and more typically two or three – for each SET sector which are deemed to have positive conditions for FOAK projects.

[9] Bond finance is generally only available to refinance bank loans post-completion. It is possible that these project sponsors have insufficient knowledge as to where bond finance is most applicable and made assumptions about its potential

Overall, framework conditions play a crucial role in helping to persuade or dissuade funders from committing to FOAK projects in different EU Member States. Where these conditions are not working optimally, any resulting negative impacts must be mitigated through public sector interventions.

ES2.4 Scale of the prize for supporting SET FOAK projects in the EU

Market replication is the prize for public support of SET FOAK projects. Replication will help to unlock capital flows from the private sector and allow such innovations to become firmly established in the market. It will bring considerable economic and environmental benefits to the EU economy, such as increased investment, employment and global export opportunities. It will also contribute to the fulfilment of carbon reduction policies and enhanced energy security.

Successful FOAK projects can achieve large future sales. Based on a survey of European FOAK project sponsors, the study found that 20 typical FOAK projects, covering eight SET sectors, required total investment costs of €1.8 billion. Potential maximum returns from successful deployment of all these projects was estimated by sponsors at €6.2 billion after two years (a multiple of over 3 times), rising to €26.9 billion after five years (a multiple of 15 times)[10]. Such figures indicate the potential rewards from concerted action to effect change in the FOAK funding landscape.

Technological successful and cash-flow positive SET FOAK projects also create a more positive profile for this high risk asset class. This will attract more market participants into the commercialisation 'Valley of Death' over the long-term: a crucial step forward for enabling EU innovations to be brought to market more successfully. This in turn will help the EU to fulfil the strategic objectives of a future integrated Strategic Energy Technology Plan (SET-Plan)[11].

ES2.5 Role of the public sector

The public sector plays a vital role in funding FOAK projects at EU and Member State level, mainly through grant support, whereas loans are only used in some schemes, including the recently established InnovFin Energy Demo Project (EDP) debt facility[12] and the French 'Investments for the Future' programme (PIA). Despite its prolific usage, grant provision, especially at Member State level, is often not large enough to adequately support SET FOAK project funding requirements. A further potential complication for grant support is that the time period from feasibility to operation for FOAK projects may be very long – potentially up to 10 years - making them challenging to align with public sector programme timescales. This has been seen in many projects within the NER 300 programme and at Member State level in the UK's Marine Energy Array Demonstration programme[13].

Potential funding shortfalls in key Member States are also in evidence as a result of the:

- Closure of support schemes;
- Re-orientation of schemes away from SET FOAK towards proven energy technologies;
- Re-orientation of schemes away from energy (towards, for example, digital technology); and,
- Potential uncertainty for schemes reliant on private-sector co-financing.

Table ES2.2 provides a high level summary of availability for different funding streams (i.e. grants, equity, debt) across SET sectors. A few of the more established SET sectors, such as biomass, SPV and wind, are generally well served with high availability of both grants and equity, in contrast to emerging sectors such as CSP, Geothermal, LES and Ocean. Debt has mixed availability across territories and SET sectors. CCS is particularly poorly served in the current funding landscape, not least due to the enormous costs of projects which often fall outside the funding thresholds of many support schemes.

[10] Sales forecasts assume all projects become operational at the same time and that project sponsors experience no impediment in delivering their business plans. Given the very high risk nature of FOAK projects, these forecasts only represent an idealised indicator of potential market replication and take no account of failure rates.

[11] C(2015) 6317 final, *Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation*, September 2015 https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v8_0.pdf This Communication provides a stock take of success under the current SET Plan and identifies ten priority actions to accelerate the energy system transformation in Europe which need to be discussed with Member States and stakeholders.

[12] *http://www.eib.org/attachments/documents/innovfin_energy_demo_projects_flysheet_en.pdf*

[13] Siemens had to pull out of the Skerries Project in Wales for this reason

The overall funding provision for FOAK projects, while certainly positive for projects in mature SET sectors (e.g. SPV, Wind) and in more established Member States (e.g. France, Germany, Sweden, UK), could be enhanced in other SET sectors and Member States.

For private financial market participants, the funding situation for FOAK projects is sub-optimal; and there are few incentives (such as risk-sharing mechanisms) to become more closely involved.

Table ES2.2 Summary of availability of funding sources for SET FOAK projects

	AEN	BIOMASS	CCS	CSP	GEO	LES	OCEAN	SPV	WIND
Suitable funding structures for SET FOAK projects:									
	Equity & grant: not lending risk	Equity & grant: availability of debt depending on technology types	Equity & grant, but to date no full-scale precedents. Debt will be needed, but availability highly uncertain	Equity, grant & debt: lender caution, as some precedents have failed	Equity, grant: lender caution, as few sectoral & regional precedents. Insurance used to cover drilling risks	Equity & grant: lenders uncertain of some technologies (not pumped storage) plus demand & business case	Equity, grant and debt: very limited as some precedents have failed, but tidal farms will need debt support	Equity, grant & debt: lender caution, as some precedents have failed	Equity, grant & debt: lender caution and some projects are very high value, requiring significant funds
Equity	✓	✓✓		✓	✓	✓	✓	✓✓	✓✓
Debt (loans)		✓		✓	✓	✓	✓	✓	✓
Grants	✓✓	✓✓	✓	✓	✓	✓	✓	✓✓	✓✓

Availability of options:

✓✓	*High availability across Member States*	✓	*Medium availability (e.g. some Member States)*		*Limited or Unavailable*

Source: ICF

ES2.6 Reasons for failing to achieve a Final Investment Decision

Many SET FOAK projects, across various sectors, are unable to achieve a Final Investment Decision (FID) or financial close. The study identified several reasons for this impasse:

- A number of potential 'showstoppers' (high risks) can cause a project to stall or fail if not adequately tackled by experienced project managers.
- Despite a number of EU and Member State support schemes offering mainly grants (and some limited loan provision) to innovators, the scale of funding on offer at the project level is often insufficient. A large part of the problem is that few EU and Member State support schemes explicitly target the commercialisation 'Valley of Death' (i.e. TRL 7-8). The exceptions are the EU's NER 300 programme (grants) and the recently introduced EDP facility (specialist debt). However, the former scheme has only managed to date to achieve 3 operational projects from 39 awards; the latter currently has just €150 million with which to act across the entire FOAK market.
- Traditional investors in FOAK projects either have reduced their interest in this asset class for strategic reasons (e.g. corporate engineering companies) or else cannot simply afford to fund such projects off their balance sheet (e.g. energy utilities) and require project financing. This has not only reduced an important stream of both equity and debt, but exposed such FOAK projects to outside financial parties who do not have the same risk appetite for such deals.
- The neutral, or sometimes negative, market conditions in some SET sectors and within certain Member States (see above) will do little to convince funders to back FOAK projects in such jurisdictions.

ES2.7 Helping to close the SET FOAK funding gap

Without adequate funding, there is a clear threat that the EU's leading-edge SET innovations will not progress from demonstration to commercial status to the extent desired; and the anticipated contribution that such innovations will make to achieving EC climate and energy policy objectives will be impacted greatly. This is likely to lead to increased costs of fulfilling policy objectives and economic leakage as the EU becomes less competitive.

There is an over reliance on grant support across EU and Member State schemes, even though grants alone are insufficient to meet the funding needs of the plethora of SET FOAK project types.

Achieving successful SET FOAK projects in the EU requires:

- Scale of response, i.e. support is delivered quickly, given fast-approaching policy goals;
- Sensitivity to individual project circumstances; and
- “Crowding in” of market participants at Member State and EU level.

All Market Participants consulted in this study felt that the European Commission should provide equity to support FOAK projects. Most also felt debt should be made available. For Specialist Investors, debt could be made available as mezzanine and low-interest loans; for Banks, debt could be made available as bridging finance. Further grant provision was also widely called for, both for feasibility and construction phases of FOAK projects, which enable project sponsors to overcome important initial funding needs which are often stumbling blocks to successful project implementation.

Financial instruments (FIs) can catalyse investment and finance from the private sector into SET FOAK projects, assuming they are cost efficient and are designed in a way to incentivise private actors and ‘crowd in’ funding (e.g. through first-loss mechanisms). FIs can also enable increased investments to flow through the European Fund for Strategic Investments (EFSI) as well as other financing mechanisms.

The addition of equity and debt provision creates greater options for policy makers to tailor funding most efficiently to market need, and create more sustainable funding mechanisms, as follows:

1. Equity provision - corporate sponsors are a key constituent party in the supply of equity, but utilities no longer have money to spare for such innovation funding, and major engineering companies are highly selective about what they sponsor. While levels of equity provision delivered into the European venture capital (VC) and lower mid-market private equity space by the European Investment Fund (EIF) are enormous (making the EIF the de facto largest VC and private equity (PE) investor in the EU), this equity is mainly providing early stage and expansion capital into high growth companies on a *pari passu* basis, delivered via equity funds. EIF does not provide equity into project financing vehicles, nor does it offer such equity for individual final beneficiaries (i.e. project sponsors) at the scales required by SET FOAK projects. Most importantly, equity is not offered with a first-loss covered by the European Commission which is what financial market participants believe should be on offer in a new European SET FOAK equity fund in order to ‘crowd in’ private investment. Levels of equity provision need to be sufficient to support at least 10 to 20 FOAK projects. The Fund and its manager should take a hands-on and proactive approach to managing the whole project cycle alongside sponsors, from identification to selection and trouble-shooting/remedial action after financial close, which would also include delivery and completion, commissioning and operations.
2. Loan provision - the recently established EDP debt facility, operated by EIB, has got off to a good start in raising its profile to FOAK sponsors, by attracting over 70 enquiries. It has signed its first loan (to an ocean energy project in Portugal) and has four further FOAK projects in advanced stages of screening and due diligence. By offering specialist loans that most private sector debt providers simply cannot provide, the EDP facility is filling a gap in the market. It is structured with a first-loss piece which allows the facility to take on more of the risk than other debt providers. However, the current size of the facility needs to be increased, both to enable at least 10 to 20 FOAK projects, across different SET sectors, to be supported.

Overall, both the proposed Equity Fund and existing EDP facilities appear to suit well the needs of the market and help provide the necessary equity and debt that is required for SET FOAK projects. Indeed, there is clear complementarity between the two mechanisms such that combining both instruments could enhance their overall effectiveness in the market.

To ensure full coverage of FOAK funding and support needs, EU action is also required in supplying:

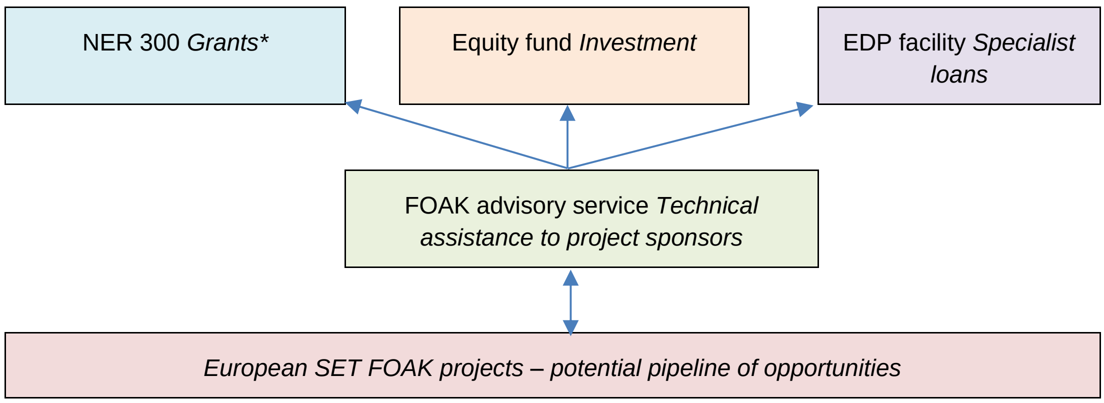
3. Grant funding – this needs to be targeted at SET sectors where risks are greatest, i.e. where technologies are further from market, including at TRLs prior to the ‘Valley of Death. It is also needed at the early stages in the life of a FOAK project to help sponsors to overcome critical funding shortfalls (since few other funders have interest at this stage) in order to achieve key

milestones such as Front-end Engineering and Design (FEED) studies and planning and permitting.

4. A SET FOAK Advisory Service, comprised of sector experts, is required to help innovators and sponsors to navigate and advise on the most appropriate funding and support channels at EU and Member State level. This would have the benefit of helping to facilitate a FOAK project pipeline in the EU. Current support is provided by the Innovation Finance Advisory Service and European Investment Advisory Hub (EIAH)[14]. These are mechanisms supporting project promoters to enhance their access to financing for their projects. For this purpose, Innovation Finance Advisory Service offers access to finance advisory, while the EIAH acts as a single access point to a broader array of advisory services across the entire project cycle.

A combination of EC-backed debt and equity facilities, supported by upfront grant funding and project-specific expert advice (see Figure ES2.2), would help different project types to access the most suitable forms of funding, since each offers a different form of funding support.

Figure ES2.2 Future SET FOAK project sponsors might benefit from a more integrated EU service offer



*Source: ICF. *Note: the use of financial instruments are to be explored under the Innovation Fund*

Creating more formal linkages between Member State and EC schemes may help to maximise limited Member State R&D budgets in the future. This is an important finding because it suggests that national funding schemes to support late stage R&D need to be set up (and receive state aid clearance) in such a way that can allow FOAK projects to be funded appropriately, if it is deemed to be of significant economic benefit to the Member State. The risk of not having such a connection is that technology developers with potentially game-changing innovations may be unable to qualify for a national scheme that can meet their demonstration funding needs and also not be sufficiently aligned with EC schemes which might have helped to plug the finance gap.

Encouraging Producers and VC/PE funds to become more interested in FOAK project investment is likely to require various mutually-reinforcing approaches, including:

- Greater awareness of technological development needs;
- Improved connectivity across technology developers, producers and supply chains;
- More successful sector precedents to build confidence;
- Advice on appropriate deal structuring – perhaps from experienced investors who can mentor others with limited sector expertise; and,
- Appropriate financial incentives to provide rewards for taking on elevated risk levels, including equity investment structures that allow syndication on deals within an overall portfolio of FOAK projects.

[14] A joint-initiative by the European Commission and the EIB to respond to the Second Pillar of the Investment Plan for Europe

ES2.8 Good practices from current EC and Member State schemes which could improve the effectiveness and efficiency of FOAK support schemes

ES2.8.1 Fundamental scheme principles are important for ensuring credibility

To be effective, any new FI at either the EC or Member State level, must try to adhere to some fundamental principles including:

- Having clear strategic and operational objectives;
- Being financially large enough to have market presence and credibility;
- Having transparent eligibility criteria;
- Being flexible enough to deal with different SET sectors and different scales of project;
- Having financing mechanisms which allow greatly flexibility to attract potential private co-financiers/investors;
- Having sufficient support, from different stakeholder groups, including economic and environmental regulators if necessary, to have visibility; and,
- Ensuring that operational costs from scheme delivery do not represent too great a percentage of overall costs.

ES2.8.2 The application and project monitoring process is critical to achieving strong market uptake and robust projects being funded

Some examples of good practice from our review of support schemes include:

- Ensuring clear guidance and supporting project applicants during the application and development stage is often financially worthwhile as it will greatly help to reduce poorly developed proposals and should increase the success rate significantly;
- Having a two-stage application process can create efficiencies for both applicants and fund managers and help to filter out weaker projects at an early stage;
- Ensuring project ideas are both technically and financially assessed in a thorough and robust manner, in order to identify which innovations would most likely fail under market circumstances;
- Having close technical, financial and political support throughout project implementation to create incentives, even for bigger companies, to support high risk FOAK projects;
- Employing highly qualified staff in the responsible funding scheme administration for assessing and supporting bid applicants and project sponsors; and,
- Mechanisms to help improve the knowledge of financial market participants regarding new technologies, SET areas and successful FOAK project exemplars, will help both to improve confidence in market opportunities and lower risk perceptions.

ES2.8.3 Non-EU support schemes provide useful lessons for tackling FOAK project funding

Observations from other schemes include:

- Ensure there is long-term political commitment – this is important to create the right market ‘signals’ and ensure that the scheme ‘beds down’ and achieves market branding and credibility;
- Adopt a very strategic market focus to understand the nature and scale of market opportunities for proposed technologies which are to be supported. This helps to reduce potentially wasteful investments on ‘dead-end’ innovations which will be difficult to bring to market;
- Commit sufficient resources to the challenge - any scheme specifically designed to target FOAK projects in the EU should have a minimum budget size that gives it the ability to support a large number of FOAK projects, rather than being limited to a handful;

- Work with industrial companies and the venture investment community at the earliest opportunity – this can increase the visibility of new innovations and help increase levels of "buy-in" to investment propositions (rather than coming 'to the table' late which can increase investor perceptions of risk);
- Adopt strict procedures for 'dropping' failing projects that are not delivering against their objectives is prudent, as is having robust clawback provisions which are well-defined in order to avoid any funding commitments to projects that cannot move forward;
- Working with the public and private sector to ensure a continuum of funding is on offer for the most promising innovations can avoid potential funding gaps in the commercialisation pathway;
- Be strategic about which SET technologies to target and identify early on where FOAK project support is going to yield large economic value for the EU and will enhance EU supply chains; and,
- Build a robust monitoring and evaluation framework – this will enable project outcomes and impacts to be determined. Being able to measure the overall success and value of the intervention is vital to demonstrating long-term value to stakeholders and their continued financial support for the policy objective.

ES3 Recommendations

Recommendation 1: Increased visibility of SET FOAK projects and their sponsors

DG RTD should work closely with DG Energy in their efforts to undertake a comprehensive mapping of SET FOAK projects and to enhance the understanding as to why such projects may not have progressed beyond the TRL 7-8 stage. This will help to build the evidence base for expanding debt and equity provision, as well as yielding case studies of successful financing, demonstration and market replication.

Recommendation 2: Overall EC provision for SET FOAK projects

DG RTD should explore the potential for a more integrated and seamless EU offer to SET FOAK project sponsors (i.e. a "one-stop shop", comprising debt, equity, grant support and any modifications to the current provision of advisory services being delivered by EIB) in order to satisfy market need.

Recommendation 3: Equity provision

The concept of a SET FOAK Equity Fund should be further explored in detail, as there is a clear need for more equity provision for FOAK projects in the EU. Based on market soundings, an initial fund size of €250 million to €500 million should be explored. This level of funding is likely to have a sufficient impact on the market with sponsors and others; it is also at a scale where recruitment and retention of high calibre staff will be possible.

Since it is outside the study Terms of Reference to examine in detail how such a Fund might work, further research should also examine:

- the corporate and institutional structure for such Fund;
- the aims, objectives and investment criteria for such Fund, including investment horizons and divestment, and mechanisms for market penetration;
- where, how and under what regulation, accountability and control such a Fund be set up;
- the level of regulation that is applied to equity investment advice and fund management; and,
- the required qualifications and experience of staff participating in such activity.

Recommendation 4: Specialist debt provision

DG RTD should consider increasing the size of the EDP facility from €150 million (for 2016/17) to at least €250 million, and ideally €500 million, in order to offer specialist debt provision to FOAK projects at a scale that will cater to different project types and sectors. Other mechanisms should also be explored in order to allow the facility to cater to increased numbers of projects. These mechanisms could include reducing the first-loss coverage to less than the current 95% or examining whether the date of release for the guarantee on projects could be achieved sooner.

Recommendation 5: Grant provision

DG RTD should work closely with DG CLIMA to scope the new Innovation Fund in order to ensure that grant provision for SET FOAK projects is sufficiently well adapted to the needs of project sponsors. This includes identifying the key project milestones where grant support would make the most impact for sponsors in advancing their projects, up to and including Financial Close and potentially the construction phase. This recommendation arises, in particular, from the ICF analysis of SET project risks, which shows that the main ‘showstoppers’ occur at or before Financial Close.

Recommendation 6: Advisory services for SET FOAK project sponsors

DG RTD should consider the current provision of advisory services at the EU level to assist SET FOAK project sponsors to plan and design their projects, including finding the most appropriate funding structures to use. This will accelerate project development and catalyse a community of interest across the EU in SET FOAK projects. DG RTD should consider the existing provision of advisory services, Innovation Finance Advisory and the European Investment Advisory Hub, and assess what reinforcements and adjustments may be necessary in order to provide the desired dedicated service to SET FOAK projects.

Sommaire exécutif

ES1 Introduction

Réalisée pour le compte de la DG Recherche et innovation, cette étude porte sur le rôle des instruments financiers dans le soutien aux projets européens inédits (« First of a kind » ou FOAK) de démonstration à l'échelle commerciale de certaines technologies du Plan stratégique européen pour les technologies énergétiques (Plan SET), dits les projets SET FOAK . Elle a été menée par ICF, en association avec London Economics, entre mars 2015 et juin 2016.

Les objectifs sont les suivants :

- décrire et quantifier les besoins en matière d'investissement, ainsi que les obstacles aux investissements dans ce secteur ;
- identifier et analyser l'état du marché et les facteurs qui affectent l'emprunt et l'investissement dans les projets SET FOAK, ainsi que les besoins en matière d'intervention publique au niveau de l'UE ; et
- formuler les différentes options en termes de politiques publiques, y compris les instruments financiers visant à supprimer les obstacles au financement et à l'investissement.

Plus généralement, cette étude cherche à réduire les disparités d'information entre les développeurs et les acteurs du marché, en proposant des réponses politiques adaptées pour soutenir les projets SET FOAK dans l'Union européenne.

ES1.1 Objet de l'étude

Cette étude porte sur les projets SET FOAK ayant atteint un niveau de maturité technologique (TRL)[15] de 7 ou 8 et utilisant une technologie relevant d'un des secteurs de l'actuel Plan stratégique pour les technologies énergétiques (Plan SET).

- réseaux électriques performants (Advanced Electricity Networks, « AEN »)
- technologies de conversion de la biomasse (seconde génération) (« BIO »)
- capture et stockage de carbone (Carbon Capture & Storage, « CCS »)
- énergie solaire à concentration (Concentrating Solar Power, « CSP »)
- géothermie (« GEO »)
- solutions de stockage d'énergie à grande échelle (y compris les centrales hydroélectriques de pompage-turbinage) (Large Scale Energy Storage, « LES »)
- énergie des océans (hydrolienne, houlomotrice) (« OCN »)
- solaire photovoltaïque (« SPV »)
- éolien (« WIN ») comprenant l'éolien terrestre, l'éolien offshore fixe, et l'éolien offshore flottant

Les projets couvrent tout aussi bien la production d'énergie (chaleur, électricité), la production de biocarburants ainsi que l'industrie innovante (par exemple, les bio-raffineries, la production de module pour le solaire photovoltaïque et turbines éoliennes).

ES1.2 Méthodologie

En parallèle de recherches approfondies, la consultation de professionnels actifs dans les trois secteurs principaux du marché a permis d'appréhender la situation actuelle de l'investissement et du financement de projets SET FOAK en Europe.

- Des promoteurs de technologies ont été sélectionnés au sein de l'Union européenne et de l'espace économique européen. Sur un total de plus de 200 promoteurs pré-qualifiés, 52 réponses à l'enquête menée en ligne, dument complétées, ont été évaluées selon leur pertinence et les besoins financiers des projets étudiés. Parmi celles-ci, 41 projets ont été sélectionnés d'après

[15] Niveau de maturité technologique (Technology Readiness Levels) comme définis dans la section G du Programme Horizon 2000 pour 2016-2017 disponible en ligne : http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf , p.35.

plusieurs critères tels que le niveau de financement nécessaire, un délai avant le début des opérations n'excédant pas quatre ans, et une évaluation des six types de risques suivants : organisationnel/ actionnaire, technologique, marché, politiques énergétiques, régulation environnementale, construction et mise en service et risque opérationnel. Enfin, 35 projets SET FOAK exemplaires couvrant les neuf secteurs du plan stratégique pour les technologies énergétiques (SET) ont été retenus afin d'illustrer les besoins en matière d'investissement, les structures financières typiques (par exemple, des combinaisons de subventions, investissement de capitaux, dette, etc.), ainsi que leur potentiel de reproduction sur le marché.

- Plusieurs acteurs du marché ont été contactés en Europe, en Amérique du Nord et au Japon. Sur une liste d'investisseurs et financiers, 80 organisations ont été sélectionnées et approchées pour la phase de consultation. Certaines sont bien établies dans le secteur des énergies durables, d'autres n'ont qu'un intérêt croissant pour le secteur. Il s'agit donc de fonds d'investissement en capital-risque, banques de détail et banques d'investissement, sociétés d'ingénierie, d'industries et de services, fonds de pension, compagnies d'assurance et fonds souverains. Vingt-neuf représentants seniors de ces organisations, dont la plupart sont responsables en matière de stratégie dans le domaine des projets FOAK et preneurs de décision au sein de leurs organisations respectives, ont été interrogés dans le cadre de cette étude entre juillet et octobre 2015.
- Des mécanismes de soutien à l'innovation aux niveaux européen et nationaux ont été sélectionnés afin de dresser une cartographie complète des différentes formes d'instruments de financement publics pour les projets de niveau de maturité technologique (TRL) 7-8. Des dispositifs comparables mis en place dans des pays tiers (Australie, Canada, Etats-Unis et Japon) ont également été analysés de façon à penser une possible mise en œuvre de certaines de ces bonnes pratiques au sein de l'Union européenne. A cet égard, des responsables de plusieurs de ces mécanismes ont été interrogés dans le but de mesurer l'efficacité et les perspectives de développement de ces dispositifs.

Cet état des lieux permet de réfléchir sur les mécanismes de soutien financiers utilisés actuellement en Europe et d'identifier leurs lacunes, afin de générer des réponses appropriées en termes de politiques publiques. Deux instruments financiers clés ont été identifiés comme essentiels dans le soutien aux promoteurs : la mise à disposition de capitaux propres (« equity ») et des prêts spéciaux de type EDP.

Lors de la phase finale de l'étude, 15 représentants seniors issus d'organisations d'acteurs du marché issus du domaine financier ont été interrogés en février et mars 2016 afin de déterminer une échelle et le caractère que devraient revêtir ces deux instruments financiers. Ces consultations ont également permis de mettre en lumière les secteurs ayant le plus besoin de soutien. Les deux instruments ont ensuite été sujets d'une évaluation ex-ante, selon les critères fixés par la régulation financière européenne. Bien que l'instrument fonds-propres bénéficié d'un score légèrement meilleur par rapport à l'instrument emprunt, ces deux outils sont considérés comme étant d'importance stratégique pour garantir les besoins de financement des projets SET FOAK, et doivent être développés en parallèle, comme deux interventions complémentaires.

ES2 Conclusions

ES2.1 Le défi du financement des projets SET FOAK et les raisons justifiant une intervention publique

Le financement est un lien essentiel entre l'innovation et la commercialisation. Cependant, les projets SET FOAK européens ont d'énormes difficultés à lever les fonds nécessaires pour permettre leur clôture financière, leur construction et mise en œuvre, et donc peinent à prouver leur performance opérationnelle sur les marchés. L'ampleur des investissements requis pour de tels projets n'a jusqu'ici toujours pas été reconnue par les décideurs politiques. Les besoins en matière d'investissements pour les projets SET FOAK d'ici 2020 sont estimés entre €4.0 Milliards[16] et €28.5 Milliards[17] (ce qui

[16] La taille minimum d'une usine combinée à un scenario de déploiement minimum à travers les neuf secteurs SET.

[17] Pour les secteurs SET qui manquent le plus de financement, les chiffres sont de €3 Milliards à €18.1 Milliards.

équivaut à environ la moitié des besoins du plan SET[18]) et ces besoins varient beaucoup selon les secteurs. Par exemple, malgré l'ambition d'avoir en Europe environ neuf projets de capture et stockage de carbone financés et opérationnels d'ici 2015, il n'existe aucune chaine complète de projet dans ce domaine. Un ou deux projets commandés pourraient changer le sentiment des marchés à l'égard de ce secteur en Europe. De la même manière, le déploiement de quatre ou cinq dispositifs de production d'énergie houlomotrice pourrait grandement aider à diminuer la perception du risque pour le secteur des énergies produites par l'océan.

En contraste avec ces besoins, ICF estime que la totalité du financement disponible – en termes de subvention, emprunt et fonds propres (« equity ») pour les projets FOAK au niveau européen (à travers des outils comme NER 300 a €2.1 Milliards) et au niveau des états membres – atteint €4 Milliards. Cela laisse un déficit de financement d'environ €10 Milliards pour atteindre le niveau maximum de projets de démonstration FOAK[19]. L'échec de certaines technologies à s'établir commercialement entraine des conséquences négatives importantes. Cela limite en effet les chances de réduire le cout normalisé de production de l'énergie des technologies à faible intensité carbonique sur le marché de production énergétique européen ; cela réduit le potentiel de ces technologies à contribuer aux objectifs européens de climat et d'énergie ; cela limite le potentiel de démonstration que des projets innovants ayant réussi pourraient avoir sur les marchés financiers, en Europe et dans le monde ; enfin, cela entrave la croissance d'une offre industrielle européenne susceptible de créer de nombreux bénéfices économiques et sociaux sur son territoire. Il y a donc des raisons claires et convaincantes de résoudre cette question de financement.

[18] Répondre aux besoins de financement de démonstration, déploiement et mise sur le marché de technologies énergétiques à faible intensité carbonique émergentes, en relation avec le Plan SET, requiert une somme d'au moins €60 Milliards en matière de développement technologique sur la période 2010-2020 à travers tous les secteurs SET, notamment le secteur de la bioénergie (€9 Milliards) ; solaire photovoltaïque et énergie solaire à concentration (€16 Milliards) ; éolien (€6 Milliards) ; capture et stockage de carbone (€13 Milliards) ; et réseau électrique (€2 Milliards). Source ; JRC, 2013. Joint Research Centre Scientific and Policy Reports R&D Investment in the Technologies of the European Strategic Energy Technology Plan. Bruxelles, 02/05/2013 SWD (2013) 157 final. Disponible en ligne: http://ec.europa.eu/energy/technology/strategy/doc/swf_2013_0157_en.pdf

[19] Cette analyse se fonde sur l'agrégation de sources de financement majeures pour les promoteurs de projets FOAK. Une intervention publique pourrait raisonnablement couvrir 50% du financement, soit entre €2 Milliards et €14 Milliards sur le champ des besoins en investissement. Les subventions destinées aux projets FOAK sont estimées à environ €3 Milliards, bien que dominées par le programme NER300 et les Programmes d'Investissements d'Avenir (PIA), les emprunts sont estimés à moins de €500M (€150M via InnovFin's Energy Demo Project (EDP) ainsi que le mécanisme français des PIA, et celui de l'Allemagne via KfW) ; les fonds propres ou equity mis à disposition sont estimés à moins de €500M (principalement par l'intermédiaire d'investissements du Fonds d'Investissement européen dans des compagnies du secteur des Cleantech entre 2007 et 2013, et maintenant via le mécanisme de capital-risque de InnovFin's à destination des PME, ainsi que les PIA Français.)

Table ES2.1 Besoins en investissement dans les secteurs SET pour les projets SET FOAK

Secteur SET	Taille indicative du projet (EUR M)		Besoins de développement de projets FOAK SET d'ici 2020		Besoins indicatifs en investissements d'ici 2020 (EUR M)	Estimation des besoins de financements non satisfaits
	Taille min du projet	Taille max du projet	Nombre min de projets FOAK par secteur	Nombre max de projet FOAK par secteur		
Réseaux électriques performants	10	50	14	28	140 - 1,400	Moyen
Conversion biomasse (seconde génération)	150	600	5	10	750 - 6,000	Important
Biomasse (énergie)	8	100	10	20	80 - 2,000	Important
Capture et stockage de carbone	500	1400	1	2	500 - 2,800	Important
énergie solaire à concentration	185	330	5	10	925 - 3,300	Important
Géothermie	75	120	3	6	225 – 720	Faible
Stockage d'énergie à grande échelle	15	350	5	10	75 - 3,500	Moyen
Océan	20	100	5	10	100 - 1000	Important
solaire photovoltaïque (production)	35	50	5	10	175 - 500	Faible
solaire photovoltaïque (industrie)	45	250	3	5	135 - 1,250	Faible
Eolien (fixe)	50	300	5	10	250 - 3,000	Faible
Eolien (flottant)	125	300	5	10	625 - 3,000	Important
Total			75	149	3,980 - 28,470	

Source: ICF

ES2.2 Combinaison de mécanismes de financement pour atteindre la clôture financière

Les projets SET FOAK constituent une catégorie d'actifs particulièrement risquée qui a suscité jusqu'à présent assez peu l'intérêt du marché, à l'exception, pour certains secteurs SET, de ces projets portés par des entreprises dont les intérêts sont intrinsèques au secteur comme les fournisseurs d'énergie, ou bien des compagnies dont l'investissent dans l'innovation fait partie de leur stratégie (comme les compagnies d'ingénierie multinationales). L'une des raisons principales de ce manque d'intérêt est le large éventail d'opportunités qui existe en Europe et dans le monde pour investir et financer des innovations dans les secteurs SET pour des technologies matures (par exemple la première génération de solaire photovoltaïque, l'éolien terrestre, la combustion de biomasse, etc.) Ces opportunités offrent en effet les retours sur investissements exigés aux institutions et investisseurs privés tout en limitant le risque d'un point de vue technologique et commercial[20].

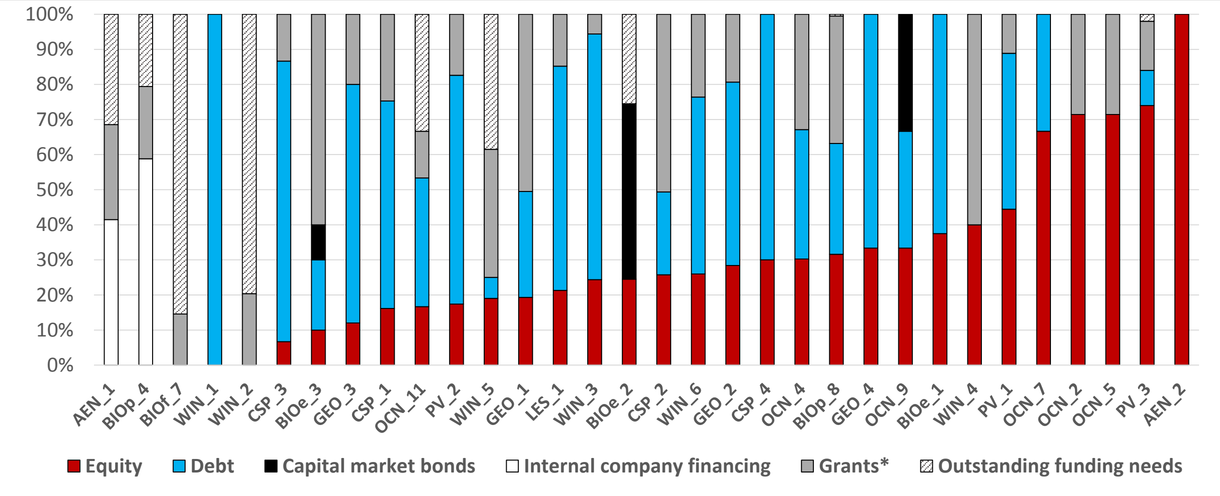
Les entretiens menés avec des acteurs du secteur bancaire (banque d'investissement et de détail, banque universelle) montrent que la dette n'est pas largement disponible pour les projets SET FOAK. Prudents, les créanciers ne souhaitent ou ne peuvent s'exposer sur des projets dont la capacité d'endettement n'est pas prouvée. L'une des raisons est l'augmentation de critères réglementaires et critères d'adéquation des fonds imposés aux banques et aux compagnies d'assurance, qui a pour

[20] Les marchés pour la plupart des innovations SET sont toujours sujets à d'importants risques politiques.

conséquence de réduire leur volonté de prendre des risques, causant un impact sur les activités d'investissement qui auraient pu être considérées dans un autre cadre. Cela renforce le besoin d'un instrument d'approvisionnement en emprunt du secteur public.

Les projets SET FOAK ont des besoins financiers complexes, qui varient beaucoup du point de vue de leur structure de financement, même au sein d'un même secteur, selon les différents types de technologie, la taille des projets, les performances antérieures des porteurs de projet, etc. (voir la Figure ES2.1).

Figure ES2.1 Projection de la structure financière des projets, en volume de capitaux propres



Source: Enquête sur les promoteurs de projets en Europe, ICF, 2015

L'étude de la structure financière[21] de 32 projets montre que :

- Les subventions (capital à risque du secteur public) jouent un rôle très important pour beaucoup de structures de deal concernant au projet SET FOAK, car les projets prévoient typiquement entre 10% et 30% de subventions, voire même des montants beaucoup plus élevés dans certains cas, comme pour la bioénergie, la bio-pyrolyse, l'énergie solaire à concentration, la géothermie et l'éolien. Les subventions sont perçues comme particulièrement importantes dans les projets de développement de l'énergie des océans, dans lesquels elles sont présentes avec des capitaux propres et plus rarement, de la dette.
- Le financement par moyen de capitaux propres est prévu de représenter 10% à 30% du financement du projet pour de nombreux projets. Il est particulièrement important pour certains projets, particulièrement dans les secteurs du solaire photovoltaïque et de l'énergie des océans, alors qu'il peut être complètement absent sur d'autres projets.
- Les besoins d'emprunt peuvent être très importants, de 10% à 70%. Selon les prévisions des promoteurs, la capacité à contracter de la dette apparait plus facile pour les promoteurs dans les secteurs SET dont les technologies sont plus matures, comme l'éolien, le solaire photovoltaïque et la géothermie[22]. Cela étant, il semble possible de lever d'importants niveaux de dette pour des projets d'énergie solaire à concentration – tandis que deux projets d'énergie des océans ne font aucune référence à l'emprunt.
- Les obligations apparaissent moins pertinentes, étant très peu mentionnées par les promoteurs[23], tout comme les financements internes aux compagnies.

[21] Pendant la consultation, la grande majorité des projets n'avaient pas encore bouclé le financement, c'est-à-dire l'étape pendant laquelle les contrats sont signés et la structure financière du projet confirmée. Les structures de financement des projets doivent être donc considérés comme indicatives et nullement comme une confirmation qu'il est possible pour le promoteur pour réaliser effectivement la répartition indiquée de la dette, des capitaux propres, etc.

[22] Bien que l'énergie géothermique soit considérée comme étant mature parce que la première centrale en opération a été mise en service en 1911 en Italie, il est reconnu que des approches plus innovantes sur le marché sont beaucoup moins matures.

[23] Les obligations sont généralement utilisées afin de refinancer des prêts bancaires après la réalisation financière. Il est possible que ces promoteurs de projet n'aient pas une connaissance suffisante au sujet de l'utilisation des obligations, et ont émis des hypothèses quant à leur potentiel.

- Les montants en souffrance indiquent soit un déficit de financement qui peut retarder un projet ou alors la non révélation d'aspects clés de la structure financière (comme par exemples des attentes en matière de *tarifs de rachat*).

ES2.3 Les conditions de marché qui exercent une influence sur le cadre du financement des projets SET FOAK : la disponibilité des ressources, le cadre règlementaire et la chaine logistique

Les facteurs qui génèrent un cadre positif pour le financement de projets SET FOAK sont les suivants :

- La disponibilité des ressources, comme par exemple une ressource viable de l'énergie de l'océan en Europe du nord-ouest ou bien l'excellent rayonnement solaire dans la région méditerranéenne pour bénéficier les projets solaire à concentration.
- Des systèmes d'autorisation et de planification bien définis, des chaines logistiques bien établies, des centres de test et démonstration et une forte acceptation du grand public pour ce type d'innovation, sont des facteurs présents là où les taux de pénétration sont déjà importants, comme c'est le cas pour le photovoltaïque, l'éolien terrestre et la bioénergie. Ces paramètres créent des conditions optimales de marché pour les projets SET FOAK.
- Les systèmes de soutien budgétaire stables et prévisibles envoient des signaux positifs aux investisseurs potentiels, et aident ainsi l'accélération du déploiement de technologies qui ont fait leurs preuves d'un point de vue technique et qui sont à un stade initial de leur développement commercial. En effet, les unités de production d'énergie renouvelables sont souvent prioritaires en termes d'accès au réseau et d'envoi de l'électricité générée là où ces conditions sont assurées.
- Un cadre règlementaire cohérent de soutien fort des politiques publiques et la définition d'objectifs ambitieux dans les Plans d'action nationaux d'énergies renouvelables (PANER), constitue un facteur déterminant pour encourager de nouveaux développements là où le déploiement est limité ou n'existe pas (par exemple, pour la géothermie, l'énergie des océans, capture et stockage de carbone et solutions de stockage à grande échelle).
- De nouvelles règlementations européennes en matière d'aides d'état pour l'énergie et le domaine de la recherche développement sont susceptibles d'influencer positivement le financement de projets SET FOAK. Par exemple, les états membres peuvent soutenir la création de nouvelles unités de production innovantes dans le secteur des bioénergies ou bio-raffineries, lorsque l'aide à l'investissement et aux opérations est permise, afin de soutenir les installations industrielles équipées d'outils de capture, de transport et de stockage de CO_2.

En même temps, des défaillances du marché et barrières tendent à inhiber l'investissement et le financement de projets SET FOAK. Elles agissent de trois manières différentes : au niveau macro-économique, de façon structurelle; au niveau de la demande, de manière à influencer les décisions d'investissement; et/ou au niveau de l'offre, particulièrement au sein de chaines d'approvisionnement émergentes ou naissantes, ou les incitations à investir ne sont pas suffisantes, ne fut-ce qu'à cause de retours financiers incertains.

Dans certaines situations, l'investissement est loin d'être optimal avec un marché qui ne s'intéresse tout simplement pas au financement de l'innovation via les projets SET FOAK (malgré un taux de rendement positif). De la même manière, des projets en principe « *bankable* » (c'est à dire pouvant générer un taux de rendement interne positif) peinent à trouver un financement adéquat à cause de l'incertitude inhérente au projet ou bien d'une structure risquée sous-jacente.

A travers l'Union, les conditions du marché pour les projets SET FOAK dans les secteurs SET varient de manière significative entre les pays et les secteurs. Cela contribue à créer un paysage complexe, rendant difficile l'analyse et l'établissement de conclusions générales sur le rôle de chaque état dans le soutien aux projets SET FOAK. Ceci d'autant plus que l'environnement politique autour des SET est en constante évolution. En général, les perspectives demeurent globalement neutres à travers tous les secteurs SET dans les différents états, bien que dans plusieurs secteurs tels que la bioénergie, l'océan et l'énergie éolienne, il y a un certain nombre de marchés démontrant une vision plus positive;

et il y a au moins un État membre - et plus généralement deux ou trois - pour chaque secteur de SET qui sont réputés avoir des conditions favorables pour les projets SET FOAK.

Dans l'ensemble, les conditions du marché jouent un rôle crucial pour aider ou dissuader les investisseurs de s'engager sur des projets SET FOAK dans différents états-membres. Là où ces conditions ne sont pas optimales, elles doivent être contrebalancées par une intervention du secteur public.

ES2.4 Importance de la récompense d'un soutien aux projets SET FOAK dans l'UE

La première application commerciale serait la récompense d'un soutien du secteur public aux projets SET FOAK. La reproduction de ces technologies de pointe participerait à déverrouiller le flux de capital du secteur privé, et permettrait à de telles innovations de s'implanter fermement sur le marché. Elle apporterait des bénéfices économiques et environnementaux considérables pour l'économie de l'Union, tels que l'augmentation des investissements et la création d'opportunités d'emploi et d'exportation. Cela devrait également contribuer à atteindre les objectifs fixés par les politiques de réduction d'émission de carbone et améliorera la sécurité énergétique de l'Union.

Les projets SET FOAK qui ont réussi sont susceptibles de générer d'importants volumes de vente dans le futur. Selon une enquête menée auprès de promoteurs de projets SET FOAK, notre étude montre que 20 projets types couvrant huit secteurs SET, requérant un cout total d'investissement de €1.8 milliards, génèrerait un retour potentiel maximal sur investissement de €6.2 milliards après deux ans pour un déploiement réussit de tous ces projets (soit le montant d'un investissement initial multiplié par trois), et de €26.9 milliards après cinq ans (multiplié par quinze)[24]. De tels nombres donnent une indication quant à ce pourraient être les résultats d'une action concertée sur le financement des projets SET FOAK en Europe.

Les projets FOAK dans les secteurs SET qui constituent des réussites d'un point de vue technologique et sont positifs en termes de retour de flux de capitaux contribuent aussi à créer un profil positif pour cette classe d'actifs hautement risquée. Davantage d'acteurs du marché seront attirés dans la « vallée de la mort » de la commercialisation sur le long terme : c'est un pas en avant déterminant pour permettre aux innovations européennes d'être mises sur le marché avec succès. De plus, ceci contribuera à aider l'Union à atteindre ses objectifs stratégiques d'un futur Plan stratégique pour les technologies énergétiques (SET-Plan)[25].

ES2.5 Rôle du secteur public

Le secteur public joue un rôle vital dans le financement de projets SET FOAK au niveau européen comme à celui des états membres, particulièrement via des subventions. L'emprunt est cependant utilisé dans quelques mécanismes, comme c'est le cas pour le récent dispositif « Energy Demo Projects (EDP) facility » du programme InnovFin[26], qui contient une facilité d'emprunt, ainsi que le programme « Investissements d'Avenir » de l'Ademe. Malgré un usage fréquent au niveau des états membres, la subvention est souvent insuffisante pour subvenir aux besoins de financement des projets SET FOAK. De plus, le temps est souvent long depuis la faisabilité jusqu'à la mise en opération d'un projet SET FOAK, cycle qui peut potentiellement durer jusqu'à 10 ans, ce qui rend difficile un alignement avec l'échelle de temps définie dans les programmes du secteur public. Cela a été le cas pour de nombreux projets du programme NER 300, et, au niveau des états membres, au Royaume-Uni avec le programme de démonstration d'énergie houlomotrice « Marine Energy Array Demonstration Programme »[27].

---

[24] Les prévisions de ventes supposent que tous les projets deviennent opérationnels en même temps et que les promoteurs de projets n'éprouvent aucun obstacle à l'exécution de leurs plans d'affaires. Compte tenu de la nature du risque très élevé de projets de tête de série, ces prévisions représentent seulement un indicateur idéalisé du potentiel de reproduction sur le marché et ne tiennent pas compte des taux d'échec.

[25] C(2015) 6317 final, Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation, September 2015 https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v8_0.pdf

Cette communication fait le point sur le succès de l'actuel Plan SET et identifie dix actions prioritaires pour accélérer la transformation du système énergétique en Europe, qui doivent être discutées par les états membres et les différents acteurs.

[26] http://www.eib.org/attachments/documents/innovfin_energy_demo_projects_flysheet_en.pdf

[27] Siemens a dû se retirer du projet Skerries, au Pays de Galles, pour cette raison.

Les éventuels déficits de financement dans les états-membres clés résultent des facteurs suivants :

- clôture de programmes de soutien
- réorientation des programmes de soutien vers des technologies plus matures
- réorientation des programmes vers d'autres secteurs que l'énergie (vers les technologies numériques, par exemple).
- incertitudes éventuelles pour les programmes qui dépendent d'un co-financement avec le secteur privé.

Le tableau Table ES2.2 fournit un résumé de haut niveau de la disponibilité des différents flux de financement (à savoir les subventions, l'équité, la dette) dans tous les secteurs SET. Certains des secteurs SET établis, tels que la biomasse, SPV et le vent, sont généralement bien servis avec une haute disponibilité des bourses et des capitaux propres, contrairement aux secteurs émergents tels que CSP, géothermique, LES et l'océan. La dette a une disponibilité mixte à travers les territoires et les secteurs de SET. CCS est particulièrement mal servi dans le paysage actuel de financement, notamment en raison des coûts énormes des projets qui tombent souvent en dehors des seuils de financement de nombreux régimes de soutien.

La provision globale de financement pour les projets SET FOAK, tout en étant certainement positive envers les projets des secteurs SET établis (par exemple, SPV, vent) et dans les États membres plus établis (par exemple la France, l'Allemagne, la Suède, le Royaume-Uni), pourrait être renforcée dans d'autres secteurs SET et États membres.

Pour les acteurs privés du marché, la situation de financement des projets SET FOAK est sous-optimale; et il y a peu de incitations (tels que les mécanismes de partage des risques) à participer plus étroitement.

ES2.6 Les raisons de l'échec d'une décision d'investissement

De nombreux projets SET FOAK s'avèrent incapables d'accomplir une décision finale d'investissement (bouclage financier), quel que soit le secteur SET concerné. L'étude identifie les raisons principales de cette impasse :

- Des écueils peuvent provoquer le ralentissement ou bien l'échec d'un projet s'il n'est pas abordé de manière adéquate par un gestionnaire expérimenté.
- Malgré un nombre important de programmes européens et nationaux offrant principalement des subventions (et parfois, dans une moindre mesure, des prêts), l'ampleur de l'offre de financement au niveau des projets est souvent insuffisante. Une partie importante du problème réside dans le fait que peu de programmes européens et nationaux ciblent spécifiquement la « vallée de la mort » commerciale (TRL 7-8). Les exceptions sont le programme NER 300 (subventions) et le dispositif EDP (emprunt spécial). Cependant, seulement trois projets bénéficiant d'une attribution financière du premier programme ont atteint le stade opérationnel ; et le second programme dispose simplement d'un montant de € 150 millions pour agir sur tout le marché FOAK.
- L'intérêt des investisseurs traditionnels pour ce type d'actifs a diminué, souvent pour des raisons stratégiques (comme c'est le cas par exemple les compagnies d'ingénierie). Parfois, les promoteurs ne peuvent tout simplement plus financer de tels projets hors bilan (par exemples les compagnies de production et de distribution d'électricité), et doivent recourir au financement de projet. En conséquence, le flux de capitaux risque et de dettes s'est vu réduire, et les projets exposés à des acteurs financiers extérieurs qui n'ont pas la même attitude face au risque pour ce type de projets.
- L'état du marché neutre ou même négatif dans certains secteurs SET et certains états-membres ne permet pas de convaincre les investisseurs de soutenir des projets SET FOAK dans de telles juridictions.

Table ES2.2 Résumé des différents types de financement pour les projets SET FOAK

	AEN	BIO	CCS	CSP	GEO	LES	OCN	SPV	WIN
Structures financières adaptées pour les projets SET FOAK SET									
	Capitaux propres & subvention: pas d'emprunt	Capitaux propres & subvention: dette disponible selon le type de technologie	Capitaux propres & subvention, mais aucun précédent réalisé jusqu'à maintenant. Dette nécessaire, mais incertitudes quant à sa disponibilité.	Capitaux propres & subvention: prudence des investisseurs, échec des tentatives précédentes.	Capitaux propres & subvention: prudence des investisseurs car peu de précédents sectoriels et régionaux. Assurance utilisée pour couvrir les risques de forage.	Capitaux propres & subvention: prudence des investisseurs à l'encontre de certaines technologies (pas d'accumulation par pompage), plus de demande et études de cas.	Capitaux propres, subvention et dette: très limité à cause de l'échec de tentatives précédentes. Fermes hydroliennes auront besoin de subventions.	Capitaux propres, subvention & dette: prudence des investisseurs à cause de l'échec de tentatives précédentes.	Capitaux propres, subvention et dette: prudence des investisseurs, certains projets à très haute valeur, requérant des fonds importants.
Capital propres (*equity*)	✓	✓✓		✓	✓	✓	✓	✓✓	✓✓
Dette (emprunts)		✓		✓	✓	✓	✓	✓	✓
Subventions	✓✓	✓✓	✓	✓	✓	✓	✓	✓✓	✓✓

Disponibilités des options:

Disponibilité importante au sein des Etats Membres

Disponibilité moyenne (par ex. pour certains Etats Membres)

Disponibilité limitée ou inexistante

Source : ICF

ES2.7 Combler le déficit de financement des projets SET FOAK

Sans un financement adéquat, le risque est bien réel que les innovations européennes de pointe SET n'avanceront pas du stade de démonstration au stade commercial et que leur contribution envers les objectifs politiques de la CE concernant l'énergie et le climat en sera diminuée. Ceci risque de provoquer une augmentation des coûts de la réalisation des objectifs politiques ainsi que des « fuites économiques » dues à une perte de compétitivité de l'UE.

Il existe une tendance à trop dépendre des subventions dans les programmes de soutien européens et nationaux, bien que les subventions seules ne suffisent pas à combler les besoins financiers des différents types de projets.

Accomplir des projets SET FOAK avec succès en Europe requiert les conditions suivantes :

- une réponse adaptée en termes d'ampleur (le soutien est délivré rapidement, suite à des objectifs politiques qui approchent rapidement.)
- une certaine sensibilité aux circonstances individuelles qui entourent le projet
- un « effet d'entrainement » des participants aux niveaux européen et nationaux.

Tous les participants consultés pour cette enquête ont le sentiment que la Commission européenne devrait soutenir les projets SET FOAK via un fonds d'investissement en capital-risque, et la plupart pensent également que l'emprunt devrait être facilité, avec notamment, pour les investisseurs spécialisés, la possibilité de recourir à un financement mezzanine ou bien à des prêts à faibles taux, et pour les banques, la possibilité de recourir à des financements relais. Les participants ont également mentionné l'importance de subventions supplémentaires pour les phases de faisabilité et de construction des projets SET FOAK, car celles-ci permettraient aux promoteurs de projets de contourner d'importants obstacles financiers sur le chemin de la mise en œuvre de ces projets.

Les instruments financiers peuvent catalyser l'investissement et le financement par le secteur privé vers les projets SET FOAK, du moment que le cout demeure compétitif et que leur design permet d'encourager les acteurs privés et rend possible un « effet d'entrainement » (par exemple, à travers un mécanisme de garanties des premières pertes). Les instruments financiers peuvent également augmenter le flux d'investissement à travers le Fonds européen pour les investissements stratégiques (EFSI), ainsi qu'au travers d'autres mécanismes de financement.

Une mise à disposition de davantage de capital-risque et de dette devrait créer de meilleures conditions pour adapter le financement aux besoins du marché, et de manière plus efficiente, ainsi que de créer des mécanismes de financement plus durables, comme décrit ci-dessous :

1. Mise à disposition d'un fonds de capital-risque – les entreprises promotrices sont des acteurs clés dans la fourniture de fonds, mais les compagnies de services (*utilities*) n'ont plus de fonds à consacrer au financement de l'innovation, et les grandes entreprises d'ingénierie sont désormais très sélectives sur les projets qu'elles promeuvent. Tandis que les niveaux de capitaux délivrés dans le capital risque européen, ainsi que le milieu du marché en capital-risque par le Fonds Européen d'Investissement (FEI) sont énormes, faisant du FEI le plus gros investisseur en capital-risque en Europe, ces capitaux fournissent essentiellement des phases précoces et extensions de capitaux dans des compagnies à forte croissance sur une base de participation ouverte (*pari passu*), fournie au moyen de capitaux propres. Le FEI ne délivre pas de capital-risque dans les véhicules de financement de projet, et n'en offre pas non plus pour des bénéficiaires individuels finaux (promoteurs de projets), à des échelles requises par les projets SET FOAK dans le secteur SET. Aussi, le capital-risque n'est pas offert avec un dispositif de garantie « premières pertes » de la Commission. Les participants de l'enquête s'accordent à penser qu'un tel dispositif devrait être propose par la Commission, dans le cadre d'un nouveau fonds d'investissement en capital-risque afin de provoquer un effet d'entrainement auprès de l'investissement privé. Les fonds doivent être suffisants pour soutenir au moins dix à vingt projets. Un tel fonds doit être géré selon une approche pratique et proactive afin d'accompagner les porteurs de projet tout au long du cycle du projet, depuis l'identification jusqu'à la sélection, ainsi qu'à travers un processus de résolution des problèmes et actions réparatrices, après la clôture financière, incluant également la mise en œuvre, la commande et les opérations.

2. L'emprunt – Le dispositif EDP, mécanisme d'emprunt récemment mis en place par la Banque européenne d'investissement (BEI) a connu un départ prometteur, recevant plus de 70 requêtes. Il vient d'autoriser son premier prêt envers un projet SET FOAK (un projet d'énergie océanique au Portugal) et comprend quatre autres projets SET FOAK à des stades plus ou moins avances de sélection et d'audit préalable. Ce dispositif comble un fossé qui existait dans le marché en offrant des emprunts spécialisés que la plupart des fournisseurs de dette privés ne peuvent fournir parce qu'ils sont structurés avec une garantie premières pertes qui permet au mécanisme de prendre plus de risque que les fournisseurs de dette classiques. Cependant, la taille de ce dispositif doit être revue à la hausse pour permettre le financement d'au moins dix à vingt projets, à travers différents secteurs SET.

Dans l'ensemble, l'instrument fonds-propres proposé et le dispositif EDP existant semblent répondre aux besoins du marché et aider à fournir les capitaux propres et la dette nécessaires pour les projets FOAK SET. En effet, il existe une complémentarité évidente entre les deux mécanismes tels que leur combinaison pourrait améliorer leur efficacité globale sur le marché.

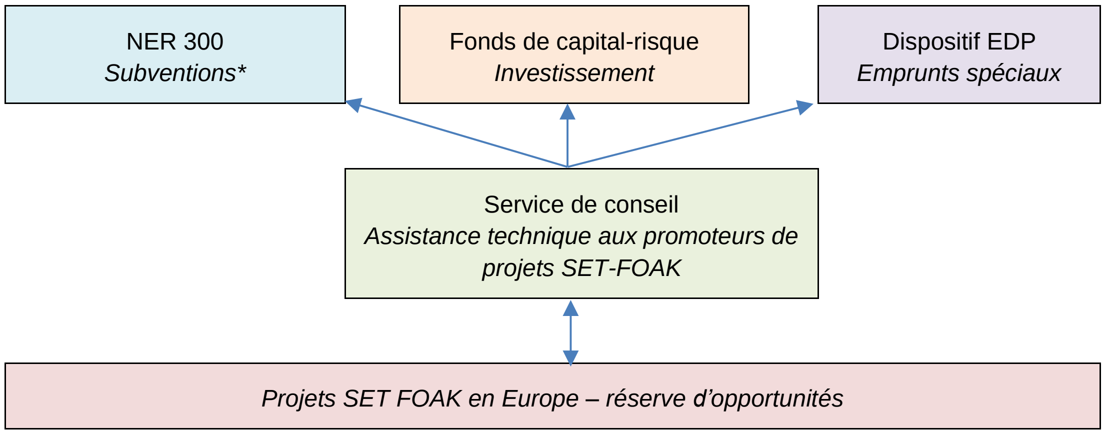
Pour assurer une couverture totale des besoins en financements, une action de la Commission est requise sur les points suivants :

3. Des subventions – qui doivent cibler les secteurs SET ou les risques sont les plus importants, pour lesquels les technologies demeurent loin d'une mise en marché. Ceci inclut des TRLs précédant la « vallée de la mort ». Il est également nécessaire d'aider les promoteurs de projet dès les phases précoces de l'existence d'un projet de surmonter d'éventuels déficits de financement qui s'avéreraient critiques (étant donné que peu d'autres financeurs sont intéressés à ce stade), afin d'atteindre certaines étapes clés telles que les études d'ingénierie préliminaire (« Front End Engineering and Design, FEED), la planification et l'obtention des permis.

4. Un service de conseil pour les projets SET FOAK dans les secteurs SET, comprenant des experts du secteur, dont le but est de conseiller les promoteurs au sujet des canaux de financement les plus appropriés ainsi que les différents soutiens qui existent au sein de l'Union et des états membres. Un tel outil aurait également le bénéfice de participer à la création d'une réserve de projets SET FOAK en Europe. Il existe déjà des services de soutien similaires : les services de conseil du dispositif InnovFin, qui donne des conseils financiers aux promoteurs, et la plateforme européenne de conseil en investissement (« European Investment Advisory Hub », EIAH[28]) qui donne un point d'accès à un éventail plus large de conseils durant tout le cycle du projet.

Une combinaison d'instruments financiers emprunt et capitaux propres de la Commission européenne, soutenus par des subventions intervenant en amont et des conseils d'experts (voir la Figure ES2.1) apporterait l'aide nécessaire aux promoteurs de différents types de projets pour accéder à la forme de financement la plus adéquate, étant donné qu'ils offrent chacun une forme de soutien différente aux projets SET FOAK.

Figure ES2.1 Les futurs promoteurs de projets SET FOAK pourraient bénéficier d'une offre européenne de services intégrés



[28] Une initiative conjointe de la CE et la BEI vis-à-vis le second pilier du plan d'investissement pour l'Europe

ES2.8 Bonnes pratiques de la Commission européenne et des Etats membres susceptibles d'améliorer les mécanismes de soutien aux projets innovants

ES2.8.1 Les principes fondamentaux assurant la bonne crédibilité du mécanisme

Afin d'être pleinement efficace, tout nouveau mécanisme qu'il soit européen ou à l'échelle d'un Etat membre doit répondre aux principes fondamentaux suivants :

- Définir des objectifs stratégiques et opérationnels clairs;
- Etre suffisamment important du point de vue financier afin d'acquérir une présence et une crédibilité sur les marchés;
- Avoir des critères d'éligibilité transparents;
- Etre suffisamment flexible pour pouvoir couvrir différents secteurs SET et différentes échelles de projets;
- Avoir des mécanismes financiers permettant une bonne flexibilité dans le but d'attirer des investisseurs et co-financeurs issus du secteur privé;
- S'assurer du soutien de différents groupes d'acteurs, y compris les régulateurs économiques et environnementaux si nécessaire, afin d'avoir une plus grande visibilité ; et
- S'assurer que les couts opérationnels ne représentent pas un pourcentage trop important des couts totaux du mécanisme.

ES2.8.2 L'application et le suivi du projet est critique pour permettre le financement et la commercialisation de projets solides

Quelques exemples de bonnes pratiques issues de la revue des mécanismes de soutien:

- Fournir une aide claire ainsi qu'un soutien aux porteurs de projet pendant la phase de candidature et la phase de développement s'avère être financièrement bénéfique car cela concourt à réduire le risque de voir des candidatures peu développées, et augmente significativement les chances de succès ;
- Définir une procédure de candidature en deux phases peut se révéler efficace pour les candidats comme pour les gestionnaires du fonds. Cela permet notamment d'écarter les projets les plus faibles à une phase initiale;
- Veiller à ce que les idées de projet soient évaluées aussi bien techniquement que financièrement de manière approfondie et rigoureuse afin d'identifier quelles innovations sont davantage susceptibles d'échouer dans le contexte du marché;
- Bénéficier d'un soutien technique, financier et politique pendant toute la durée de la mise en œuvre du projet afin de créer des incitations à soutenir des projets innovants risqués, y compris pour les plus grandes entreprises;
- Employer du personnel hautement qualifié au sein de l'administration du mécanisme afin d'évaluer et de soutenir les candidats et porteurs de projet ; et,
- Aider à développer les connaissances des acteurs du marché des nouvelles technologies, des secteurs SET ainsi que des projets ayant réussi participe à l'essor d'une plus grande confiance dans ces opportunités nouvelles, ainsi qu'à la baisse du niveau de risque perçu.

ES2.8.3 Les mécanismes de soutien de pays-tiers fournissent des leçons utiles pour s'attaquer à la question du financement de projets innovants

Les observations de mécanismes mis en place dans des pays tiers sont les suivantes :

- Assurer un engagement politique de long terme ; ceci est important pour créer des signaux positifs sur les marchés, et de faire en sorte que le mécanisme soit doté d'une bonne image ainsi que d'une importante crédibilité sur les marchés ;

- Etre attentif à la nature et à l'échelle des opportunités qui existent sur les marchés pour les technologies proposées. Cela permet de réduire les investissements potentiellement inefficaces vers des technologies difficiles à commercialiser dans le contexte des marchés;
- Engager suffisamment de ressources ; tout mécanisme ciblant les projets FOAK en Europe doit bénéficier d'un budget lui permettant de soutenir un nombre important de projets, plutôt que d'être limite à quelques-uns;
- Travailler avec l'industrie et la communauté des investisseurs aussitôt que possible ; cela permet aux innovations de gagner en visibilité et aide à augmenter les propositions d'investissement (plutôt que d'intervenir tardivement, ce qui contribue à augmenter la perception du risque);
- Il est prudent d'adopter des procédures strictes pour écarter les projets qui ne répondent pas aux objectifs fixés, ainsi que de mettre en place des dispositions de récupération robustes, bien définies, afin d'éviter tout engagement de financement vers des projets qui s'avèrent peu efficients;
- Travailler de concert avec les secteurs publics et privés enfin de créer un continuum dans le financement, offert pour les projets les plus performants, permet d'éviter tout déficit de financement dans la voie vers la commercialisation;
- Cibler les technologies SET de manière stratégique, et identifier suffisamment tôt où le support au projet est susceptible de générer le plus de rendement économique pour l'Union européenne, et d'améliorer la chaine logistique européenne; et,
- Mettre au point un cadre de monitoring et d'évaluation robuste afin de rendre possible la détermination des résultats et impacts du projet. Pouvoir mesurer le succès et la valeur d'une intervention est vital pour démontrer aux différents acteurs la valeur de l'intervention et l'impact de leur soutien sur le long-terme.

ES3 Recommandations

Recommandation 1: Augmenter la visibilité des projets SET FOAK SET et des promoteurs

La DG Recherche et innovation devrait travailler étroitement avec la DG Energie afin de joindre ces efforts respectifs dans la réalisation d'une cartographie complète des projets SET FOAK et de renforcer notre compréhension quant aux raisons pour lesquelles tant de projets ne dépassent pas les TRL 7-8. Ceci devrait contribuer à bâtir la base de données empiriques pour étendre la provision de dette et de capital-risque, ainsi que de produire des études de cas des projets qui ont clôturé leur financement avec succès, ainsi que leur phase de démonstration et celle de commercialisation.

Recommandation 2: Mesures d'ensemble de la Commission européenne pour les projets SET FOAK

La DG Recherche et innovation devrait explorer le potentiel d'une offre plus intégrée à destination des promoteurs de projets SET FOAK (à savoir, un service unique comprenant un accès à l'emprunt, au capital-risque et aux subventions, ainsi que des modifications aux services de conseil actuels de la BEI) afin de satisfaire pleinement les besoins du marché.

Recommandation 3: l'accès aux capitaux propres

Le concept d'un fonds destiné aux projets SET FOAK dans les secteurs SET devrait être exploré en détail dans la mesure où existe un réel besoin de capitaux pour ce type de projets en Europe. Sur la base d'une enquête réalisée auprès d'acteurs du marché, la taille initiale d'un tel fonds devrait être pensée autour de €250 millions à €500 millions. Ce niveau de financement est susceptible d'avoir un réel impact sur le marché auprès des promoteurs de projets et autres acteurs. De plus, le recrutement de personnels qualifiés serait, à ce niveau, rendu possible.

Cette présente étude, sur la base des termes de référence, n'a pas pour objectif de se pencher sur la façon dont un tel fonds doit fonctionner. Des recherches sont donc nécessaires pour examiner les paramètres suivants :

- structures d'entreprise et structures institutionnelles nécessaires au fonctionnement d'un tel fonds
- objectifs et critères d'investissement, y compris les horizons d'investissement et de cession, ainsi que les mécanismes de pénétration du marché
- où, comment et selon quelle règlementation, responsabilité et contrôle un tel fonds peut être mis en place
- le niveau de réglementation appliqué au conseil à l'investissement en capital-risque et gestion du fonds
- les qualifications et l'expérience requises des personnels évoluant dans cette activité.

Recommandation 4: accès aux emprunts spéciaux

La DG Recherche et innovation devrait considérer une augmentation de la taille du dispositif EDP de €150 millions (pour 2016-2017) à au moins €250 millions et idéalement €500 millions, afin d'offrir des possibilités de contracter de l'emprunt à une échelle qui devrait pourvoir aux besoins de différents types de projets et secteurs. Afin de satisfaire un plus grand nombre de projets, d'autres démarches pourraient être envisagés, par exemple, la réduction de la garantie premières pertes à moins que l'actuel 95%, ainsi que le report à une date antérieure de la date de libération de la garantie sur les projets.

Recommandation 5: Provision de subventions

La DG Recherche et innovation devrait travailler avec la DG CLIMA sur la portée du nouveau fonds Innovation afin d'assurer que la provision de subventions pour les projets SET FOAK soit bien adaptée aux besoins des promoteurs. Cela comprend l'identification d'étapes clés dans le cycle du projet, ou la subvention aurait le plus d'impact, jusqu'à la clôture financière et potentiellement la phase de construction. Cette recommandation est issue de notre analyse des risques des projets SET qui montre que les principaux obstacles se situent au niveau ou avant le bouclage financier.

Recommandation 6: Services de conseil pour les promoteurs de projets SET FOAK

La DG Recherche et innovation devrait considérer la possibilité d'offrir des services de conseil au niveau européen pour assister les porteurs de projets à designer et planifier leur projet, ainsi qu'à trouver le financement le plus approprié. Une telle offre permettrait d'accélérer le développement de projets et de créer une communauté d'intérêt en Europe dans les secteurs SET. DG RTD devrait prendre en considération les dispositifs existants, comme : les services de conseil du dispositif InnovFin et a plateforme européenne de conseil en investissement, et évaluer quels ajustements il faudrait apporter pour fournir le service désiré pour les projets SET FOAK.

1 Introduction

This is the Final report of a study, commissioned by DG Research & Innovation, to examine the role of financial instruments in the support of commercial scale, first-of-a-kind (FOAK) projects focused on Sustainable Energy Technology (SET) sectors in Europe.

The study was carried out by ICF, in association with London Economics, between March 2015 and June 2016.

The underpinning research has required extensive research and consultation with European technology sponsors, financial market participants (drawn from the global financial supply side) and technology and innovation support schemes at the EU and Member State level as well as in non-EU countries.

1.1 Study aims and objectives

The study aimed to:

- Describe and quantify the investment needs and current financing bottlenecks related to the financing of SET FOAK projects;
- Identify and analyse the market conditions which affect the investment and lending to SET FOAK projects and the need for further public intervention at EU level; and,
- Formulate appropriate policy options, including FIs, to remove identified investment and/or financing 'bottlenecks'.

Cost efficient and effective FIs that can catalyse investment and finance from the private sector into SET FOAK projects will help fulfil the strategic objectives of a future integrated Strategic Energy Technologies Plan (SET-Plan)[29].

FIs can also enable increased investments to flow through the European Fund for Strategic Investments (EFSI) as well as other financing mechanisms.

1.2 Scope of the study

The study focused on European first-of-a-kind (FOAK) commercial-scale demonstration projects at Technology Readiness Level (TRL)[30] 7 or 8 that use innovative low-carbon energy technologies from the following SET-Plan sectors:

- Advanced electricity networks (AEN);
- Biomass conversion technologies, 2nd generation only (BIO);
- Concentrating solar power (CSP);
- Carbon Capture and Storage (CCS);
- Geothermal energy (GEO);
- Large scale energy storage solutions, including pumped-storage hydropower (LES);
- Ocean energy (comprising tidal stream, wave energy and tidal lagoons) (OCN);
- Solar photovoltaics (SPV); and,
- Wind energy (WIN) - comprising fixed onshore, fixed offshore and floating offshore turbines.

Applications covered energy generation (heat, power), biofuels production and innovative manufacturing (for example, bio-refineries and the production of SPV modules and wind turbines).

[29] C(2015) 6317 final, *Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation*, September 2015 https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v8_0.pdf This Communication provides a stock take of success under the current SET Plan and identifies ten priority actions to accelerate the energy system transformation in Europe which need to be discussed with Member States and stakeholders.

[30] Technology Readiness Levels are defined in Section G of the Horizon 2020 Work programme for 2016-17 available at http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf , p.35

1.3 Structure of this report

This Final report is structured as follows:

- Section 1 provides a description of the aim, scope and objectives of the Study.
- Section 2 sets out our approach to the study and provides an overview of study tasks.
- Section 3 summarises findings under the initial phase of study which aimed to frame the investment needs for FOAK projects and identify financing bottlenecks and opportunities. The section covers: Identifying and understanding European SET FOAK projects; Mapping and analysis of public sector funded SET support schemes in Europe, including a review of the effectiveness of such schemes; Mapping and analysis of financial market participants; Market conditions affecting SET FOAK projects; and, Mapping and analysis of public sector funded SET support schemes outside the EU, including a review of the effectiveness of such schemes.
- Section 4 presents findings under the second phase of the study which aimed to analyse the investment/lending conditions of financial market participants and the need for public intervention at the EU level. The section includes an analysis of risks perceived by project sponsors and market participants and a summary of the general funding levels across SET sectors by grants, equity and debt.
- Section 5 sets out the EC's framework for ex-ante assessment of FIs and the approach taken by ICF.
- Section 6 proposes a new equity-based FI which would focus on filling shortfalls in equity investment for SET FOAK projects across the EU, and presents the ex-ante assessment of the Fund.
- Section 7 presents the ex-ante assessment for an existing debt-based FI, the Energy Demo Project (EDP) facility which offers a risk-sharing loan guarantee instrument for project sponsors. Since the EDP facility is already operational, the assessment reviews the facility in its current format and, where appropriate, refers to potential future developments to enhance its delivery and simulates changes to the current fund size.
- Section 8 compares the main ex-ante assessment results from the two FIs, allowing the key market impacts of each to be better understood.
- Section 9 describes a potential SET FOAK Advisory Service a concept providing advice and technical and financial assistance to FOAK project sponsors leveraging on the existing Advisory Services. The FOAK Advisory Service would be able to signpost sponsors to the EC funding mechanisms, and improve the bankability of the projects.
- Section 10 presents study conclusions.
- Section 11 puts forward recommendations from the study.

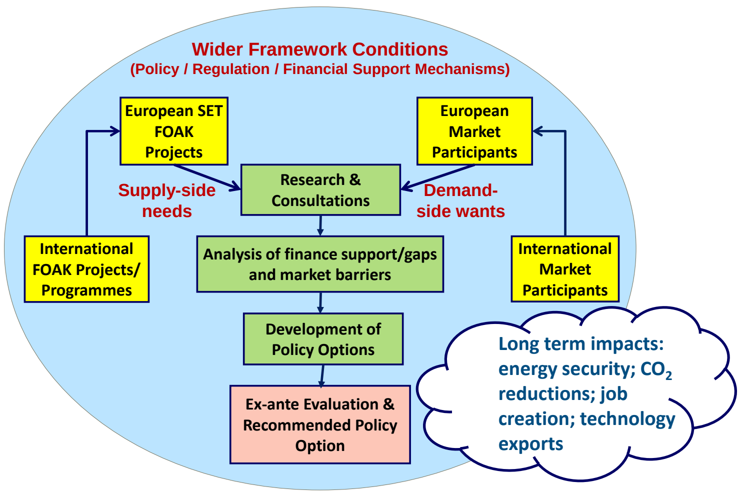
2 Approach taken to achieve the study objectives

2.1 Introduction

The study required ICF to undertake a broad literature review of SET FOAK projects at TRLs 7-8 in Europe, and of grants and FIs that are available through EU and Member States, as well as to build an understanding as to which kinds of financial market participants are active in this field, not only in the EU but globally. Further, the study needed to gain a fuller insight into what business and financial risks market participants face in supporting SET FOAK projects and whether there is a demonstrable market need for the European Commission to consider introducing new or adapted FIs to address these risks.

Overall, the study sought to bridge the knowledge gap between technology developers and financial market participants in order to generate constructive policy options which are supportive of SET FOAK projects in Europe (see Figure 2.1). The general aim of the study is thus to evaluate the need and potential for dedicated risk finance instruments at EU and Member State level for projects within scope.

Figure 2.1 The study aimed to bridge the knowledge gap between developers and market participants in order to generate robust policy options to support SET FOAK projects



2.2 Overview of study tasks

2.2.1 Task 1: Framing investment needs, financing bottlenecks & opportunities

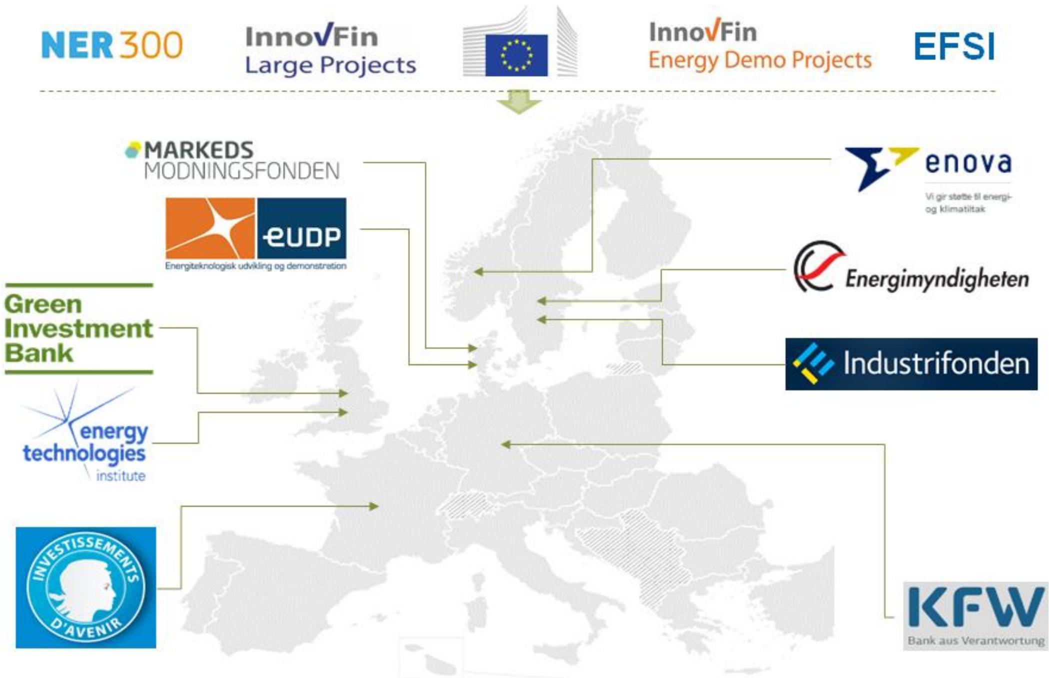
The purpose and outcomes of Task 1 can be summarised in the following five sub-tasks:

Task 1.1 – The aim was to identify and engage with the technology sponsors of relevant classes of European SET projects at TRL 7-8 actively looking for money to help with their FOAK project. The objective was to find more than 50 sponsors willing to engage with the study and for at least 20 sponsors to provide ICF with key metrics and insights on the status and financing needs of their projects. The study team drew together a list of over 340 technology/project sponsors. Following review, a pre-qualified list of over 200 sponsors were sent an e-survey. We received 52 completed responses (25% response rate). We also recorded 22 partially completed surveys which were then abandoned by sponsors, indicating a reluctance to divulge confidential information. Overall, 18 of the 52 completed responses lacked some or all of the financial data requested. Having assessed the relevance of projects and their current financing needs, ICF was able to screen 41 potential projects using strict criteria to generate 35 exemplar FOAK projects across the nine SET sectors which required funding[31].

[31] In a couple of cases, the project had recently reached financial close

Task 1.2 – The aim was to identify and map potential public sector instruments available at both EU and Member State level, including those focused on TRL 7-8. In total, 14 instruments were researched (with key information sources reviewed including guidance documents and evaluation reports to provide secondary supporting data) and consultations conducted with scheme managers. Besides InnovFin and NER 300, instruments researched comprised of EFSI and schemes from Denmark (2), France, Germany (3 – all KfW), Sweden (2), UK (2) as well as Norway (see Figure 2.2).

Figure 2.2 ICF reviewed 14 SET support schemes at the EU and Member State level including several covering with specific SET FOAK project support



A series of scheme description sheets were written to capture key aspects of each support mechanism including, where possible, the market acceptance of the instrument; effectiveness of the instrument for classes of projects such as FOAK projects and the efficiency of the instrument, including achieved leverage and overall suitability for supporting FOAK.

Task 1.3 – The aim was to identify, collate and describe representative groups of the financial community who may be interested or willing to provide medium to long term funding to SET FOAK projects. The objective was to find market participants (investors/financiers or lenders) who either had an established track record in different SET areas or an emerging interest in SET FOAK projects. In total 80 organisations were shortlisted including: venture capital and private equity firms, retail and investment banks, public banks, engineering and industrial firms and energy utilities, pension funds, insurance companies and sovereign wealth funds. These organisations collectively covered:

- Different types of institutions (e.g. banks, private equity funds) from different countries;
- Relevant asset classes (e.g. debt, equity, other financing mechanisms); and,
- Different types, sizes and profiles of investments in a wide range of EU Member States.

Task 1.4 – The aim was to review and collate information from a series of recognised and published sources concerning market conditions[32] in the nine SET sectors of interest. The objective was to determine in which European markets conditions are favourable for SET FOAK projects and to understand how changing market conditions may have led to SET projects becoming more “bankable” or “investment ready”. Using literature and data from 2013 onwards

[32] Main areas of interest included policies, market growth perspectives, market support mechanisms (feed-in tariffs, capacity mechanisms etc.), permitting and licensing procedures, social acceptance issues, as well as sectoral state aid issues.

and focusing on key developments, the task sought to describe sector-specific market conditions across the 32 European countries studied (EU-28 plus Iceland, Norway, Switzerland and Ukraine).

Task 1.5 – The aim was to identify suitable public sector instruments outside the EU, especially those focused on TRLs 7-8, to understand how they are delivered and to see whether any practices and learning could be replicated in the EU context. For example, how they are being used to incentivise commercial investors and financiers to become involved with FOAK projects. The objective was to consult where possible with scheme managers and seek feedback on the success of their support schemes and views as to how SET FOAK projects are best supported. ICF examined seven support mechanisms (comprising grants and loans / loan guarantees) in Australia, Canada, Japan, New Zealand and the USA (see Figure 2.3).

Figure 2.3 ICF reviewed 7 international schemes supporting clean energy projects

2.2.2 Task 2: Analysing the investment/lending conditions and need for public intervention at EU level

The purpose and outcomes of Task 2 can be summarised in the following two sub-tasks:

Sub-task 2.1 – The aim was to interview a broad selection of market participants (as described in Sub-task 1.3). The objective was to establish their modus operandi and their reasons for or against supporting FOAK projects as well as seeking candid views on example FOAK projects (based on project sponsor responses in Task 1 but with no disclosure of key project data) and to gauge willingness to provide investment/finance to them. Understanding the risks that FOAK projects operate under and the financial parameters they might operate within were key aspects of the consultations. Gaining insights on which public support mechanisms (either at EU, Member State level or non-EU) the market participants had already engaged with or knew about, and their role in assisting FOAK projects, was an important aspect of the research. In total, 29 organisations were interviewed[33] which represents 36% of the original list and above a 29% response rate in all four types of market participant (see Table 2.1). Interviewees were senior representatives, often responsible for deciding on SET/FOAK strategy and decision making. Given the overall investment and financial volumes disbursed by these organisations, views expressed by this sample are deemed to be representative of equity and debt providers overall within the European market.

[33] One interviewee approached ICF with interest in providing their views having heard about the study but was not on the original list of 80 organisations

Table 2.1 ICF interviewed 29 market participants providing representative sector coverage

Market Participant type	Total in sample	Interviewed	Percentage of sample
Specialised investors (VC/Private equity)	16	7	44%
General investors (Asset managers/Pension funds)	11	6	55%
Producers (Energy utilities/Engineering)	25	8	32%
Banks (Retail / Investment / Public)	28	8	29%
Total	80	29	36%

Sub-task 2.2 – The aim was to analyse the responses from market participants and to build a picture of the current nature of FOAK support across market participants. The objective was to establish where there remains a need for public sector intervention in different SET areas for FOAK projects and to establish the types of financial instrument that might help to overcome the risks which are impacting (or are perceived to impact) on the commercialisation 'Valley of Death'. The study team collated key findings by the four groups of market participant to explore characteristic features and prevailing attitudes to SET in general and to FOAK projects specifically. This also helped to identify investment opportunities and barriers for each SET area. Taking into account the nature of current support schemes, we then examined a potential suite of support mechanisms / FIs suggested by market participants which they believed would help to alleviate some of the key obstacles to funding SET FOAK projects.

2.2.3 Task 3: Formulating policy options to remove financing bottlenecks

The objectives of this task are, firstly, to devise structures suitable for financing SET FOAK projects of the kind identified in Task 1 and, secondly, bearing in mind the results of Task 2, to make recommendations with respect to existing and new public financing mechanisms. The financial instruments put forward were subjected to ex-ante assessment in accordance with the procedure and key criteria set out by the Commission in the EU Financial Regulation.

3 Framing investment needs, financing bottlenecks & opportunities

3.1 Identifying and understanding European SET FOAK projects

3.1.1 Introduction to the project sponsors with live or stalled FOAK projects

The objective of engagement with project sponsors was to generate relevant "live" FOAK projects seeking funding, in order to discuss typical FOAK exemplar projects with financial market participants.

ICF obtained 52 completed e-surveys from technology developers, comprising both SMEs and mid-sized to large companies. Responses originated in 15 Member States as well as Norway. The highest number of survey responses were in the following sectors: ocean energy; biomass (including biomass to energy and second generation biofuels production); and CCS. The lowest number of survey responses were from: Advanced Electricity Networks (AEN) and Concentrating Solar Power (CSP). Levels of response by SET sector can be regarded as a fairly good indicator of FOAK funding need by sector.

An additional 22 partially-completed e-surveys allowed some insights to be gathered, including feedback on barriers and indicative levels of risk for different FOAK project types, although they did not provide any financial information. This illustrates the challenge of obtaining commercially sensitive information from FOAK project sponsors. This issue was encountered once again when short-listed projects were approached to provide more information. It proved impossible to generate more detailed metrics to further define FOAK deals and their specific financing requirements and cash-flow potential.

Screening criteria were used to assess responses from project sponsors and to shortlist the 52 projects down to 35. Criteria included the following six types of risk: organisational/shareholder risk; technological risk; market conditions / energy policy; environmental regulatory; construction & commissioning risks; and, operational risks.

Table 3.1 consolidates by SET sector the information received from sponsors regarding 35 exemplar projects. Information pertaining to key metrics is presented visually in diagrams in Annex 3 but is summarised below.

There is large variability in project sizes across SET sectors and also within certain sectors. Conversely, there is evidence of certain size convergence in some SET areas (e.g. for CSP). The stage of leading-edge development for Ocean and floating Wind is currently at the small array project scale (i.e. using two to three turbines which are grid connected) with expectations that 'farm' scale developments will occur in the next five years) - see Figure A3.1 in Annex 3.

Total costs show significant funding requirements for biofuels, CCS, CSP, LES, and fixed Wind projects in contrast with sectors with funding requirements of €50m or less such as AEN and Ocean - see Figure A3.2 in Annex 3.

Very high relative costs of technologies (up to €10m/MW) are characterised by either limited current capacity (in the case of geothermal power) or else very nascent technologies (such as for ocean energy and floating wind). A group of technologies all sit between €2m and €5m per MW or per Kt. These include 2nd generation biofuels production, CCS and CSP (see Figure A3.3 in Annex 3.

Risk scores from technology sponsors indicate broad trends across technologies, with the lowest for Bioenergy and highest for CCS, Ocean & fixed Wind (see Figure A3.4 in Annex 3).

The funding requirements across the diverse set of ICF project responses correlate well with several of the project cost ranges outlined by JRC in their 2013 report on FOAK project funding needs. ICF's sample however covers all nine SET sectors in comparison with the JRC report and offers far more comprehensive data. This information has formed the basis of the detailed investment needs analysis outlined below (and detailed in Annex 5).

Table 3.1 Summary of FOAK projects received via project sponsor e-survey responses

SET sector	No. shortlisted projects	Typical size of developer	Size range	Total cost range	Range in Cost per MW	Range in overall risk values	Risk categories with highest values
AEN	2	No typical size	53-70 MW	€30m – €41m	€0.57m per MW – €0.58m per MW	1.75 – 2	Org risk, Tech risk, Market/ policy risk
BIO	7	< 250 employees	Diverse*	€8m – €300m	Diverse*	0.75 – 2.25	Tech risk, Market/ policy risk
CCS	4	> 1000 employees	250-300 MW	€500m – €1400m	€2m per MW – €4.24m per MW	1.75 – 4	Market/ policy risk, Env. reg. risk, Tech risk
CSP	4	< 250 employees	41-111 MW	€185m – €330m	€3.0m per MW – €4.9m per MW	2 – 3	Market/ policy risk, Org risk, Tech risk
GEO	3	< 250 employees	12-93 MW	€75m – €117m	€2.2m per MW – €9.8m per MW (heat & power combined)	2.75 – 3.25	Tech risk, Operations risk
LES	4	> 1000 employees	6 – 250 MW	€16m – €350m	€1.3m per MW – €2.8m per MW	1.25 – 3.5	Tech risk, Market/policy risk
OCN	4	< 250 employees	4 – 320 MW	€20m – €1000m	€3.1m per MW – €10m per MW	2.75 – 3.75	Tech risk, C&C risk, Ops risk
SPV	3	< 250 employees	Diverse*	€38m – €50m	Diverse*	2.25 – 2.75	Org risk, Tech risk, Market/ policy risk
WIN	4	< 250 employees	2 – 400 MW	€54m – €2000m	€1.4m per MW – €10m per MW	2.25 – 3.75	Tech risk, C&C risk

** A size range is less meaningful for biomass conversion projects, owing to the variety of processes and products of the shortlisted projects; the same is true of SPV projects, which include manufacturing projects*

3.1.2 Financial structures for FOAK projects

One of the most important insights from consulting with real European FOAK projects across different SET sectors was obtaining the typical financial structures which sponsors felt would be used. SET FOAK projects have complex funding needs and large variations in financing structures exist, even within sectors, due to the different technology types, scale, track record of sponsors. Figure 3.1 provides forecasted financial structures for 32 FOAK projects.

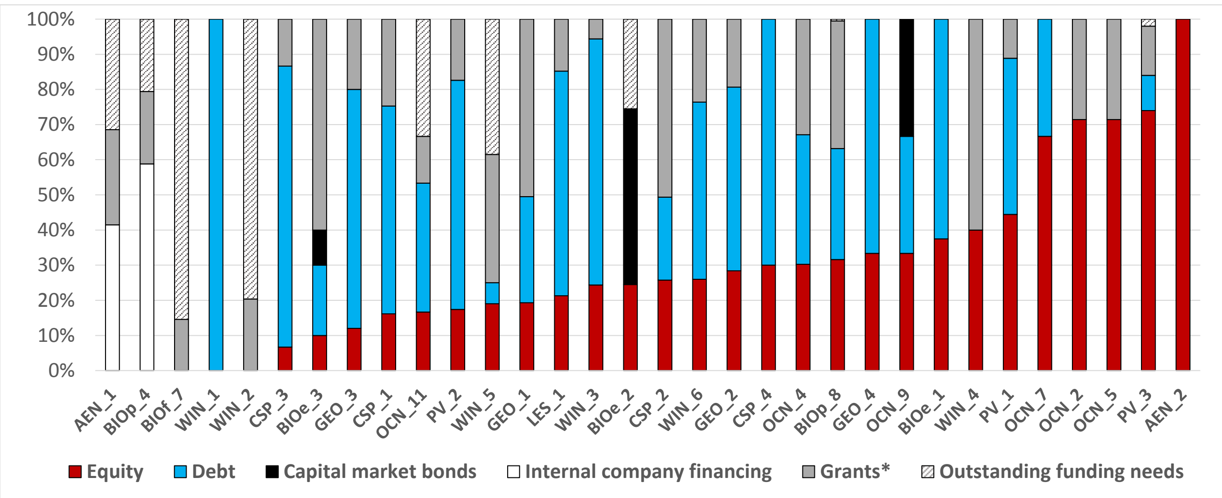


Figure 3.1 Forecasted financial structure of projects, organised by amount of equity

Source: ICF survey of European project sponsors, 2015

The financial structures[34] in Figure 3.1, gathered from 32 different project sponsors, show that:

- grants (i.e. public sector risk capital) play a very important role overall in many SET FOAK deal structures, with projects typically forecasting between 10-30% or much higher amounts in some isolated cases (e.g. for bioenergy, bio-pyrolysis, CSP, geothermal, wind); grants are perceived as particularly important for ocean energy, generally making up the balance with equity and, infrequently, debt;
- equity investment is forecast between 10-30% in many projects, but is particularly high for several solar PV and ocean energy projects while being absent in other projects;
- debt requirements can be very large, varying from 10% of total funding to more than 70%. – Based on sponsor forecasts, the ease with which FOAK projects are perceived to be able to raise debt is highest in the most mature SET sectors, i.e. wind, solar PV and geothermal[35]; although it is also perceived to be possible to raise very high levels of debt for CSP projects – in contrast, two ocean energy projects make no reference to debt;
- bond finance is of limited relevance, being hardly mentioned by sponsors[36], as is true for internal company financing; and,
- outstanding funding needs either indicate shortfalls in funding which may stall a project or else non-disclosure of key aspects of the financial structure (such as expectations of feed-in tariffs).

3.1.3 Size of the investment need for FOAK projects

The following subsection quantifies the investment gap for FOAK projects in the EU and hence helps to provide estimates of the forecast level of funding required to support FOAK projects across 12 sectors[37] in order to help achieve EC policy objectives.

ICF has analysed the size of projects which formed the basis of our project sponsor analysis (see above). We took both the typical capacity of plants and the total investment costs for such plants to derive estimates of the likely number of SET FOAK projects which the market would require to have a credible demonstration effect for such innovations to become established in the market. This in turn would help to unlock further funding or capital flows from the private sector thereby enabling market replication to occur.

For example, the lack of any full-chain CCS FOAK projects in Europe, despite an ambition to have at least ten projects funded and operational by 2015, means that even ensuring that one or two such projects become operational could help to fundamentally change EU market sentiment on CCS. The deployment of 4 to 5 tidal stream arrays could also help to greatly lower risk perceptions for the ocean energy sector. This is in contrast to the likely need for many more AEN and large-scale energy storage FOAK projects due to the different regulatory requirements across each Member State and likely need for different business models to ensure sufficient revenues are generated.

Table 3.2 summarises these investment needs across SET sectors (and Annex 5 provides a full review including detailed explanations of these values). Overall, total investment needs for FOAK projects across all SET sectors by 2020 are estimated at €4.0bn to €28.5bn. This range is derived from considering both the minimum and maximum capacity of potential plants as well as the minimum and maximum deployment opportunities.

Considering only those sectors deemed to have the highest unmet funding needs (marked 'High' in Table 3.2) produces a funding need for FOAK projects of between €3.0bn and €18.1bn.

[34] Note that the vast majority of projects when consulted had yet to reach 'financial close', i.e. the point at which contracts are signed and the financial structure of the project is confirmed. FOAK project structures should be therefore regarded as indicative and by no means confirmation that it is possible for the sponsor to actually achieve the stated breakdown of debt, equity, etc.

[35] Geothermal energy is characterised as mature given that the first commercial geothermal power plant started operation in Italy in 1911, although it is recognised that more innovative geothermal approaches are much less mature in the market

[36] Bond finance is generally only available to refinance bank loans post-completion. It is possible that these project sponsors have insufficient knowledge as to where bond finance is most applicable and made assumptions about its potential

[37] Biomass, solar and wind have been split into two discrete areas

Table 3.2 Investment needs across SET sectors

SET sector	Indicative project sizes (EUR M)		EU SET FOAK project deployment needs to 2020		Indicative investment needs to 2020 (EUR M)	Estimate of current unmet funding needs
	Min size of project	Max size of project	Min no of FOAK projects per sector	Max no of FOAK projects per sector		
AEN	10	50	14	28	140 - 1,400	Medium
BIO (biofuels)	150	600	5	10	750 - 6,000	High
BIO (energy)	8	100	10	20	80 - 2,000	High
CCS	500	1400	1	2	500 - 2,800	High
CSP	185	330	5	10	925 - 3,300	High
GEO	75	120	3	6	225 - 720	Low
LES	15	350	5	10	75 - 3,500	Medium
OCEAN	20	100	5	10	100 - 1000	High
SPV (generation)	35	50	5	10	175 - 500	Low
SPV (manufacturing)	45	250	3	5	135 - 1,250	Low
WIND (fixed)	50	300	5	10	250 - 3,000	Low
WIND (floating array)	125	300	5	10	625 - 3,000	High
Total			**75**	**149**	**3,980 - 28,470**	

Source: ICF

It is evident that the minimum and maximum number of FOAK projects which need to be supported to 2020 across all SET sectors (covered by this study) ranges from 75 to 149. Even with a minimum size, minimum deployment scenario, total investment needs for SET FOAK projects are around €4 billion (and hence public sector contributions to such projects might reasonably be expected to be at a 50% intervention rate or €2 billion).

By way of example, the total forecast investment needs of 31 FOAK projects, covering eight SET sectors, as reported by sponsors to ICF, amounts to €3 billion or an average investment cost per project of €95 million (these projects are summarised in Annex 4).

The assessment of unmet funding needs shown in Table 3.2 is based not only on the prevailing market views of financiers and investors (from ICF consultations in Summer 2015 and Spring 2016), but also the scale of the funding requirement and the extent to which existing EC and Member State mechanisms are currently meeting sectoral funding needs.

There are six sectors where investments (i.e. equity) needs are believed to be most unmet by the market currently: second generation biofuels, bioenergy, CCS, CSP, Ocean and offshore floating wind. The total funding need for these sectors (marked as ‘High’ unmet funding needs in Table 3.2) is between €3.0bn and €18.1bn.

Table 4.4 (in Section 4.2.3) illustrates the general availability of the main forms of funding (i.e. equity, debt, grants, etc.) for FOAK projects across SET sectors. Clearly at such a high level, some of the sector nuances are lost. For example, biofuels FOAK projects are perceived as requiring equity by market participants. However, for other BIO project types equity is available (based on project sponsor feedback). Floating wind projects in particular are perceived as requiring equity against a background of quite large equity availability for wind overall.

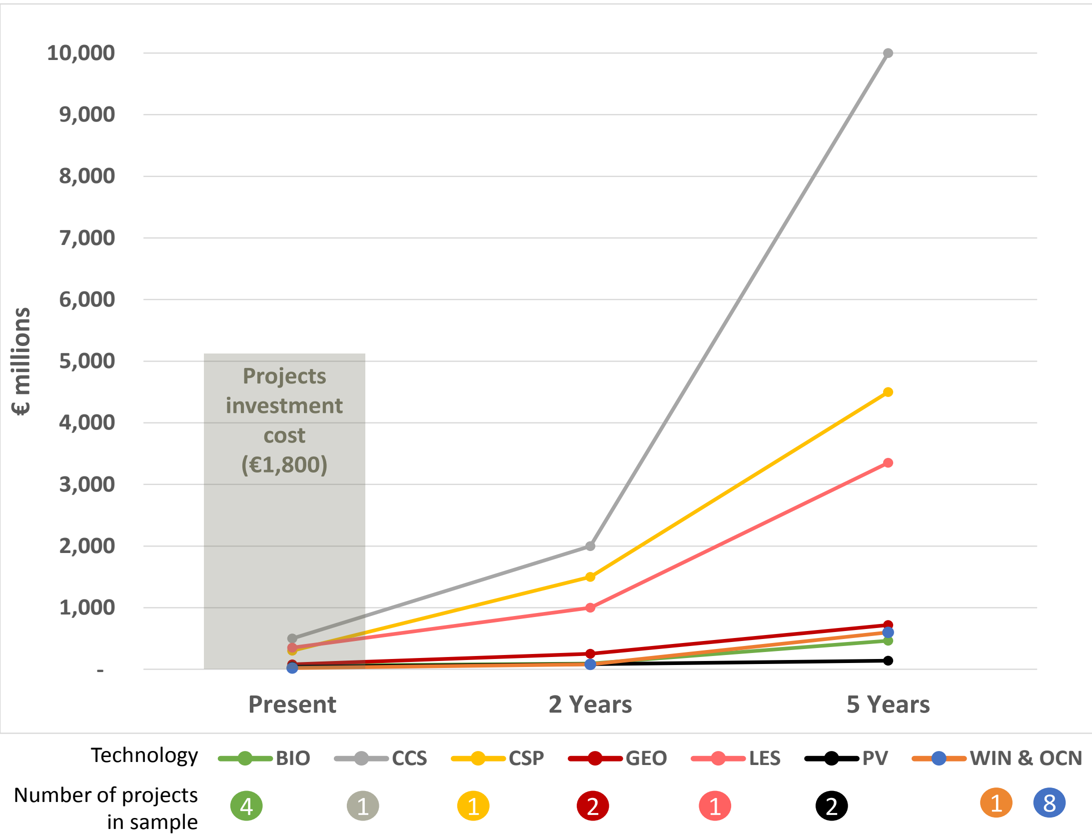
3.1.4 Market replication potential from demonstrating FOAK projects

Successful FOAK projects can achieve large future sales and could bring considerable future benefits to the EU economy. ICF asked those FOAK project sponsors it consulted to provide sales forecasts based on a successful operational demonstration of their project. Forecasts were provided in terms of number of plants, installed capacity and total sales for a period two and five years after the plant became operational. Figure 3.2 depicts the average *present* investment cost of projects and the average forecasted sales (in *2 years* and in *5 years*) per SET sector. The number of projects assessed under each sector is shown below the figure.

The study found that 20 typical FOAK projects in Europe, covering eight SET sectors, required total investment costs of €1.8 billion. Potential maximum returns from successful deployment of all these projects was estimated by sponsors at €6.2 billion after two years (a multiple of over 3 times), rising to €26.9 billion after five years (a multiple of 15 times)[38].

While the estimates assume project sponsors all achieve 100% success in realising their business plans, such figures do indicate at a project level the potential rewards from concerted action to effect change in the FOAK funding landscape. Annex 4 provides a full breakdown of these forecasts including at a sector level.

Figure 3.2 Cost and sales projections (in € million) per sector for FOAK projects across sectors



Source: ICF survey of European project sponsors, 2015

[38] Sales forecasts assume all projects become operational at the same time and that project sponsors experience no impediment in delivering their business plans. Given the very high risk nature of FOAK projects, these forecasts represent an indicator of potential market replication.

3.2 Mapping and analysis of SET support schemes in Europe

3.2.1 Introduction to prominent EU and Member State support schemes

Table 3.3 presents 14 prominent EU and Member State schemes used to support SET technology projects including, in many cases, FOAK projects. The age of support schemes varies widely with some being over 30 years old. Several, such as Denmark's EUDP, Germany's ERP Innovation Programme and UK's ETI, were all set up in 2007 at the height of the cleantech/low carbon technology funding boom – prior to the economic downturn and a flight away from early stage cleantech funding in the EU venture capital space. The remaining schemes researched are less than five years old.

Table 3.3 EU and Member State[39] schemes used to support SET projects

Scheme	Region/ Country	Started	Implementer
New Entrants Reserve 300 (NER 300) and proposed Innovation Fund	European Union	2010	EC/DG Climate Action/EIB/Member States
InnovFin Large Projects, and one of its umbrella schemes: the Energy Demo Projects Pilot facility	European Union	2014, 2015	EIB
European Fund for Strategic Investments (EFSI)	European Union	2015	EC/EIB
Energiteknologisk udvikiling og demonstration (Energy Technology Demonstration Programme, EUDP)	Denmark	2007	*Energiestyrelsen* (Danish Energy Agency)
Markedsmodningsfonden (Market Development Fund)	Denmark	2013	*Erhvervstyrelsen* (Danish Business Authority)
Programme d'Investissements d'Avenir (PIA) (Investments for the Future programme)	France	2010	*ADEME* (Energy & Environment Management Agency)
BMUB Umweltinnovationsprogramm (Environmental Innovation Programme)	Germany	1979	KfW Bank, *BMUB* (Ministry of Environment)
ERP Innovation Programme	Germany	2007	KfW Bank
Energy transition financing initiative	Germany	2012	KfW Bank
Industrifonden	Sweden	1979	Industrifonden Fund
Programme for Demonstration and Commercialization	Sweden	2011	*Energimyndigheten* Swedish Energy Agency
Energy Technologies Institute (ETI)	UK	2007	ETI
Green Investment Bank (GIB)	UK	2012	GIB
Enova (support for introduction of new technology)	Norway	2012	Enova

Source: ICF

[39] Norway's Enova scheme was included due to its relevance to EU project sponsors who might take advantage of the funding

Besides grant funding, which is the most common form of support, financial instruments (i.e. equity, loans and guarantees) have all been identified as being in operation within Member State schemes (although not necessarily enabling first-of-a-kind demonstration per se). Coverage includes:

- Equity investments – either directly into projects (France's PIA, UK's GIB) or into SMEs (Sweden's Industrifonden, UK's ETI) or via cornerstone investment into dedicated managed funds (UK's GIB);
- Repayable loans (France's PIA, Germany's KfW schemes, Norway's ENOVA); and,
- Guarantees (Denmark's Market Development Fund, UK's GIB).

A relatively common financial model for support of projects is to provide grant or other forms of finance in stages based on clear deliverables (for example, as practised by UK ETI) or on presentation of incurred costs (e.g. the Danish Market Development Fund, the Norwegian ENOVA fund). This means, however, that companies have to cash-flow the project; for smaller companies, this might pose a barrier to entering the competition.

Box 3.1 below shows the different EU support schemes being accessed by project sponsors. Only those EU schemes which can support innovations at TRLs 7-8 or beyond were assessed.

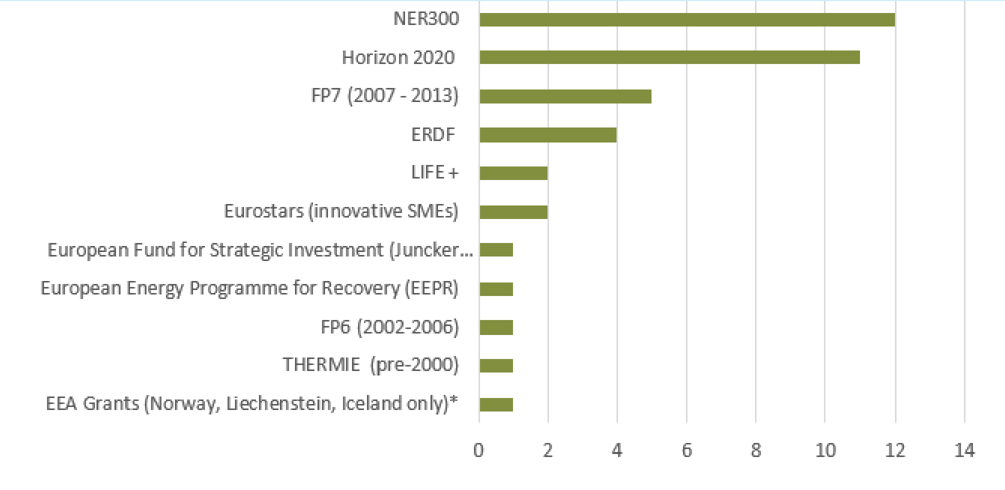
Box 3.1 EU funding sources are being used extensively by project sponsors seeking to get their projects to FOAK demonstration scale

The graph below illustrates that technology sponsors who responded to ICF's e-survey have placed a large reliance on the FP7/Horizon 2020 funding streams to get their innovations to the point at which they now require FOAK project funding.

The NER 300 scheme clearly stands out as the preferred choice for large-scale FOAK projects (projects taking part in the survey had either been successful or unsuccessful with their funding application). This is primarily due to the instrument offering the largest levels of funding per SET category of any mechanism available in the EU.

The plethora of other EC schemes illustrates the different funding channels that exist to support different aspects of the SET innovation funding market.

EU schemes to which developers had applied (successfully and unsuccessfully)



* Non-EU support scheme
Note: some respondents have applied to more than one scheme

Source: FOAK project sponsors who responded to ICF e-survey (May – June 2015)

3.2.2 Summary assessment of EU and Member State support schemes

An assessment of these schemes is given in Annex 6, with a summary shown in Table 3.4 below. Key points from this analysis include:

- Schemes typically cover projects from TRL 5 (early demonstration with a strong research focus) to TRL 9 (with its emphasis on deployed and proven technology). Only a few schemes focus specifically on TRLs 7-8 such as in Denmark (EUDP), UK (ETI) and Germany (ERP Innovation).
- Annual scheme budgets vary widely with France offering generous grant and loan support to projects and the largest budget of any Member State at €471m per year. EU schemes are considerably larger, especially the NER 300 grant programme which has awarded grants worth €2.1 billion to 39 projects at TRLs 7-8 (see Annex 7 for a summary of all NER 300 projects).
- Grants are the most common form of support with interventions up to 50%.
- Fixed term loans and guarantees, sometimes with a risk-sharing component, are financing mechanisms more focused on TRLs 8-9 projects, as projects/firms are often able to generate revenues from more proven technologies or less risky research which feeds existing operations.
- Equity-based investment into projects is rarely used: an example is the French PIA scheme.
- Project eligibility criteria varies widely, although common elements include: a requirement for substantial innovative content in the project; the financial credibility of partners; demonstrable emissions reductions; as well as clear market replication potential including a business plan.

Table 3.4 Financial schemes supporting SET projects including first-of-a-kind in the EU and Member States

Scheme Name (delivery body)	Geographical Area	Year Started	Status	Type of Instrument	Budget	Project Funding Levels	Suitability for FOAK Projects
New Entrants Reserve 300 (NER 300) and proposed Innovation Fund (DG Climate Action, EIB, Member States)	European Union	2010	Open	Grants	€2.1bn	50 - 60% co-financing[40]	High – has attracted a wide range of applications from across the EU-28 in numerous SET sectors, although it has faced challenges in delivery, which should be rectified under Innovation Fund
InnovFin Large Projects (EIB)	European Union	2014	Open	Loans & guarantees	€25bn (to 2020)	€25m - €300m	Medium to High - track record established under RSFF, although no evidence to date that this is supporting FOAK projects under SET (hence rationale for establishing EDP facility)
InnovFin Energy Demo Projects facility (EIB)	European Union	2015	Open	Loans & guarantees	€150m for 2015-2016[41]	€7.5m - €75m	High - over 40 applications already across SET sectors
European Fund for Strategic Investments (EFSI)	European Union	2015	Open	Loans & loan guarantees	€21bn	€50m - €75m[42]	Medium to High – though this depends on the appetite for risk shown, which for current projects is not high
Energy Technology Development and Demonstration Programme (Danish Energy Agency)	Denmark	2007	Open	Grants	€50m per year	€0.7m - €30m, although typically <€1m	High – well established scheme with good SET coverage, offering the potential for larger funding where required. Aligns with EC schemes such as NER 300. Funding was halved in 2015 due to a change in government[43]

[40] The threshold for NER 300 is 50% although smaller interventions have been committed. Under the proposed Innovation Fund, up to 60% of relevant project costs may be supported

[41] Following the pilot phase in 2015-16, a decision will be taken by the EC and EIB on the size and possible new features of the facility.

[42] Unspecified. However, in the renewables and resource efficiency space, projects to date suggest that a minimum of €50-75m is put forward for a guarantee under the Fund

[43] Feedback from scheme manager

Scheme Name (delivery body)	Geographical Area	Year Started	Status	Type of Instrument	Budget	Project Funding Levels	Suitability for FOAK Projects
Market Development Fund (*Markedsmodnings-fonden*)	Denmark	2013	Open	Grants & guarantees	€18m (2013-2015)	Grant funding: €0.4m - €1.3m Guarantees: €0.4m - €1.6m	Limited – Fund does not usually support large demonstration plants (limited to biogas projects at commercial scale) hence majority of energy demonstration projects apply to the EUDP scheme (see above)
Investments for the Future / *Investissements d'Avenir* (ADEME)	France	2010 (to 2016/ 2017)	Open	Grants, repayable loans, equity	€3.3bn fund value (€471m/ year)	€3m or more	High – large level of funding but mixed success to date despite broad sectoral coverage.
BMUB Environment Innovation Programme (KfW)	Germany	1979	Open	Loans & investment grants	€25m/year	€1m	Limited - some early renewable projects funded. Emphasis now on energy efficiency across industry/manufacturing
ERP Innovation Programme (KfW)	Germany	2007	Open (energy Window due to close)	Loan (subordinated tranche, not collateralised, & debt tranche)	N/A	Up to €25m per project or up to €50m in loans per enterprise	Low – Support to innovative energy technologies is limited and the lack of market uptake means Window closing Dec 2015
Energy transition financing initiative (KfW)	Germany	2012	Open	Loans provide 50 - 100% of debt finance required	ca.€150m	€25m – €100m covering max 50% of project costs	Low – the commercial terms offered unlikely to attract first-of-a-kind SET projects compared with proven technologies
Industrifonden	Sweden	1979	Open	Equity capital & risk sharing loans	Fund value €430m in 2012 / Investments €40m/year	€0.6m – €11m (15-50% of ownership)	Low – Cleantech is no longer an explicit focus and projects leading to an expensive demonstration-stage project are avoided
Programme for Demonstration and Commercialisation	Sweden	2009-2011	Closed	Grants	€95m	€15m - 24m (25-50% of project cost)	High – When open the scheme helped fund several first-of-a-kind demonstrations in key SET sectors so it

Scheme Name (delivery body)	Geographical Area	Year Started	Status	Type of Instrument	Budget	Project Funding Levels	Suitability for FOAK Projects
(Swedish Energy Agency)							is a good source of lessons learned
Energy Technologies Institute (ETI)	UK	2007 (to 2017)	Open	Grants, debt & equity	€1.3bn budget over lifetime	Currently up to ~£60m (€85.3m)	High – novel funding concept using public and private sector funding but additional co-investment proving difficult
Green Investment Bank (GIB)	UK	2012	Open	Loans & guarantees	ca. €1bn annually	To date >£50m (€65m)	Limited – initial focus helped support some first-of-a-kind demonstrations but strategy now into proven technologies and refinancing (e.g. wind farms)
Support for the introduction of new technology (Enova)	Norway	2012	Open	Grants	Spent €224m over 3 years (2012 – 2014)	Average Grant: €5.6m Largest Grant: €190m (in 2014)	High – SET projects are eligible for support. Since they must be located in Norway few are funded, but the scheme is a good source of lessons learned.

3.2.3 Insights into effectiveness of Member State support schemes

Large-scale, first-of-a-kind SET projects, requiring a minimum of €20m, are unlikely to be adequately supported by Member State support schemes

At face value, given the modest budgets available through most Member State schemes, which translate into very modest funding levels per project (e.g. typically of the order of €1m maximum), it is highly unlikely that large-scale, first-of-a-kind SET energy generation technologies requiring a minimum of €20m, as well as innovative manufacturing processes/plants requiring €50-100m, can be adequately supported by the Member State mechanisms ICF reviewed. Furthermore, given that several of the largest and highest spending Member States in this area were included in the analysis, the overall provision across Member State schemes in the EU-28 appears to fall well short of total FOAK investment needs identified to 2020 (see section 3.1.3).

Indeed, a gloomy picture is painted from ICF's analysis of current FOAK funding support, characterised by the following observations from some Member States:

- A lack of co-investment into high risk demonstrators (e.g. the UK Energy Technologies Institute which may end up closing down in 2017 due to a lack of interest from its member multinationals/engineering majors who have been annually funding the public/private partnership alongside the UK government);
- An emphasis more on low risk, proven technologies, leaving first-of-a-kind funding to others (e.g. the UK's Green Investment Bank);
- Retrenchment away from SET / cleantech funding, potentially jeopardising existing investments and sending a negative signalling effect to the wider market that investments into the sector are not profitable (e.g. Sweden's Industrifonden);
- Closure of demonstration schemes (e.g. Sweden's Programme for Demonstration and Commercialization which has closed after spending €95m on five projects; and the UK's CCS Commercialisation Competition – *see further details below*);
- SET – and renewable energy generation in particular – no longer regarded as a priority area to support (e.g. Germany's BMUB EIP scheme); and,
- A complete lack of market interest in accessing defined funding support for the development of new technologies to save, store, transmit or produce energy (e.g. Germany's KfW's ERP IP scheme which is closing a specialist funding window in December 2015 which allowed up to €25m grant funding per project or up to €50m in loans per enterprise).

On the other hand, France's PIA is investing very large sums overall (a budget of €3.3 billion over 6/7 years or ~€470m per year) into future "options" across numerous SET sectors at various TRLs, including 7-8. These significant sums should ultimately help deliver market-ready solutions, although a few of the first projects to complete had not achieved their objectives (see below).

An interesting finding is that while the sums of money involved in much pre-commercial R&D support in Member States is relatively modest, levels of due diligence and project monitoring are very high which can put off project applicants. Conversely, the sums of money associated with FOAK project funding can be enormous; and even for smaller FOAK projects, total funding requirements may in fact be larger than the budget of any one Member State scheme.

To a large extent, these modest funding levels for pre-commercial R&D are not only a result of a tightening of Member State finances post the economic downturn; they also tend to reflect an emphasis in many Member States on overcoming more fundamental R&D challenges for firms, especially SMEs and those at a pre-revenue stage. Member State government intervention in early stage technology and company development enables a greater array of future options to be generated and avoids the problem of "picking winners" and committing a large proportion of a national R&D budget to a handful of larger, riskier projects.

One scheme which sought to counter this 'flow' and pick a winner, in the interest of overcoming a clear funding gap, was the UK CCS Commercialisation Competition[44], regarded as one of the most significant public support interventions in the CCS sector globally. DECC committed to make available £1 billion (€1.3 billion) of capital funding, together with additional operational funding through the UK Electricity Market Reforms, to support the design, construction and operation of the UK's first commercial-scale CCS project. Despite being close to the point at which it would decide which of two projects it would back, following Front-End Engineering and Design (FEED) studies, owing to a change in government policy the government decided to axe the competition in November 2015. Clearly this came as a massive blow to the sector given the scale of funding required for a 'full chain' CCS plant, especially in the absence of other viable support mechanisms at the Member State or EC level[45].

There appears to be mixed success with Member State and EU support schemes

SET support schemes at the Member State and EU levels, including those targeting FOAK projects, have had mixed success to date. While many schemes had not been fully evaluated, ICF's consultations revealed the following insights:

- In Sweden, of five large-scale projects supported, totalling €113m in public and private investment, only one project had completed, two were on-going while two (totalling €65m) had been withdrawn[46].
- In the UK, several large-scale demonstration projects supported by the ETI had either stalled for technical or financial (e.g. private co-funding) reasons[47].
- Early results from France's PIA scheme, where a small number of projects had closed, showed that most did so without having reached their expected technology development and commercialisation stages. By mid-2015, only an estimated ten projects had reached so-called "completion", i.e. the relevant technology had been successfully developed and deployed. However, even for these so-called 'successful' demonstration projects, their commercialisation was felt to be sluggish, as evidenced by the slow pace to that point in the level of reimbursements made by project sponsors to the French State[48].

These examples illustrate that in the few Member States where public money is made available for FOAK projects, the process of achieving private match-funding, successful technical demonstration and market commercialisation is not without risk and far from straightforward.

In contrast to the above:

- In Denmark, a mid-term evaluation carried out in 2014 of the Energy Technology Development and Demonstration Programme, which disburses €50m per year to around 80 projects, found that over 70% of all project participants expected to bring new energy technology on to the market, in most cases within five years of completing their project[49].

[44] Not researched but it was due to offer to one full-chain CCS project £1bn (€1.3bn) in state-aid approved grant support

[45] The exceptions being the one CCS project awarded under NER 300 (White Rose), which was one of the two projects at FEED stage in the CCS Competition; other CCS projects have previously been supported under the EC's EEPR but no full chain CCS project has yet to be built from this grant programme.

[46] Source: Dr Lars Guldbrand, Swedish Energy Agency – presentation at RTD workshop, 8th December 2015

[47] ICF consultation with ETI, UK, 2015

[48] ICF consultation with CGI, France, 2015

[49] ICF consultation with Danish Energy Agency, 2015

- Germany's BMUB EIB scheme, which disburses €1m loans to companies from an annual budget of €25m, indicates a 95% success rate in helping technologies into the market, despite the relatively low levels of funding provided. A very thorough selection process, followed by a hands-on management approach with close technical monitoring by the German Environment Agency, coupled with financial advice and verification by KfW, appears critical to this high success rate, implying higher (but worthwhile) overhead costs on the part of public delivery bodies.

EU schemes offer significant support opportunities for FOAK projects, but overcoming key milestones such as planning and permitting and co-funding requirements can also be challenging. The following examples give a flavour of insights for FOAK projects:

- Under the €2.1 billion NER 300 grant programme the deadline for implementation had to be extended to allow project sponsors more time to develop their projects. Despite this extension, as at September 2016, only three of the 39 awarded projects had become operational, with most yet to achieve a Final Investment Decision.
- The InnovFin EDP facility, worth €150 million, has attracted over 70 enquiries (including many full applications) since May 2015, illustrating strong market demand for this specialist loan support. While the attrition rate for applicants is high, owing to strict eligibility criteria imposed by EIB, and in many cases projects are deemed to be at too early a stage in their development for the loan support[50], the first EDP loan was made to an ocean energy project in Portugal in July 2016. A further four applications are in advanced due diligence phase.
- It is also worth being reminded of the objectives and outcomes of the EU's Energy Programme for Economic Recovery (EEPR) which targeted, amongst other energy sectors, innovative offshore wind and CCS projects with very modest success to date (see Box 3.2). In many ways CCS should be fundable, except for: (a) the quantum of money needed (approximately €1 billion) and (b) the projects have 2-3 major components which cannot be integrated, so there is a lack of overall control on project completion, which is key for success.

Box 3.2 The EC's Energy Programme for Economic Recovery shows that co-funding is tough

The €4bn Energy Programme for Economic Recovery (EEPR), established in 2009 to stimulate new energy infrastructure and innovation, provided grant support to the SET area. However, many FOAK projects it supported were beset with co-funding challenges, notably for offshore wind and CCS.

In offshore wind, EEPR aimed to fund large-scale testing, manufacturing and deployment of innovative turbines and offshore foundation structures, as well as the development of module-based solutions for grid integration of large amounts of wind electricity transmission. Only three of nine offshore wind projects have been completed (with two terminated prematurely) with €237m paid to projects.

Progress also stalled on six CCS projects originally awarded €1bn. Only one project completed and three were terminated prematurely. Two projects are on-going (ROAD in Rotterdam and Don Valley in Yorkshire, UK); and €427m has been paid to these projects. However, both remaining projects *"continue to experience significant difficulties in obtaining the necessary funding for both construction and operation."*

Source: Report on the Implementation of the EEPR, October 2015, COM (2015) 484 Final[51]

[50] ICF consultation with InnovFin EDP, 2015

[51] https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v6_0.pdf

Given that the overall success rate for FOAK projects appears quite modest – either because projects fail to be initiated post-award, or projects are unable to achieve their objectives, or the demonstrated technology ultimately fails to find a strong market opening - may lead some to question the value of public sector interventions. However, public support for late stage research and demonstration can be very helpful in generating more robust future project developments in SET areas. Lessons learnt from failed projects and by consortia can lead to new configurations of technologies and projects amongst technology developers and the supply chain. Public sector investments also generate knowledge spillovers across project consortia and into the wider market, generating future economic benefits across sectors. This intangible value has been assessed by ICF for the UK government, including within the offshore wind supply chain, and has enabled an evaluation framework for spillovers to be developed which is now informing UK innovation support[52].

Leverage and signalling effects vary between different types of funding mechanisms

Many Member State schemes highlight their success in "crowding in" private sector funding with average leverage factors reported to be between one (which would result from a 50% intervention rate) and two (33% intervention rate). This is very typical of grant funding mechanisms. Equity and loan/loan guarantee instruments can often achieve larger leverage than simple grants. For example, a stock-take by the European Commission on the implementation of the full range of its EU-level financial instruments over the period 2007-2013 found[53] that the following leverage ratios were achieved:

- 5 for Equity Instruments;
- 4.8 to 31 for Guarantee Instruments;
- 10 to 259 for Risk-sharing Instruments; and
- 1.54 to 158 for Dedicated Investment Vehicles.

However, this is not always true for FIs. For example, in the case of the UK Innovation Investment Fund, investing in a broad spread of high growth sectors including low carbon energy, public equity only achieved 1.2x leverage, implying the need for more public support where investment risk levels are higher in order to 'crowd in' private investors[54]. This contrasts with the International Finance Corporation (IFC) which reported an average weighted total leverage ratio of 5.45 for its renewable energy project activities[55]. Clearly the objectives and deployment strategy of the FI play an important role in determining the ultimate leverage.

For some established schemes, such as the EC's InnovFin Large Projects (ILP) facility[56] and the German BMUB EIB scheme, both of which offer loans to projects, managers highlighted the strong impact the scheme has had in providing a quality stamp to the project, thereby helping to attract other investors/lenders. However, in other cases, such as the UK's ETI, co-funding from private investors has been challenging, especially at the levels of funding often required for FOAK projects.

---

[52] See further details in "ICF, *Economic Analysis of Spillovers from Programmes of Technological Innovation Support*, March 2014, for Department of Business, Innovation & Skills". Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288110/bis-14-653-economic-analysis-of-spillovers-from-programmes-of-technological-innovation-support.pdf

[53] COM(2014) 686 final, Report from the Commission to the European Parliament and the Council on financial instruments supported by the general budget

[54] The UK Innovation Investment Fund (UKIIF) disbursed £150m of public funding and leveraged £175m of private co-investment. BIS (2012), Early assessment of the UK innovation Investment fund, CEEDR Report to Department for Business Innovation and Skills

[55] IFC (2013), Leverage in IFC's Climate-Related Investments. A review of 9 Years of Investment Activity (Fiscal Years 2005-2013)

[56] Largely based on the continuation of the RSFF into the InnovFin Large Projects facility

Ability for EU and Member State schemes to meet investment needs

ICF estimates that total current grant, debt and equity provision for FOAK projects at EU and Member State level is around €4 billion, when measured across both EU support schemes (such as the NER 300 at €2.1 billion and InnovFin EDP) and available through key Member State support schemes. This leaves a public funding shortfall of around €10 billion to achieve the maximum levels of FOAK demonstration projects and investment needs discussed in section 3.1.3[57]. Obviously any new funding provision for FOAK projects, for example, via the EFSI or the proposed follow-up scheme to the current NER 300 grant programme, the Innovation Fund, will be a welcome addition to the current FOAK funding landscape.

Creating more formal linkages between Member State and EC schemes may help to maximise limited Member State R&D budgets in the future

None of the Member State schemes reported a direct link to European funding schemes such as NER 300, with the exception of the Danish EUDP which also manages Danish applications to NER 300. However, most scheme managers were aware of the key support options at the European level and indicated that their own schemes would be eligible for additional support by these schemes. For example, all German schemes allow co-funding from other public sources including EC schemes.

Some scheme managers (including the UK's ETI) highlighted that many of the European funding mechanisms/Calls do not provide the flexibility for the technical and financial needs of Member State projects. For example, the different needs and market conditions act as barriers for cross-border cooperation, such as the development of ocean energy projects. However, the Swedish Energy Agency indicated that they changed the focus of their funding scheme, the "Programme for Demonstration and Commercialisation", after the NER 300 scheme was launched to complement the support provided by the grant scheme. Sweden then went on to submit 10 applications for NER 300 funding which indicated its strategic approach and domestic interest in supporting large-scale demonstrators.

The general lack of visibility of future EC calls which might otherwise be aligned in a broad sense with Member State support is coupled with the length of time required to arrange the funding (if successful). For innovators, the need to ensure rapid responses to funding calls is often vital in securing private match funding. One scheme managed also noted that consortia rules for European funding schemes should be relaxed as technology needs are too different across Member States.

3.3 Mapping and analysis of financial market participants

3.3.1 The sample of financial market participants was deemed to be representative of the market

The sample of 80 market participants provided good coverage across leading investors and financiers who support the funding landscape for SET (i.e. proven technologies) and FOAK (i.e. TRL 7-8) projects in the EU and globally. An overview of the market participants is provided in Annex 8, with key points summarised below.

The 80 market participants were grouped together into four categories:

1. Specialised investors (i.e., venture capital, private equity firms) – 16
2. General investors (i.e., asset managers (2), pension funds (5), insurance companies (4), and foundations (1)) – 11;
3. Banks (i.e., public, private and project banks) – 28; and,

[57] Analysis is based on a bottom-up aggregation of major funding streams for FOAK project sponsors. Public sector intervention for FOAK projects could reasonably be expected to provide 50% funding, i.e. between €2bn and €14.25bn of the overall investment need range. Grant provision for FOAK is estimated at around €3bn through schemes dominated by NER 300 and France's PIA; loan provision is estimated at less than €500m (€150m via InnovFin's Energy Demo Project (EDP) facility as well as France's PIA's scheme and Germany's KfW provision); and equity provision is estimated at less than €500m (mainly via European Investment Fund into early stage cleantech companies during 2007-13 and now through InnovFin's SME Venture Capital scheme, and France's PIA scheme)

4. Producers (i.e., utility and energy companies, industrial conglomerates and manufacturers) – 25.

Importantly, financial market participants were drawn from both the EU (with 12 EU Member States represented) and non-EU, including institutions in North America, the Middle East and South East Asia and Japan.

Of all deals identified, 73% were made into the Europe/Middle East/Asia (EMEA) region and nearly half of all financing was represented by deals in Germany (20%), UK (18%), Spain (7.5%) and Denmark (4%).

Dominant SET sectors supported by market participants were wind, solar PV and bioenergy: the three most mature renewables markets in the EU (barring hydropower). SET sectors of medium importance to market participants were large-scale energy storage, advanced electricity networks and CSP. CCS, geothermal and ocean energy were of least importance to market participants

The 80 market participants have contributed €40 billion through 297 investments to 270 SET projects, of which €2 billion has been contributed through 87 investments to 85 projects identified as FOAK projects. Co-investors/co-financiers invested €60 billion into the same projects, bringing total deals identified to €100 billion.

Most deals (85%) identified as FOAK projects fell into the smallest category of deal size (i.e. < €75m) although 12% of deals were between €75m and €375m, and 4% of deals were worth up to €750m. This illustrates the high levels of funding which market participants are prepared to work with for the right FOAK projects.

The sample of 80 market participants can be considered representative of the European renewable energy investment landscape relative to the global benchmark sources identified[58].

The 80 market participants offer a satisfactory range of countries, technology sectors and financing support mechanisms (e.g. equity, debt, hybrid).

The market participants identified by the study are those that have a track record of providing funding (either equity investment and/or debt), into SET projects including many who are making investments into innovation activities[59]. This potentially makes them more likely than other parties to take on the uncertainty of first-of-a-kind deals in a similar field, although that hypothesis was tested further during consultations.

One of the key aspects of the consultations was to drill down into the specific interests and market perspectives of different actors. A good illustration of the different investment strategies and focus across the three main equity provider types is shown in Box 3.3 (below).

Box 3.3 Investment focus of different equity providers

Equipment suppliers and utility, or corporate, developers have, generally, a long-term perspective of 10 or more years, and their weighted cost of capital is of the order of 8-20% (post tax)[60]. Their main concerns are the business economics, principally revenue and regulatory risks, with the technology and completion risks self-managed to their satisfaction. Their interest in supporting FOAK can be well aligned with their overall business strategy and therefore a good justification exists for taking on greater risks than other funders. Such companies represent an important target for any new EC intervention.

[58] BNEF report "Global trends in clean energy investment q4 2014" (January 2015). Available at: http://about.bnef.com/presentations/clean-energy-investment-q4-2014-fact-pack/content/uploads/sites/4/2015/01/Q4-investment-fact-pack.pdf. Last accessed 16/04/2015; "Global trends in renewable energy investment 2014" (February 2015). Available at: http://fs-unep-centre.org/system/files/globaltrendsreport2014.pdf. Last accessed 16/04/2015; "Preqin Special Report: Renewable Energy Infrastructure" (October 2014). Available at https://www.preqin.com/docs/reports/Preqin-Special-Report-Renewable-Energy-Infrastructure-October-14.pdf. Last accessed 16/04/2015

[59] Note: "SET project" means an energy project involving one of the nine technologies of interest to this study from the SET Plan. SET projects can be either first-of-a-kind SET projects or non-first-of-a-kind SET projects.

[60] ICF estimate based on expert project financing opinion

Private equity (PE) funds may be institutional at source, but managed by “green” or “low carbon” investment bankers, who earn - or charge investors - both management fees and ‘carried interest’ fees. PE funds are often sector (energy type) specific (for example, focused on wind or solar) and restricted to OECD/Eurozone countries. Furthermore, the underlying project funding structures and arrangements may be somewhat multi-layered and opaque, optimizing taxation opportunities, which may not be acceptable in some quarters for public service entities. Finally, their investment horizon may only be 3-5 years, slightly shorter than for VC. Typically, a primary investment criterion is to invest post-completion, unless a major corporate is involved to provide financial muscle in the face of possible project completion issues (delays or cost overruns) or technology failure. PE funds may have a role in FOAK developments. However, they tend to hold similar views to lenders in terms of only supporting “proven” technologies, albeit as subordinate funders to lenders. Their appetite for high risk FOAK projects is very limited – and their willingness to fund larger deals (as noted above) dropped between 2012 and 2013.

“Low carbon” VC funds, on the other hand, usually represent a single funding source, e.g. a family trust, or, at most, a limited source range. They tend to operate on a longer time horizon than PE, from 5-7 years or longer, for example, 7-10 years, depending on target sectors. Their input is more aggressive, i.e. whilst they may be prepared to take project construction and completion risks, they will impose tighter managerial controls, which may, or may not, be acceptable to entrepreneurial developers. Further, many aspire to returns of 20-30% or more, demanding share options, controlling managerial appointments, etc. Such VC funds are numerous and often small-scale, with minimal market profile. Nevertheless, their funding is expensive.

3.3.2 Summary of key findings from consultations with financial market participants

The sample of market participants consulted was considered representative

Given overall investment and financial volumes disbursed by the 29 organisations with whom ICF consulted, and that interviewees were senior representatives often responsible for deciding on SET/FOAK strategy and decision making, views expressed by this sample are deemed to be representative of equity and debt providers overall within the European market[61]. Key findings are summarised below and elaborated in Annex 11.

The strategic focus of market participants was mainly on established SET projects but Producers had the most interest in supporting FOAK projects

Overall availability of funding across market participants for SET projects using proven technologies is generally high, especially in the EU. Typically, there is no shortage of funding for proven onshore wind and solar PV, since returns are regarded as safe; the technology risks have been largely eliminated; and the Levelised Cost of Energy (LCOE) has fallen to levels where subsidies are now far less important than they were. Other SET areas where there has been some funding, but of far less significance, include biomass (bioenergy rather than biofuels), high temperature geothermal (in limited EU Member States such as Italy, France, Germany), and CSP (although money has moved to non-EU areas such as South Africa and the USA, often using proven Spanish technology).

Unsurprisingly, in view of their general attitude towards unproven technology and since FOAK projects involve technologies that, in most cases, are some considerable distance short of satisfying standard investment-readiness criteria (as applied to energy and infrastructure project financings), there was only a limited appetite to support FOAK projects in Europe amongst many of the market participants interviewed.

All Banks and almost all General Investors interviewed restrict themselves to opportunities involving SET projects at TRL 9 or higher. Conversely, Producers (i.e. energy utilities, energy operators and engineering companies) and Specialised Investors (i.e. VC/PE) have investment horizons covering a wider range of TRLs, namely TRLs 5-9. However, of all the

[61] Several of the market participants were based outside the EU but had strategic interests in European markets

market participants consulted, Producers are likely to have the greatest propensity (and track record) to invest in FOAK projects.

Specialised Investors remain an important part of the funding mix but less than in the past. Of those ICF consulted with, a few currently active in FOAK no longer have the same appetite for such investments as they did previously; and we heard that several Specialised Investors had also left the FOAK field altogether. Explanations for this retrenchment included bad experiences with FOAK deals (and also SET deals) and the competing attraction of opportunities in other sectors, especially more "capital-light" deals. Consequently, only very modest levels of equity funding are available (e.g. less than €4m). These findings reflect European-wide statistics on VC/PE investments into renewable energy which show investment fell by 83% between 2012 and 2013; and average VC/PE deal sizes have also plummeted from €37m to just €9m in 2013.

Levels of equity and debt provision for FOAK projects

Levels of equity committed to FOAK projects differ widely across investor types, with Producers able to offer the highest investment levels.

The scale of funding required for FOAK projects is beyond the usual value range for VC funds (at least in the EU); and private equity is currently more interested in financing proven technologies at scale and with known and demonstrable opportunities for market replication. Producers offer valuable potential support although their commitment to FOAK projects (in terms of direct equity contributions) varies widely and aligning interests with innovative SMEs may be challenging.

Given the equity shortfall for FOAK projects from Specialist Investors, Producer interest is critical to support FOAK projects. Long-term commitment from Producers will help provide sector stability and send the right market signals to financial institutions. However, unless Producers are keen to contribute equity to the FOAK project equity gap in large volumes, for many of the proposed FOAK projects identified in this study - and most likely many future FOAK project types - major injections of public sector grant or equity support appears inevitable.

Interviews with private sector banks (investment, retail, universal) confirmed with some confidence the anticipated conclusion that debt is seldom used as a major form of finance for FOAK opportunities, i.e. prudent lenders are not interested or able to take exposures on FOAK projects. Increasing regulatory and capital adequacy requirements imposed on private banks and insurance companies have reduced their willingness to take risk, impacting investment activities which might have otherwise been considered. In contrast, public banks may be more inclined to do so, such as Germany's KfW, the Scottish Investment Bank and the EIB (e.g. via the InnovFin EDP facility).

Confidentiality of deal information and decision making criteria

Market participants overall were reluctant to divulge the financing decision criteria used in deals. Members of the study team, who have experience as private sector project financiers, believe that this is do with the commercial value in such decisions as they are vital to achieving successful deal structures and outcomes, and maintaining competitive advantage.

Importance to financial market participants of identifying and managing risks

All four types of market participant cite risks due to technology and regulatory instability as fundamental criteria for project decisions. Project completion and revenue risks are also important aspects taken into account which together have a major bearing on the overall determination of commercial viability. While risks due to unproven technology, regulatory instability or inherently unviable project economics are only ever cited as deal 'showstoppers', a series of business risks including viable business models (including secure feedstock and/or energy offtake agreements), project developer capabilities and supply chain integration are also important considerations, especially for Specialist Investors and to a lesser extent Producers.

The fundamental importance of stable EC and Member State policy and regulatory frameworks for mitigating risks to investors and debt providers and helping to unlock support for FOAK projects across all sectors is clear. However, both technology and regulatory risks have an equal ability to stop progress in projects, either singularly or in tandem.

A more detailed analysis of project risks, and the sentiments of market participants to such risks, is set out in section 4.2.1 and elaborated further in Annex 12.

3.3.3 Macro-trends in the supply of investment and finance into FOAK and SET in general

From our analysis of all information sources, the following trends in the supply of investment and finance are prevalent:

- The scale of investment needed for FOAK projects is beyond the usual value range for venture capitalists. Demonstration projects for renewable energy technologies generally cost tens of millions of euros. European VCs tend to invest in smaller amounts on multiple projects to diversify risk. Owing to bad experiences with FOAK deals, and also SET deals, and the competing attraction of opportunities in other fields, fewer VC/PE investors are now active than previously and those that are, have reined in their investments compared with previous years. As one firm noted: *"The depth of funding is thin as the risk appetite has gone out of the market"*. Many big European clean-tech names who were active from 2005 to 2010 have now moved into focusing their investment on "late stage" companies, i.e., to those with revenues of over €7 million and with a product people want to buy. Producers offer the most viable solution to large-scale FOAK project financing equity requirements as they are more readily able to invest in riskier ventures. However, in the Ocean and CCS sectors, even Producers have pulled back from high risk and capital intensive projects.
- Institutional investors have started to diversify their portfolios and look long-term, although in the main they continue to pursue low risk, conservative investment strategies. Pension funds and insurance companies are increasing their exposures in renewable energy, but rarely for FOAK projects and typically as acquirers of debt or equity portfolios from other market participants in established projects with operational benchmarks and a commercial track record.
- Regulatory barriers on banks and insurance companies have affected investment activity – since the 2008-9 Financial Crisis, Basel III rules have important implications for lending practices of banks, which constrain liquidity with a view to creating greater stability and resilience in banks. The impact of Basel III restricts the supply of long-term funding available from banks, which infrastructure and energy projects demand, and limits their willingness to take risk. Hence, they are more circumspect when reviewing funding opportunities in these sectors. One consequence is that opportunities for financing small companies/special purpose vehicles (SPVs) using an innovative low carbon energy technology are passed over as being not cost-effective to pursue.
- Limiting the ability of banks to provide long-term, non-recourse project finance, has had implications for the availability of capital for infrastructure projects. The "collateral damage" is that these tightened rules have led to less willingness by banks to fund sustainable investments. At a time when many EU member States are embarking on major investments in infrastructure and energy, not least as a way to pull their economy out of recession, the Basel III requirements imposed on banks make no differentiation as to the nature of bank's lending exposures, such that energy and infrastructure loans receive no special treatment or benefit. Similarly, the Solvency II Directive requirements for insurance undertakings also require institutional investors to adopt a more stringent, harmonised risk-based regime and new, more rigorous accounting standards.

3.3.4 The willingness of financial market participants to support FOAK projects has changed significantly across time

Based on research and consultations, there are various internal and external factors at play which help to explain why attitudes and actions towards FOAK funding are evolving.

Internal factors

Internal factors include:

- Changes in investment strategy, especially within VC funds - For VC/PE, few funds now focus exclusively on energy generation opportunities as they may have done in the past – for example, one VC firm in the USA noted that renewable energy was now secondary to energy efficiency in the ratio 35:65 for total equity invested. One reason is that innovative energy efficiency technologies can be rapidly deployed; another is that levels of risk are substantially lower. In the UK, the Green Investment Bank is investing €130m into equity funds exclusively targeting deployment of proven energy efficiency technologies into commercial and business opportunities.
- Significant money lost in the past - Several market participants have previously backed FOAK projects (e.g. in bioenergy & biofuels, ocean, solar PV, CSP) and have been severely 'burnt'. As one VC noted: *"People have stopped investing in FOAK because they have lost money"*.
- Poor financial returns – the ability to satisfy the investment requirements of limited partners in funds can lead to more risky SET FOAK investments being stopped.
- Risk levels too great - Commercial-scale FOAK demonstration projects in the EU are perceived as highly risky;
- Shortage of FOAK-specific in-house expertise as opposed to more traditional, company-focused VC expertise; and,
- Limited network connections with technology and project developers at the scale required.

External factors

Internal factors include:

- Capital intensity of FOAK projects - the opportunity for VC/PE to support less capital intensive opportunities (e.g. energy efficiency, as well as ICT/media or pharma), coupled with previously negative experiences of cleantech funding, has led to a flight of equity capital away from innovative FOAK projects;
- Long time to market for SET technologies – the time taken to plan, permit and deploy a FOAK project may fall outside the investment/lending horizons of many market participants;
- Tightly regulated markets – the ability to generate returns is restricted by economic regulators in the energy market.
- Potential lack of successful and profitable precedents in the market - although access to data is challenging due to commercial confidentiality, the cleantech space (especially in the EU) has yet to establish a strong track record in delivering consistent returns that will lead to a step-change in levels of private investment. European-wide statistics on VC/PE investments into renewable energy do not paint a good picture for support to FOAK projects. Overall investment fell by 83% across the EU between 2012 and 2013. However, the number of deals fell only by 30%, making deal sizes smaller in 2013. In 2012, the average VC/PE deal size was €37m, but dropped to just €9m in 2013)[62]. Opportunities therefore continue to arise but investment levels are becoming ever tighter; and,
- Withdrawal of financing from potential co-investment and financial partners for higher risk ventures due to the impact of the economic downturn (i.e. from 2008 onwards).

[62] Eurobserv'er, *'The State of Renewable Energies in Europe'*, 2014 Edition. http://www.energies-renouvelables.org/observ-er/stat_baro/barobilan/barobilan14_EN.pdf

3.3.5 A sectoral 'heat map' shows where investors and lenders are most interested

Based on the overall current interest of those financial market participants ICF consulted who provide equity and debt into SET and FOAK markets, Table 3.5 illustrates a 'heat map' of those SET categories which have most activity, both currently and historically. Key features include:

- The largest and most mature SET sectors within the study - Bioenergy, SPV and Wind - are also the markets with the strongest interest from financial market participants;
- Both AEN and LES have medium levels of interest, although only from Specialised investors and Producers;
- Minor or historic activity is evident for both CSP, Geothermal and Ocean energy; and,
- CCS attracts interest from only Specialised investors – and even then it is only Minor.

More detailed feedback and attitudes to FOAK projects from different types of market participants are captured in Table A11.2 in Annex 11.

Table 3.5 Financial market participants have very different levels of interest in SET & FOAK projects[63]

Market Participants	Funding types	Funding levels	TRLs of interest	Key Sectors	Medium interest	Minor interest	Historic interest
Specialised investors	Equity & sub-debt	€1-5m	5-9	BIO SPV	AEN LES WIND	CCS GEO	CSP OCEAN
General investors	Debt & Equity	€1-20m	Mainly 9	SPV WIND		BIO CSP	AEN GEO LES
Producers	Balance Sheet Equity & SPVs	€20-100m	5-9	WIND	BIO LES	AEN CSP GEO OCEAN SPV	
Banks	Debt only	€20-100m	9	BIO, SPV WIND		CSP GEO	

Source: ICF survey of financial market participants

3.3.6 Financial market participant recommendations for supporting SET FOAK projects in Europe

Encouraging Producers and VC/PE funds to become more interested in FOAK project investment is likely to require various mutually-reinforcing approaches, including: greater awareness of technological development needs; improved connectivity across technology developers, producers and supply chains; more successful sector precedents to build confidence; advice on appropriate deal structuring; and appropriate financial incentives to provide rewards for taking on elevated risk levels in FOAK projects. Deal syndication[64] within a tailored EC support intervention appears one viable route for achieving the high equity and debt volumes required for FOAK project types. However, even such syndication could prove

[63] The table illustrates where financing and investment interest lies across SET sectors. Clearly some market participants (e.g. banks) have little or no interest in FOAK projects. However, others (e.g. investors, producers) do and hence the table shows sectors they are most likely to prioritise, although all would be technically in-scope.

[64] Where a funding vehicle allows investors or financiers to co-invest / co-lend alongside others into the best FOAK projects

problematic given the limited support from European equity investors in SET and FOAK projects and the limited interest from Banks.

Market participants recommended that the EC should offer support to market participants in three main areas:

1. Providing funding alongside tailored interventions to enhance the innovation support system in Europe for FOAK projects;
2. Playing a role in helping shape the policy landscape and improve framework conditions, including through more stable tariff structures and regulatory regimes, more rapid planning and permitting for FOAK projects, and other approaches that can enable viable business models to be created (e.g. for energy storage projects); and,
3. Providing greater awareness of successful FOAK projects, for example through success case studies and through the provision of support to assist innovators in navigating a complex regulatory and support landscape in Europe.

All Market Participants felt that the EC should provide equity to support FOAK projects since this will help to mitigate technology risk; and most also felt debt (loans) should be made available including, for Specialist Investors, as mezzanine finance[65] and low-interest loans[66], and for Banks as bridging finance for construction[67]. These findings helped ICF to refine its formulation of appropriate policy options to remove financing bottlenecks for FOAK projects, leading to the development of a new FI (a SET FOAK equity fund) as well as providing support for the EDP facility. The ex-ante assessments of both these FIs are covered in sections 6 and 7 of this report.

It is important to recognise that grant provision was also widely called for by market participants, both for FOAK project feasibility and construction phases. Interestingly, few organisations mentioned the NER 300 support mechanism, despite this being an important source of grant support at EC level and in which upfront funding for critical early project stages was available to a few projects[68].

The majority of this public sector support would help to overcome financial risks, but not necessarily the business risks associated with FOAK projects. To achieve a step-change in private investment in FOAK projects will require more fundamental changes to EC and Member State energy and climate regulatory frameworks which is beyond the scope of this study.

3.4 Market conditions affecting SET FOAK projects

On the basis of information obtained through an extensive review of the literature, Table 3.6 shows for each SET, which of the 32 countries reviewed have a positive outlook for market conditions, and which have a neutral or negative outlook. It also shows which countries are of particular interest due to recent sustained growth in capacity (or development and deployment budget, in the case of advanced electricity networks) combined with a positive (or at least neutral) outlook.

Several market conditions which generate positive framework conditions for funding FOAK projects were identified as being important perquisites for demonstrators. They include:

- Resource availability, such as a viable ocean energy resource in the North West of Europe and excellent solar radiation across the Mediterranean to benefit CSP.
- Well-designed planning and permitting systems, established supply chains, testing/demonstration centres and greater public acceptance, are more likely to be in

[65] Note that mezzanine finance or sub-debt is usually classified as “equity”

[66] Soft loans, i.e. on concessionary terms, might help, but only for large-scale FOAK project such as CCS which has very long-term capital recovery

[67] Note that neither equity nor debt provision will mitigate regulatory risks

[68] Upfront funding was available as long as the respective Member State government guaranteed the project which was not the case in many of the Member States involved

place where high penetration rates already exist, as with Solar PV, (onshore) Wind and Bioenergy. This creates more optimal market conditions for FOAK projects.

- Stable and predictable systems of fiscal support have a positive signalling effect to potential investors/financiers of FOAK projects since they help to accelerate deployment of technically proven and early commercial technologies. Renewable energy plants are often given priority in terms of network access and dispatch of generated electricity where fiscal support is provided.
- Consistent and supportive policy framework, including ambitious future capacity targets in National Renewable Energy Action Plans (NREAPs), plays a crucial role in fostering new developments for sectors where limited or no market deployment exists (e.g. CCS, GEO, LES and OCN) as well as for sectors with a high level of market deployment (e.g., biomass conversion technologies).

As policy frameworks vary widely, it is no surprise that existing capacities and capacity growth rates vary, even between countries whose resource availabilities are similar.

The legend below identifies the symbols used to categorise countries across the sectors in Table 3.6 overleaf:

☺	= positive outlook for market conditions
😐	= neutral outlook for market conditions
☹	= negative outlook for market conditions
	= particular interest

Table 3.6 Countries where market outlook is positive (or negative) and which are of particular interest

Country	AEN*	Biomass conversion technologies	CCS**	CSP	Geo-thermal energy	LES***	Ocean energy	Solar PV	Wind energy
Belgium	😐	☹	😐	😐	😐	😐	😐	😐	☺
Bulgaria	😐	**☺**	😐	😐	😐	😐	😐	😐	☹
Czech Republic	😐	**☺**	😐	😐	☹	😐	😐	😐	☹
Denmark	😐	☺	☹	😐	😐	😐	😐	😐	**☺**
Germany	**☺**	**☺**	😐	😐	**☺**	**😐**	😐	**☺**	**☺**
Estonia	😐	☺	😐	😐	😐	😐	😐	😐	☺
Ireland	☺	😐	😐	😐	😐	😐	☺	☺	😐
Greece	😐	☺	😐	☺	☹	😐	😐	😐	😐
Spain	☺	😐	☺	☹	😐	**😐**	😐	☹	☹
France	**☺**	**☺**	😐	☺	**☺**	😐	**☺**	😐	**☺**
Croatia	😐	😐	😐	😐	☺	😐	😐	😐	😐
Italy	☺	**☺**	😐	**😐**	☺	☺	😐	😐	😐
Cyprus	😐	😐	😐	😐	😐	😐	😐	😐	☹
Latvia	😐	☺	😐	😐	😐	😐	😐	😐	☹
Lithuania	😐	😐	😐	😐	😐	😐	😐	😐	☺
Luxembourg	😐	☺	😐	😐	😐	😐	😐	😐	☺
Hungary	😐	😐	😐	😐	😐	😐	😐	😐	☹
Malta	😐	😐	😐	😐	😐	😐	😐	☺	☹
Netherlands	😐	☺	**☺**	😐	**😐**	😐	☺	**☺**	**☺**
Austria	😐	😐	😐	😐	😐	😐	😐	😐	☺
Poland	😐	**☺**	😐	😐	😐	😐	😐	☺	😐
Portugal	😐	☺	😐	☹	☺	☺	☺	☹	😐
Romania	😐	☹	😐	😐	😐	😐	😐	**😐**	😐
Slovenia	😐	☺	😐	😐	😐	😐	😐	😐	😐
Slovak Republic	😐	☺	😐	😐	☹	😐	😐	😐	☹
Finland	☺	😐	😐	😐	😐	😐	😐	😐	😐
Sweden	😐	😐	😐	😐	😐	😐	☺	😐	☺
United Kingdom	**☺**	😐	☹	😐	😐	**☺**	**☺**	😐	**☺**
Switzerland	😐	😐	😐	😐	😐	😐	😐	😐	😐
Iceland	😐	😐	😐	😐	**😐**	😐	😐	😐	😐
Norway	😐	😐	**😐**	😐	😐	😐	😐	😐	☺
Ukraine	😐	😐	😐	😐	😐	😐	😐	😐	☺

☺ = positive outlook
😐 = neutral outlook
☹ = negative outlook

AEN* = Advanced electricity networks
CCS** = Carbon Capture & Storage
LES*** = Large scale energy storage

= particular interest

The magnitude of direct policy support mechanisms (e.g. FiTs) is often used as a proxy for the attractiveness of different countries' investment environments and thus the fundamental economic parameters, commercial viability and thus the 'bankability' of projects. However, calculating the bankability of projects requires substantial knowledge on a Member State level, not only of the factors affecting the development of the project in question, but also of the supply chains, established infrastructure and, not least, the "counterfactual" scenario which the project is being measured against (i.e. how easily and cheaply could a conventional fossil-fuel plant be built or else other proven renewables).

Low levels of direct renewable energy support are not necessarily indicative of worse market conditions for specific technology types due to the different regimes which countries operate. The new Contracts for Difference (CfD) regime in the UK aims to drive down the cost of renewable energy deployment through annual auctions in which competitive bids amongst project developers help to lower costs to consumers; the CfD also helps reduce investor risk while incentivising technically proven but near- or early-commercial solutions to be implemented (for example seven offshore wind farms have been supported under initial CfD competitions in the UK). However, CfD is not a panacea due to its complexity, uncertainty of the auction process and, crucially, since projects must be largely viable in their own right. This approach therefore captures less FOAK 'territory' than targeting early commercial projects. Further, CfD applications are likely to be manageable only by larger and more experienced developers with resources to bring forward projects.

With respect to other market conditions, planning and permitting policies, the presence of emerging or mature supply chains and demonstration centres for projects at TRL 7-8, as well as the general public's social acceptance, are more likely where high penetration rates have already occurred - for example, for SPV, Wind and Bioenergy - thereby providing more optimal market conditions for FOAK projects to be established. Where low or no market deployment has occurred (e.g. for CCS, Geothermal, LES and Ocean) policy support plays a more crucial role in fostering growth and can also take much longer for environmental regulators to develop guidance and issue permits for more novel and untested technologies.

Not surprisingly, wide differences in market conditions exist across SET sectors and EU-28. However, in general, across all SET and countries, the outlook can be taken as generally neutral, with some sectors such as biomass, ocean energy and wind energy showing a more positive outlook than in other sectors. There is also at least one Member State - and more typically two or three – for each SET sector which is deemed to have positive conditions for FOAK projects.

Some countries may currently have limited or zero capacity, but do have resource and political aspirations – such as NREAP targets – to start to deploy SET in due course. Furthermore, for each SET, there is at least one country of particular interest for FOAK development. Biomass conversion technologies have the most Member States where FOAK projects might be suitable (BG, CZ, DE, FR, IT, PL), in contrast with CSP which has just one (IT). Ocean energy currently has two countries of interest (FR, UK) while for CCS just two countries represent FOAK project siting opportunities (NL and Norway).

Importantly, the dynamic nature of market conditions and the political instability that has been seen across many SET markets of late, means that conditions can change overnight. For example, the UK government recently axed its €1.3bn CCS Commercialisation Programme Competition after over five years of planning, impacting two planned projects, in England (White Rose – the only NER 300 CCS awardee) and Scotland (Shell/SSE). It is uncertain whether the former will progress, while the latter has been cancelled. The market conditions for CCS in the UK were therefore downgraded to a negative outlook.

State aid regulations have presented problems for at least one FOAK support programme (i.e. the UK's ETI), for example, regarding complex rules which are difficult to navigate and intervention rates placed upon Member State schemes (i.e. typically no greater than 50% in most cases for late stage research) which create co-financing challenges (see Box 3.4 for further insights).

Box 3.4 The challenge of working with EC State aid regulations was articulated by the UK's ETI

> The ETI believes that, at face value, the State aid framework for R&D presents a sensible approach for managing public funding support to companies. However, it presumes that all technologies are in a similar market position. For example, for floating wind turbines, there is currently no market and the associated risks are very high. Under State aid rule, ETI is only allowed to support projects that are additional, i.e. do not have a full commercial case. However, the R&D framework only allows ETI to fund a floating wind or other FOAK project at an intervention rate of around 40-50%. Some of ETI's projects however need 100% funding as they are not yet commercially viable. For a small company with a novel idea, but no market to sell into yet, the ETI reported that it would require an intervention level from them of 90%. In this matter, the size of company taking forward the innovation is important. Obviously firms with larger balance sheets will be better able to afford to self-fund (or co-finance) such ventures alongside the ETI's contribution.

Notwithstanding such limitations, new European state aid regulations for energy and R&D are likely to have a positive influence on FOAK project funding including in sectors such as CCS, biofuel and smart grids. For example, Member States can provide support to new innovative production plants for novel biofuels or bio-refineries; and operating and investment aid are permitted to support industrial installations equipped with CO_2 capture, transport and storage facilities. Demonstration projects are also exempt from a required transition under State Aid rules for subsidy schemes to move away from FiTs to feed-in premiums; they are also exempt from standard balancing responsibilities. These exemptions could be used by Member States to create demonstration-specific support schemes for SETs of particular interest. The new State Aid guidelines for energy and environment also include provisions for technology-specific tenders on the basis of the potential of a new or innovative renewable energy technology.

Market conditions, including more details on State aid, are analysed further in Annex 9.

3.5 Mapping and analysis of SET support schemes outside the EU

3.5.1 Introduction to leading non-EU support schemes

The following seven schemes (also illustrated in Figure 2.3) were reviewed in detail including via consultations with several of the scheme managers:

- Advancing Renewables Programme (ARP), Australia
- NextGen Biofuels Fund, Canada
- Loan Programs Office, USA
- Carbon Capture Program, USA
- ARPA-E grants Program, USA
- New Energy and Industrial Technology Development Organisation (NEDO), Japan
- Callaghan Innovation, New Zealand

Key findings and an assessment of scheme effectiveness are summarised below and in Table 3.7, with further analysis in Annex 10.

3.5.2 Summary assessment of support schemes

There is a high degree of relevance of international schemes towards FOAK support, with five of the seven offering interventions around TRLs 7-8[69]. Schemes that focus primarily on TRLs 7-8 include the Canadian NextGen Biofuels Fund and the U.S. Loans Projects Office (which also covers TRL 9).

Grant funding is the most common form of support in Australia, Japan, New Zealand and several U.S. support schemes. However, some interesting financial instruments have also been deployed. These include:

[69] The one scheme which does not cover FOAK projects is ARPA-E, while the New Zealand grants scheme does not offer sufficient grant funding to undertake a large-scale FOAK project of consideration in this study.

- zero-interest loans for a second generation biofuels demonstration programme in Canada, in which the loan repayment terms are based on a negotiable percentage of free cash flow over a period of 10 years after project completion;
- loans and loan guarantees within the Loans Projects Office, USA, in which the average loan length ("tenor") is over 22 years, far longer than for more commercial, mainstream projects; and,
- Combination of grant and loan support in Australia. For example, a €26.3million project involving a 10.6 MW first-of-a-kind, solar PV installation with storage at the DeGrussa Copper Mine aims to showcase the potential for renewable energy at mine sites. Grant support of €14m million from ARP complements up to €10m in debt finance from the Australian Clean Energy Finance Corporation, which specifically targets projects which the commercial sector is not yet willing to back.

On the whole the schemes are judged to be recognised and visible by the market, with funding levels in the right 'ball park' for FOAK-scale project support. For example, maximum funding levels included: €33m (Australia), over €92m (large-scale CCS in USA), €140m (biofuels, Canada), and over €1bn (for CSP within the LPO, USA).

Demonstration of the technology at pre-commercial pilot scale is often required to be eligible for funding, as are defined economic benefits that the support will generate such as market replication potential. Most schemes have also thought clearly about where it makes strategic sense to back particular SET areas to enhance domestic supply chains.

Table 3.7 Financial schemes supporting SET projects including first-of-a-kind in non-EU countries

Scheme Name (delivery body)	Country	Year Started	Status	Type of Instrument	Budget	Project Funding Levels	Suitability for SET Projects
Advancing Renewables Programme (ARP)	Australia	2015	Open	Grants	~€217m for 2015/16 (total agency budget)	€70,000 to €33m (min 50% co-financing)	High – new programme focused on reducing costs and barriers to SET. Provides a robust funding 'ecosystem' where applicants are supported throughout the TRL spectrum through to TRL 9. VC fund and links to other public sector funders provides overall provision.
NextGen Biofuels Fund™	Canada	2007	Closed to new projects	Zero-interest Loans	€349m	40% of eligible costs or maximum of €140m	High – well established and well-published scheme which provides a continuum of funding for bioenergy innovations proven under the €412m STDC Tech Fund. Scale of ambition not matched by funded and operational projects (just 2 supported).
Loan Programs Office (LPO)	USA	2009	Newly opened in 2015	Loans (Full & Partial) and Guarantees	€31.4bn (€2.8bn of new funding announced)	€23m (LES) to over €1bn (CSP)	High – regarded as a key mechanism for 'bridging the finance gap' for commercial lenders with respect to FOAK projects. Wide project selection across SET, although there is some uncertainty regarding the TRL levels of the support since some technologies supported appear less technologically risky and already proven (e.g. Solar PV, CSP, Geothermal, Wind).
Carbon Capture Programme	USA	2009	Open	Grant	€92m per year (Agency) & €3.1bn previously earmarked from Recovery Act for the Office of Fossil Energy	Varying funding based on scale & type Intervention rates for power plants (30.8%) vs industrial CCS (62%)	High – well intentioned CCS programme, with opportunities for varying TRL support including for large-scale demonstration projects at coal-fired power stations (e.g. over €92m for FOAK projects capturing thousands of tonnes CO_2 per day). However, inability to finance such projects due to co-financing and permitting issues has led to just two of six original projects proceeding. More success with industrial CCS projects.

Scheme Name (delivery body)	Country	Year Started	Status	Type of Instrument	Budget	Project Funding Levels	Suitability for SET Projects
ARPA-E grants programme	USA	2009	Open	Grants	€257m (FY2015)	€2.8m on average (max €8.3m per project)	Not applicable – TRL focus makes it too early-stage as a support scheme for supporting FOAK projects. However, the approach taken gives valuable insights for effective interventions, including its strategic market focus to understand the nature and scale of market opportunities for technologies it supports; its close working with industrial companies and the venture investment community; and the discipline to close projects earlier which are not delivering against target.
New Energy and Industrial Technology Development Organisation (NEDO)	Japan	1980	Open	Grants	€1.1bn (FY2015)	Not specified (highly variable based on technology)	High – NEDO has a strategic intent to align FOAK project demonstration with clearly targeted international market opportunities which will support and enhance domestic innovation and supply chain capabilities. It has had success in supporting FOAK demonstration projects in the EU (e.g. France, Spain, UK) and elsewhere.
Project and Growth Grants (Callaghan Innovation)	New Zealand	2013	Open	Grants, repayable loans, equity	€97.5m for grants mechanism (and €48.8m operational funding)	up to €3m Intervention rates vary between 30-50%	Not applicable – New Zealand already has a mature renewables market and no immediate security of supply issue, so there is no pressure to push innovation or reduce emissions in the energy generation market. However, this scheme offers generic support to innovators who can then seek FOAK funding from the Ministry of Business, Innovation and Employment if necessary.

Source: ICF

3.5.3 Effectiveness of public intervention in non-EU countries

Scale and scope of non-EU support schemes

Overall, the schemes reviewed generally have higher annual budgets and greater levels of project specific funding than their counterparts in EU Member States, but they are equivalent to those offered by EC funding mechanisms such as NER 300. This is enabling large-scale, first-of-a-kind SET energy generation technologies to be supported across SET sectors of interest in several countries.

It is noteworthy that even schemes which are of limited relevance for FOAK have maximum support levels of €2.8m (ARPA-E, USA) and €3m (New Zealand) which are often higher than some Member State interventions. These schemes generally have higher annual budgets and greater allowable levels of project-specific funding.

Those schemes that have been evaluated (formally or informally) paint a mixed picture as regards their overall impact on the market for FOAK project support.

The schemes reviewed comprise a mixture of well-established schemes (e.g. NEDO, NextGen Biofuels Fuel), maturing schemes (e.g. CCS support and the LPO in USA), and brand new schemes (e.g. ARP in Australia). For some, it is still too early to measure programme impact.

Two of the apparent successes are broad-based schemes from the USA and Japan:

- In 2011 the Loans Projects Office (USA) very rapidly deployed US$22 billion of loans/loan guarantees to support FOAK projects in Bioenergy, CSP, Geothermal; Wind, SPV. The LPO claims success in seeding the U.S. utility-scale PV market with its €4.2bn (4.6bn) support for 1.5GW of utility-scale solar PV, enabling it to become a mature asset class and 'bankable' to mainstream finance. In its ex-post assessment of the LPO's market stimulation effect, it concluded that *"initial investments made by LPO built a market that subsequently financed an additional 17 PV projects larger than 100 MW in the United States – all financed without DOE loan guarantees and many of them by banks that LPO had worked with."*[70]
- NEDO (Japan) has helped to support FOAK demonstrations worldwide, including within Europe (e.g. smart grid projects in Spain and a 7MW wind turbine project in the UK), in order to maximise market opportunities for domestic supply chains. NEDO adopts an interesting perspective on calculating the effectiveness of its investment into key technologies. It looks at future market sizes and relates this market opportunity back to the cumulative investment levels into key technologies. This demonstrates that the largest return to date by far has been for NEDO's solar PV support.

This contrasts with sector-specific schemes in Canada and the USA:

- The €350m NextGen Biofuels Fund (Canada) has been in operation for 8 years. However, the scale of investment achieved appears to have fallen well short of policy expectations. It has only loaned a total of €63 million to two major projects over eight years[71], less than 20% of the Fund value. While this investment has leveraged a further €109m from private industry, the Fund has a large underspend and has not achieved its aim of stimulating a domestic second generation biofuels supply chain in Canada. Various factors might explain the shortfall, including: Canada may have fewer companies developing next-generation biofuels than anticipated; less industry appetite for biofuels production in Canada; less appetite for equity investments from investors; and, potentially, eligibility criteria for the Fund may have been too restrictive.
- A large-scale CCS Demonstration Programme (USA), focused on power and industrial plants, has experienced several terminated projects due to co-financing and planning considerations. The scheme manager reported the difficulty of attracting high levels of

[70] U.S.DOE LPO, Powering New Markets: Utility-scale Photovoltaic Solar, February 2015. Available at: http://energy.gov/sites/prod/files/2015/02/f19/DOE_LPO_Utility-Scale_PV_Solar_Markets_February2015.pdf

[71] Based on a review of funded projects at https://www.sdtc.ca/en/portfolio/projects. Active projects include: AE Côte-Nord RTP™ Project (CAN $27m) and Enerkem Alberta Biofuels Project (CAN $63.6m); a third project Mascoma Drayton Valley Biorefinery was given funding of CAN $643,000 but is inactive [Accessed September 2016)

private investments into CCS demonstration projects (many of which were linked to enhanced oil recovery, not climate change sequestration in the strictest sense), albeit with more success for industrial CCS than fossil-fuel plants. Permitting challenges had also been observed for CCS projects.[72]

Clearly, attracting co-funding for FOAK projects, either via equity or debt channels, remains challenging in some SET areas in non-EU markets, particularly given the risks associated with getting plants built as well as the uncertainty of outcomes.

The apparent success of the LPO is at slight odds with the overall assessment of the U.S. Department of Energy (U.S. DOE) energy demonstration project funding. Lester & Hart (2015)[73] catalogue a series of 'chronic problems' (shown in the Case Study 1 below) and quote one group of knowledgeable observers who believe that *"the underlying fundamental difficulty is that the DOE, and other government agencies, are not equipped with personnel or authorities that permit the agency to pursue first-of-a-kind projects in a manner that convincingly demonstrates the economic prospects of a new technology."* Certainly the experience of the U.S. CCS FOAK projects support programme (see above) illustrates the on-going difficulties of finding the right approach to supporting such projects. Promisingly, the findings from the U.S. ARPA-E review show a more strategic and business-focused approach to earlier stage R&D, the results of which may help improve other agencies supporting FOAK projects[74].

Case Study 1 Criticisms of historic approach taken by U.S. Department of Energy to energy demonstration programmes

Lester & Hart (2015) reveal problems that include:

- Underestimation of project costs by agency officials;
- Failure to plan for future variability in fuel prices (e.g. oil price declines);
- Political interference in technology selection, facility siting and personnel appointments, together with Congressional pressure which may limit the ability to adjust or terminate projects after clear changes in conditions have occurred;
- Lack of policy consistency and funding over the lives of projects; and,
- A lack of clear institutional mission at the US DOE and a focus more on scientific achievement than the commercial and industrial viability of new technologies.

Leverage varies across non-EU support schemes using grants and is typically (but not always) enhanced if loans are used instead

For grants, leverage of 1 (resulting from a 50% intervention rate) and two (a 33% intervention rate) is possible. This echoes that found in EC and Member State support schemes. The following illustrate the differences across schemes:

- ARENA - can demonstrate leverage of 1.3x public investment for Queensland, Australia;
- NextGen Biofuels Fund – leverage of 1.7x from two demonstration projects in Canada;
- LPO (USA) – leverage of 0.2x (assumes min. 20% equity commitment from sponsors).

The signalling effect of the LPO on the wider market, which then goes on to invest and finance further projects, is arguably seen as much more significant than the financial return from the original loans and guarantees. A further important observation is that many of the projects supported by the LPO enjoyed both tax credits and municipal or state grant funding, thereby benefiting from substantial public support packages overall.

The key lesson here appears to be that assessing simple financial leverage is not the only measure of scheme success: ultimately, long-term market replication without public intervention is a clear sign that innovation support was successful and worthwhile.

[72] ICF consultation with CCS Demonstration Programme manager, 2015

[73] Lester, R.K. & Hart, D.M., *'Closing the Energy-Demonstration Gap'*, Issues in Science & Technology, Volume XXXI Issue 2, Winter 2015 http://issues.org/31-2/closing-the-energy-demonstration-gap-2/

[74] ICF consultation with ARPA-E, 2015

Most schemes have thought clearly about where it makes strategic sense to back particular SET areas to enhance domestic supply chains

Nowhere is this strategic approach more evident than in Japan, where NEDO seeks to align ‘best in class’ Japanese technologies with future market opportunities, both inside and outside Japan.

In the USA, the support for large-scale projects under the LPO scheme, focused on areas which were expected to yield job creation, energy security (i.e. barrels of oil avoided being consumed) and GHG emissions reductions, as well as reducing the need for future public financing support by creating successful exemplar projects.

In Australia, ARENA’s ARP seeks not only to improve the competitiveness of renewable energy technologies (through reducing costs of renewable energy generation and removing barriers to adoption) and to increase renewable energy supply, but also to increase skills, capacity and knowledge to enhance Australian supply chains. This approach is echoed by the Canadian NextGen Biofuels Fund which aimed to stimulate a domestic supply chain in second generation biofuels production, using Canadian biomass, although this strategic ambition has not been realised.

Case Study 2 A supportive equity investment community which may have direct scheme links can be important

There is evidence of funding ‘ecosystems’ in Australia, Canada, Japan and the USA (under the CCS programme which funds early stage through to FOAK projects). Here, efforts are made by scheme managers to source private finance from, VC funds or link into other public funding mechanisms, both during or after the project is completed.

For example, in Australia, ARENA has established an equity link into the Australian ARP to support promising innovations via a VC fund. While in the USA, ARPA-E is fostering a strong connection to the VC community, both as a way of attracting a high quality project pipeline, but also to ensure that follow-on funding is available and that fund managers / high net worth individuals are comfortable with technological risks.

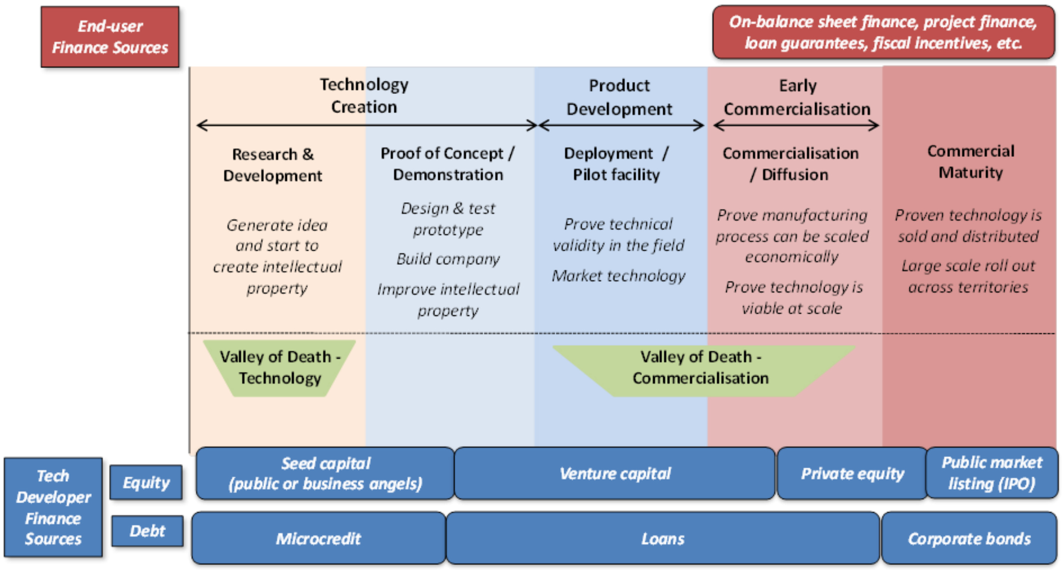
4 Understanding market failures and analysing the funding conditions and the need for public intervention at EU level

4.1 Understanding the market failures impacting low carbon markets

Overview

As illustrated in Figure 4.1, a number of *potential* financing sources are appropriate for developers of low carbon energy technologies at various stages of the life of an innovation, from initial idea through to early market deployment. This includes financial sources available to potential end users of such technologies, for example to help finance their on-site technical demonstration and prove their commercial viability. However, the ability of technology developers and project promoters to raise the requisite levels of funding to meet the 'financing gap' challenge is seriously impacted by the presence of far-reaching market failures and barriers in this particular sector.

Figure 4.1 The Commercialisation 'Valley of Death' is particularly problematic for many innovative low carbon energy supply technologies



Source: ICF - based on an original diagram by Bloomberg New Energy Finance

Substantial market failures and barriers inhibit investment and financing of SET FOAK demonstrators and act in one of three areas: structurally, at a macro-economic level; on the demand side; and/or within the supply side, especially in nascent and emerging supply chains where there is often insufficient incentive to invest in new innovations, not least because of uncertain returns. Barriers also include sub-optimal investment situations, in which the market is not interested in supporting FOAK projects (despite there being a positive economic rate of return) or where projects that are in principle bankable (i.e. can generate a positive IRR) but the finance or investment is inadequate because of a project's unproven character, inherent uncertainty or underlying risk structure.

Market failures and barriers can be grouped under four themes, summarised in Table 4.1 (and elaborated further in Annex 1), which affect stakeholders engaged directly or indirectly in the process of bringing low carbon technologies to market. Some are internal barriers (i.e. acting within a project) while some barriers are external (i.e. wider framework conditions acting on project developers or financing organisations by government or external agencies).

Table 4.1 Market failures and barriers to investment in low carbon energy innovations

Financial barriers	Policy and regulatory barriers	Skills, knowledge and information barriers	Technology barriers
■ High initial costs of renewables ■ Lowest oil prices in over 10 years ■ Investment needs for TRL 7-8 well beyond usual range of business angels / VC funds ■ Bank lending still low in Europe ■ Under-developed corporate bonds, equity and securitisation markets ■ Basel III rules have increased risk aversion and reduced capacity to fund new exposures ■ Lack of viable business models to aid deployment ■ Future returns from R&I hard to capture	■ Policy driven investments, so any policy uncertainty will knock confidence ■ Regulatory uncertainty (e.g. retroactive feed-in tariff changes) ■ Perverse incentives (e.g. fossil fuel subsidies) ■ Poorly designed support programmes with too stringent requirements ■ Underdeveloped secondary regulation (e.g. health and safety, planning, environmental permits) ■ State aid restrictions on grant funding at Member State level	■ Asymmetry of information between stakeholders changes risk perceptions ■ Lack of specific skills among investors, technology developers and potential clients ■ Inability of institutional investors to assess project risks properly ■ Limited experience for new technologies ■ Lack of tools for system integration (e.g. resource maps) ■ Difficulties in awarding environmental permits for complex projects	■ Technology unproven at commercial scale, so significant risk of technical failure ■ Limited sector champions in some key SET sectors ■ Nascent or disconnected supply chains prevent key technologies coming to market ■ Implementation risk for end users favours incumbent (proven) technologies ■ Long operational time for new technologies to gain market confidence before commitment to purchase

Source: ICF

The commercialisation 'Valley of Death' creates structural market failures which prevent SET FOAK projects from being supported to the levels required

It is worth considering the different types of financial market participant in our study in the context of the commercialisation pathway of SET innovations. More particularly, when analysing the clean energy value chain that starts with technological development and ends in mass-deployed, proven technologies, it is very clear that only a few types of entities are prepared to even consider very high risk ventures such as FOAK projects.

Figure 4.2 shows that technology development is dominated by government (almost exclusively providing grant funding for early stage R&D, pilot plants as well as seed funding for initial 'spin out' ventures, for example from public universities and/or research institutes (RTOs)). This combines with often modest equity investments from both VC funds and corporates (who either fund projects off their balance sheet or often use their own in-house Corporate Venturing funds).

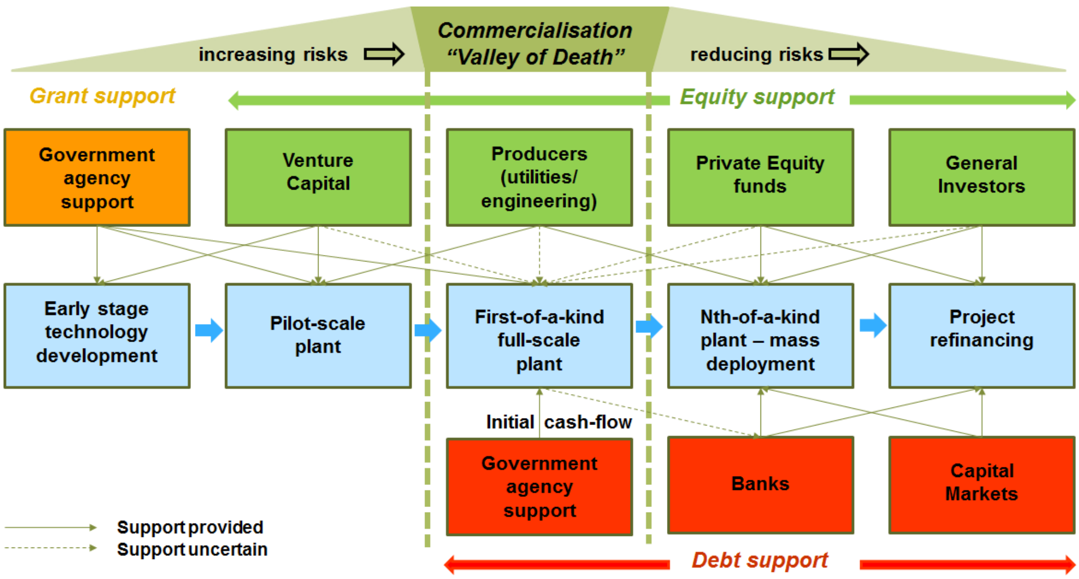
Commercial-scale SET FOAK demonstration projects (at TRLs 7-8) in the EU are perceived as highly risky and funding levels are much lower than mainstream SET financing. Funding within the 'Valley of Death' is dominated by public sector contributions in the form of grants and some loan support. These support mechanisms by necessity need to 'crowd in' other private sector funders in order to overcome the FOAK funding gap. However, the commercialisation 'Valley of Death' creates structural market failures which can often prevent SET FOAK projects from being supported even with current public support provision. This is primarily because only few types of commercial entities – such as large corporates, some energy utilities, selective VC and private equity firms and some asset managers – are prepared to even consider such ventures. As one VC fund manager commented: *"we would be happy to take care of [projects when they reach] the other side"* of the 'Valley of Death'.

So, while all three stakeholder groups (i.e. the public sector, investors, lenders) have a critical role to play in FOAK funding, their relative contributions are uncertain; worse, one or more groups may be absent from any one FOAK funding structure. This situation creates two major challenges:

- Market participants have very different appetites for risk which in turn leads to complex financial structures being required to enable SET FOAK projects to achieve financial close;
- There is high demand for a suite of public sector funding mechanisms to be made available to project sponsors so as to fill the commercialisation 'Valley of Death' funding gap.

Figure 4.2 illustrates that once FOAK technologies are proven at scale and achieve the 'Nth-of-a-kind' milestone, ready for mass deployment, the number and types of funding source increases dramatically. This includes significant debt availability from capital markets. This debt can also be used to refinance FOAK projects and free up equity from sponsors and other investors for new investments. The risks taken by the public sector in intervening in the 'Valley of Death' via FIs, not grants, can therefore be rewarded by later repayments from private capital funding. This will help to increase the sustainability of public sector funds.

Figure 4.2 SET market participants have different strategies and propensities for high risk ventures leading to large uncertainty for FOAK funding within the 'Valley of Death'



Source: ICF

Clearly the figure simplifies the clean energy value change and the overall financing situation for SET FOAK projects. It also does not identify the risks which prevent flows of finance into individual SET areas – or individual FOAK projects (see Annex 12 for a review of risks acting on individual FOAK projects). However, it does help to illustrate the main funding 'pinch points' for this study and the focus of potential future interventions.

Evidence of a continued challenge for funding in the 'Valley of Death' for FOAK projects was corroborated by feedback from financial market participants interviewed by ICF in March/April 2016. Of fourteen who provided comment, the vast majority believe that the funding landscape for FOAK projects, which was already found to be poor in 2015[75], had either remained unchanged (n = 8) or become worse (n=3) since the second half of 2015. These perceptions are based on two main reasons: an absence of significant new players as existing funding institutions are getting more and more constrained by regulatory and risk aversion agendas; and

[75] Based on the results of an ICF survey of market participants in summer 2015

a general scarcity of funding sources (covering both equity and debt) – one mentioned “tight” financing. One interviewee noted that it was *“impossible to fund a FOAK project of €5-10m unless you get a big name EPC contractor who takes all the risk”*). Examples of projects (such as CCS) being abandoned due to a lack of additional financing, despite having secured funds from the EC, were also cited by interviewees. The problematic funding situation is at odds with the scale of the EC policy ambition.

4.2 Analysis of investment opportunities & barriers and need for EU intervention

4.2.1 Business and financial risks of FOAK projects

The project sponsors perspective

The critical issue for project developers is that as technology development and demonstration progress, the risk profile changes, with less emphasis on technology risk and an increase in market and operational risk perspectives. This means that at the point of market entry and volume production and/or mass deployment, operational considerations –i.e. business economics (revenue to costs) and risks dominate the business strategy.

This study has captured insights regarding the technical, market and financial issues pertaining to FOAK project sponsors who responded to ICF’s e-survey. These are elaborated by SET category in Table A12.1 in Annex 12. They provide compelling evidence of the challenges which beset sponsors and limit their ability to raise equity (as well as grant funding in some cases) or debt. FOAK project sponsors provided insights into the different types of risk and their severity. These are illustrated in three main risk themes: technology, market and financial, as follows:

Technology risks – the SET categories with the highest technical risks include BIO, Geothermal, LES, Ocean and Wind (offshore). While all new technologies carry some unknown risks because the technology is still being proved, there are some interesting remarks made about technology risks within, for example, geothermal, ocean and wind energy. One ocean energy developer noted the main obstacles *“are technological. The OEM's in the market, even those with a major multi-national as a parent are not in a position, or not willing, to provide commercial warranties for their devices.”*

Market risks – appear most important for CCS and CSP projects although the strength of comment from project sponsors regarding LES shows that market risks is a major issue which affects investment, with *“a lack of long-term Members State strategies over electrical network requirements*” noted by one sponsor, “*uncertainty in markets for storage services*” by another, and criticism of the planning system by another (UK) “*Lack of intuitive planning system in many Member States creating major issues for developers (e.g. 50MW limit before Development Consent Order (DCO required in UK)*.”

The recent cancellation of the UK’s CCS Commercialisation Programme Competition in November 2015 is a good illustration of the large market risks for a SET sector and it has already impacted on the future chances of the two planned CCS projects being progressed.

Financial risks and investor requirements – much of the financial risk being articulated by sponsors stems from the technology risk which is inherent in their projects and which then impacts on uncertainty around revenue streams. Nowhere is this felt more acutely than in ocean energy where one UK developer identified the barrier to achieving long-term operational performance to achieve more ‘traditional’ project finance: *“Lack of operational hours to prove reliability and forecast energy generation assumptions in financial model - therefore no access to 'traditional' sources of project finance.”*

Another UK ocean energy developer clearly felt that the high risk profile of their sector made it challenging to find appropriate investors in the EU: *“Risk profile is inevitably high and can only attract investors with a high risk / high reward perspective - of whom there are few.”*

A Norwegian ocean energy developer would like to see *“government involvement in supporting the first demonstration and commercial projects with [performance] guarantees.”*

A geothermal energy developer also expressed their frustration concerning the lack of bankability of their type of project: *"No commercial financial institution, bank etc. is ready to get involved in financing."*

Large capital requirements and limited or no track record for project sponsors are also regarded as major constraints on gaining investment.

The financial market participants' perspective

Financial market participants with the most positive attitudes towards FOAK were some (but not all) Specialised Investors and Producers. Specialised Investors focus on the following aspects with respect to SET equity investments overall and these insights appear to dovetail with the feedback from FOAK project developers:

- Technology risks, including scale-up and risk associated with fitting new technology into existing infrastructure;
- Regulatory risks, especially as regards changes in feed-in tariffs and (other) subsidies and other Government induced policy risks (e.g. level of subsidies to fossil fuel based generation technologies). Differences across markets and a lack of harmonisation are also important. As one VC noted: *"technologies that are commercially viable in Czech Republic may not be 'investable' in Germany because of a different regulatory regime"*;
- Commercial risks, e.g.
  - High capital costs (vis-à-vis more capital light investment propositions);
  - High cost per MWh of generation (i.e. challenging the economics of the business)
  - Unfair competition from outside Europe
  - Inefficient supply chains and less than competitive procurement channels (as for example in offshore wind)

In terms of business risks, Specialised Investors expressed issues and particular needs which would help them to engage more seriously with FOAK projects. Factors which are considered important, including for specific SET sectors, include:

Viable business models – for example, the lack of commercial structures for revenue generation for large energy storage, since it is providing a service not producing energy per se and there are such small margins to be made from day-night arbitrage. One VC commented: *"There is no way to make large-scale energy-storage projects commercial because revenue streams are not secure."* Another VC with interest in this area said that one would be to secure a contract with a utility under which the investee company provides capacity for a couple of hours when the utility requires it.

Need for feedstock supply agreements (e.g. biomass) and energy offtake agreements to be in place – this helps to commercially "de-risk" business models.

Assets installed prior to investment – again, a mechanism to help "derisk" business models, but only mentioned by one investor and clearly pointing to slightly later engagement than those getting involved for example at the FEED stages.

Developer confidence in operational performance – FOAK projects cannot attract performance guarantees, so the ability to demonstrate reliable performance is fundamental to ensuring confidence. In comparison to technologies that may have clocked up "a million hours of operational track record", and benefit from the backing of a large industrial company who can guarantee performance, business risks are elevated for FOAK projects. As one investors noted, a technology that might work for three months but then breaks down and requires three months to fix does not give confidence: *"Selling something new into the market is incredibly difficult: durability and reliability are key, not just an efficiency gain";*.

Associated investments into supply chains – one VC fund noted in solar PV that to make profits requires investments into more advanced technologies which is capital intensive if it requires investing in upgrading the manufacturing processes and building supply chains.

Size of developer - If a technology supplier company is small there is a risk that it will not be able to repay in the event of its technology not working (i.e. insufficient creditworthiness and economic strength).

IPR risks – for example, does the developer own the rights to the technology and if not how tightly controlled is any licensing arrangement including territorial access.

Management capabilities for developers – track record of undertaking similar projects is important. Some minimum thresholds such as companies having been in existence for at least five years and successfully piloted their technology.

For Producers, attitudes to SET equity investments outside their business reflect their interest in the likely outcomes from any project, which includes a longer time horizon of 15-25 years than for Specialised Investors, although there was some commonality of business issues/risks:

- How will the project help develop our business?
- What are the expected deliverables from the project?
- How complex is the project and how efficient the organisation?
- Reliability of prospective partners - can partners be expected to deliver on their tasks?
- Are there potential IPR issues?
- What are the market opportunities in short and long term?
- What are the requirements for reporting and publication during the project?

More fundamentally, the very modest levels of funding which Specialised Investors have mentioned as being able to offer (e.g. with deal size ranges of €0.5m - €4m) are a limiting factor for the supply of equity investment. This is due to the scale of project investment costs and the need to undertake deal syndication (i.e. a number of equity providers would need to collaborate). As one VC investor stated:

> *"[since] low-carbon projects are capital intensive, developing opportunities requires building a consortium to share the costs, unlike software or IT based technologies, which have lower capital requirements and have a faster route to the market. Renewable technologies have a much longer route to the market to allow investors to get their returns."*

Deal syndication could prove problematic however given the modest number of equity investors in SET innovations in Europe who may well wish to compete rather than collaborate on key FOAK deals.

Producers, on the other hand, have a deal size range of €10m - €200m for external investments, making them, at face value, as one of the most likely providers of equity for FOAK deals. This is particularly where such projects would align with their business strategy. A mixture of Specialised Investors and a Producer has worked effectively in the past for FOAK projects and could in the future.

Understanding the motivations for Producers to continue to fund FOAK projects is important. Several recent sector developments have arisen during the course of this study which are worthwhile describing briefly in order to reinforce some of the study findings. These include corporates overstretching their debt levels (Abengoa SA), feeling the effects of government policy and resource prices (DRAX Group plc), or else deciding to divest because of the time taken to commercialise ocean technologies (Siemens). These mini case studies are illustrated in Box 4.1 below.

Unless Producers are keen to contribute to the FOAK project equity gap in large volumes, for many of the proposed FOAK projects identified, and most likely many future FOAK project types, major injections of public sector support (e.g. via a grant mechanism like NER 300 or loan mechanism like EDP or something else) appear inevitable.

For many of the projects identified by this study – and certainly those awarded grants under NER 300 (see Annex 7) - the main project sponsor is typically a Producer. This is reassuring for the overall market analysis of FOAK project funding in the EU. However, trying to broaden the community of interest in supporting FOAK projects is important to ensure funding diversity occurs. Furthermore, for the many SMEs trying to bring new SET innovations into the market, a tie up with a Producer is now almost a pre-requisite for successful FOAK funding. Without this, many project sponsors lack the credibility to raise funds. Forging those connections could be achieved through a dedicated support service to FOAK project sponsors (see section 9).

Box 4.1 Producer interest in supporting FOAK projects is critical but long-term commitment is necessary to provide sector stability

CSP & Bioenergy - Major Spanish CSP and bioenergy developer, Abengoa SA, burdened with gross debt of €8.9 billion, initiated insolvency proceedings on 25 November 2015 after potential investor Gonvarri cancelled its plans to inject €350m into the business[76]. It has since reached a deal with creditor banks for a €100m lifeline but at the end 2015 it must find a further €350 million to guarantee assets for three more months[77]. Abengoa invested more than $3 billion into renewable energy projects in the United States, including several utility-scale concentrated solar power projects. While there is every chance that individual projects Abengoa has developed will continue as 'going concerns', the ability for such an important company to continue to invest heavily in leading-edge FOAK projects may become problematic if its corporate structure and overall strategy are radically changed to avoid bankruptcy.

CCS & Bioenergy - In the UK, coal and biomass-to-energy generator DRAX Group plc, which has started to convert the largest coal-fired power plant in the UK to run off biomass, exited the White Rose CCS project in September 2015 citing cash flow issues after UK bioenergy subsidy changes. Drax's Chief Executive stated that *"ultimately investment is about choices and we are in a very different financial situation today than we were two years ago when we decided to invest in the project...There have been changes to the government's renewable policy but there have also been dramatic movements in the commodity markets and that has greatly reduced our profitability"*[78]. Once again, the future propensity of such Producers to engage and financially support innovative FOAK projects continues to be uncertain, especially in the face of wider market conditions that can change so rapidly.

Ocean energy - the sale of Siemens subsidiary Marine Current Turbines (MCT) to Atlantis Resources in April 2015, inevitably caused some surprise after Siemens had acquired the company in full in early 2012. Siemen's reasons for divestment included the lack of an established market and supply chain and because it was *"taking too long for the technology to become commercial, both [in terms of] the market and the supply chain"* and that a tidal power industry *"would only ever remain a niche market for Siemens."*[79] However, Siemens retains a 10% stake in the Atlantis holding company; and it will continue to supply components to MCT and has promised with Atlantis to *"explore respective opportunities for the future"*[80].

While the comments from sponsors are too few to draw comparisons, some of the remarks, notably for wind, appear to confirm that while projects using proven wind technology can attract a lot of interest from funders, for more novel, large-scale FOAK projects, it is harder to find investors, especially those willing to commit to larger volumes of funding.

Table 4.2 overleaf provides a market overview of the SET sectors based on information obtained from project developers as well as market participants and also study findings.

[76] Bloomberg, 25 November 2015, Abengoa Bonds Plunge After Company Seeks Creditor Protection http://www.bloomberg.com/news/articles/2015-11-25/abengoa-seeks-creditor-protection-after-gonvarri-pulls-accord

[77] The Times, 14 December 2015, Abengoa fights to avoid bankruptcy http://www.thetimes.co.uk/tto/business/industries/naturalresources/article4639937.ece

[78] Reuters, 25 September 2015, Drax to pull out of UK White Rose CCS project when ends http://uk.reuters.com/article/2015/09/25/uk-britain-drax-ccs-idUKKCN0RP0GX20150925

[79] The Engineer, 24 November 2015, Siemens hunts for buyer to take on Marine Current Turbines http://www.theengineer.co.uk/news/-siemens-hunts-for-buyer-to-take-on-marine-current-turbines/1019559.article

[80] London Stock Exchange, 29 April 2015, Acquisition of Marine Current Turbines from Siemens. The deal saw Siemens receive 9.99% of the Company's enlarged issued share capital as sole consideration for the sale. Siemens will continue to supply MCT with standard components for its tidal power turbines and projects. Alongside the acquisition, Siemens and Atlantis have agreed to explore respective opportunities for the future. http://www.londonstockexchange.com/exchange/news/market-news/market-news-detail/12333207.html

Table 4.2 Market overview of sectors based on FOAK project findings from project developers[81], market participants and overall study findings

Criteria	AEN	BIO	CCS	CSP	Geo	LES	Ocean	SPV	Wind
Total project size range [1]	53-70 MW	Diverse*	250-300 MW	41-111 MW	12-93 MW	6 – 250 MW	4 – 320 MW	Diverse*	2 – 400 MW
Total project cost range [1]	€30m – €41m	€8m – €600m	€500m – €1400m	€185m – €330m	€75m – €117m	€16m – €350m	€20m – €1000m**	€38m – €250m	€54m – €2000m
NER 300 award range [2]	€8m – €85m €11m (median)	€4 – €204m €31m (median)	€300m	€40m – €60m €45m (median)	€16m – €39m €17m (median)	-	€9m – €72m €21m (median)	€8m	€11m – €113m €33m (median)
Range in Cost per MW [1]	€0.57m per MW – €0.58m per MW	Diverse*	€2m per MW – €4.24m per MW	€3.0m per MW – €4.9m per MW	€2.2m per MW – €9.8m per MW	€1.3m per MW – €2.8m per MW	€3.1m per MW – €10m per MW	Diverse*	€1.4m per MW – €10m per MW
Interesting EU markets for FOAK/SET [4]	DE, FR, UK	BG, CZ, DE, FR, IT, PO	NL	IT	DE, FR, NL	DE, ES, UK	FR, UK	DE, NL, RO	DE, DK, FR, NL, UK
Key FOAK risks identified by sponsors [1]	Org risk Tech risk Market/policy risk	Tech risk Market/ policy risk	Market/policy risk, Env. reg. risk, Tech risk	Market/ policy risk, Org risk Tech risk	Tech risk, Operations risk	Tech risk, Market/policy risk	Tech risk C&C*** risk Ops risk	Org risk Tech risk Market/ policy risk	Tech risk C&C*** risk
Key technical issues for FOAK projects from perspective of project developer [1]	Applicability of Technology			"High probability" that project may fail its goals	Implementing new reservoir technology in EGS project Uncertainty over resource prior to drilling		"Unfavourable comparison with other technologies" "Difficulty in getting investors to believe the technology is viable" "Reliability and warranties still need to be improved"	"The problem is the demonstration of the feasibility and potential of the project."	"No reference projects available - No vendor warranty given" "Obtaining market competitive performance guarantees from suppliers, specifically the turbine manufacturer"
Key market issues [1]	Impact of AEN infrastructure on	"Lack of long-term goals &	"Main obstacles are not	"Market Uncertainty"	Secondary issue is social	"No business case…revenue			"Lack of certainty for legal

[81] Includes grant funding ranges from NER 300 calls for comparison purposes.

Criteria	AEN	BIO	CCS	CSP	Geo	LES	Ocean	SPV	Wind
	tariffs	conditions at EU / MS level for biofuels”	technological, but financial / political” “We needed…a better climate for CCS” “Price of CO_2”	“Country risks in Greece”	acceptance, not an investment / finance difficulty	from power arbitrage is constantly shrinking” [in Germany] “Lack of clarity over financial support mechanisms for energy storage” [in UK]			regulations, especially for support schemes”
Key financial / investors requirements [1]	“Provision of convincing positive cost-benefit analysis”	“Investors require technical guarantees and very detailed data that is not available”	“Lack of a commercial business case for CCS”	“Not proven commercial track record hence not easy to finance… viability / profitability are in question.”	All investments front-end loaded Difficulty overcoming drilling risks Non-scalable project Investor misconceptions of business model	“Uncertainty in committed revenue streams” Grant programmes often take too long and out of sync with project “Finding suitable financing instruments. Some projects do not fit into existing schemes”	“Much higher CAPEX required to demonstrate multiple machines.” [i.e. an array] “Our equity comes from supplier partners that see a future business”	“In the present financial market risk aversion prevails.”	“Market and credit conditions” “High investment amounts required (not all investors have capacity to finance this kind of projects)” [floating wind]

Criteria	AEN	BIO	CCS	CSP	Geo	LES	Ocean	SPV	Wind
Grant availability [1]		"Max grant sizes for large-scale plants, therefore supporting only a proportion of the plant"				"Investor need significant (>> 50% of total CAPEX) investment aid."	"Effort required to access grant funding extremely time consuming for process with ~15% chance of success."		
Equity availability [1]			"Investors are scarce"						Difficult to "find private investors"
Debt availability [1]		"Since 2008 no debt from banks available for this type of project."[82]					"Capital markets are not willing to take the risk."		One of two main project obstacles was "the risk appetite of purely financial investors with respect to debt financing."

*Sources [1] Based on responses from more than 50 project sponsors who completed an ICF survey. Note, more than 10 responses for ocean energy. [2] Based on NER 300 awards (max 50% intervention so indicative of total project size) [3] Based on market participant interviews. [4] Based on markets where recent sustained growth in capacity (or development and deployment budget in the case of AEN), combined with a positive (or at least neutral) outlook – see market conditions mapping summary (Table 3.6). Notes: ** A size range is less meaningful for biomass conversion projects, owing to the variety of processes and products of the shortlisted projects; the same is true of SPV projects, which include manufacturing projects; ** = tidal barrage/lagoon included within ocean projects; *** C&C = Construction & Commissioning risks*

[82] This particular biofuels sponsor noted *"Before 2008 we had term sheets of EUR 10 million from two major banks; after 2008 nothing anymore due to crisis."*

4.2.2 Risks and mitigation actions across SET sectors which can work in tandem with funding

Table 4.3 provides an overview of sector specific FOAK project risks, which have been identified in this study through discussions with financial market participants. Regulatory risk, alongside technology and performance risk, are the main risks for SET FOAK projects.

A set of potential mitigating actions have been developed in response to market participant feedback coupled with internal study team discussion. The table serves to benchmark in broad terms the likely scale of FOAK project investment needs, by project type and SET sector.

Primary information has been drawn from project developers consulted by ICF together with comparison with JRC evidence from its 2013 report into FOAK project finance. The table illustrates the importance of stable EC and Member State policies and regulatory frameworks, and other framework conditions, for mitigating risks to investors and debt providers.

Annex 12 provides a detailed analysis of the plethora of risks acting on SET FOAK projects using the project life cycle stages as a guide to understanding how risks impact on the project as it progresses. These stages are:

- Feasibility
- Front-end engineering design (FEED)
- Planning and permitting
- Financial close
- Construction / completion
- Commissioning
- Operations

Each risk is also aligned with a potential mitigating action which is then coded in relation to the policy options which have been set out in this report (i.e. an equity fund, EDP facility and an advisory service for FOAK project sponsors).

A review of the risks shows that many of the risks identified for SET FOAK projects are generic. That is to say that they apply to FOAK and non-FOAK projects alike, across all SET sectors, and indeed many, if not most, industrial project and investment situations.

The analysis also identified very little differentiation in risks across SET sectors, other than those related to, for example:

- feedstock supply (for biomass);
- the need to obtain sea-bed licence and other permits (for ocean energy and offshore wind);
- types of offtake agreement for power or contracts to buy fuel (for biofuels production); and,
- drilling risks (for geothermal and potentially CCS).

Table 4.3 Key risks across SET projects and possible mitigating actions

SET – type	Cost range for FOAK projects[1]	Risks	Potential mitigating actions
AEN	€30 - €41m for industrialised solutions	■ Market impact on tariffs & policy ■ Technology & obsolescence ■ Viable business model ■ Convincing cost-benefit analysis	■ EU Policy & Regulation ■ EU standardisation ■ Appropriate tariff structure
BIO	€8 - €50m bioenergy; €150-€600m – biorefineries	■ Lack of long-term EU market policies ■ Lack of performance data relating to technology used ■ Feedstock issues	■ EU Policy & Regulation ■ Greater clarity on sustainability aspects
CCS	€500 - €1400m for full chain CCS	■ Some CCS have very high capex ■ Interface risk between components ■ Lack of long-term policy, re. coal usage vis-à-vis gas, and Carbon price ■ Business risk given high capex ■ Lack of commercial business case ■ Possible environmental challenges / social acceptance (on-shore storage)	■ EU Policy & Regulation ■ Certainty on carbon price
CSP	€185 - €330m	■ High cost per MW ■ Can be mechanically complex ■ Long-term operations & maintenance	■ EU Policy & Regulation ■ Institutional support for CSP country zones with grid integration[83] ■ Revenue guarantees
GEO	€75 - €117m	■ Geo resource uncertainty / drilling risk ■ Lack of tech. knowledge in market ■ Business Case viability ■ Understanding environmental issues ■ Can be high cost per MW ■ Social acceptance	■ EU Policy & Regulation ■ Support to establish market precedents ■ Reinsurance scheme for drilling risk
LES	€16m - €350m	■ Uncertainty over revenue & cash-flows (revenue from power arbitrage shrinking) ■ Lack of clarity over financial support mechanisms for storage/capacity ■ Pumped storage: well understood ■ Battery technology: choice risk	■ EU Policy & Regulation ■ EU support for R&D ■ Suitable (non-grant) financing mechanism
OCN	€20m+ for ocean energy arrays – to	■ High cost per MW ■ No optimal preferred technology yet	■ EU Policy & Regulation ■ Precedent for tidal lagoon (CfD

[83] Institutional support for CSP country zones with grid integration would be helpful because Southern Mediterranean countries are not renowned for having strong institutions and hence measures could be put in place to reduce risks

SET – type	Cost range for FOAK projects[1]	Risks	Potential mitigating actions
	€100m for farms; Up to €1000m+ for tidal lagoons	■ Much exposed to natural hazards ■ Lack of commercial precedents ■ Construction & Commissioning risk ■ Operational risk	potentially) ■ Grant / equity / debt mix for array: Scottish Investment Bank precedent for Meygen tidal project
SPV	€38m - €250m for solar manufacturing projects	■ Uncertainty over PV material market ■ Price uncertainty for new innovations ■ Long-term PV performance	■ EU Policy & Regulation ■ EU grant/loan/guarantee support for novel/large-scale PV manufacturing
WIND	€54m - €2000m for offshore wind	■ Split: onshore/offshore ■ Can be high cost per MW ■ Mechanical innovation risk ■ Much exposed to natural hazards ■ Construction & Commissioning risk ■ Operational risk (floating wind turbine arrays)	■ EU Policy & Regulation ■ Grant / equity / debt mix for floating turbine arrays *(assumes appropriate fiscal support in place)*

Source: ICF, 2015. Notes: [1] Cost ranges are based on ICF study findings from surveying FOAK project sponsors as well as the results of the 2013 JRC study, Report on Innovative Financial Instruments for the implementation of the SET Plan, First-of-a-kind projects.
http://publications.jrc.ec.europa.eu/repository/bitstream/JRC83675/ldna26058enn_002.pdf

4.2.3 Summary of availability of funding streams

Table 4.4 provides a high level summary of availability for different funding streams (i.e. grants, equity, debt) across SET sectors. A few of the more established SET sectors, such as biomass, SPV and wind, are generally well served with grants and equity, in contrast to emerging sectors such as CSP, GEO, LES and Ocean. Debt has mixed availability across territories and SET sectors. CCS is particularly poorly served in the current funding landscape, not least due to the enormous costs of projects which often fall outside the funding thresholds of many support schemes.

The overall funding provision for FOAK projects, while certainly positive for projects in mature SET sectors (e.g. SPV, Wind) and in more established Member States (e.g. France, Germany, Sweden, UK), could be enhanced in other SET sectors and Member States.

Table 4.4 Summary of availability of funding sources for SET FOAK projects

	AEN	BIOMASS	CCS	CSP	GEO	LES	OCEAN	SPV	WIND
Suitable funding structures for SET FOAK projects:									
	Equity & grant: not lending risk	Equity & grant: availability of debt depending on technology types	Equity & grant, but to date no full-scale precedents. Debt will be needed, but availability highly uncertain	Equity, grant & debt: lender caution, as some precedents have failed	Equity, grant: lender caution, as few sectoral & regional precedents. Insurance used to cover drilling risks	Equity & grant: lenders uncertain of some technologies (not pumped storage) plus demand & business case	Equity, grant and debt: very limited as some precedents have failed, but tidal farms will need debt support	Equity, grant & debt: lender caution, as some precedents have failed	Equity, grant & debt: lender caution and some projects are very high value, requiring significant funds
Equity	✓	✓✓		✓	✓	✓	✓	✓✓	✓✓
Debt (loans)		✓		✓	✓	✓	✓	✓	✓
Grants	✓✓	✓✓	✓	✓	✓	✓	✓	✓✓	✓✓

Availability of options:

✓✓	*High availability across Member States*	✓	*Medium availability (e.g. some Member States)*		*Limited or Unavailable*

Source: ICF

5 Approach to ex-ante assessments of financial instruments

5.1 Introduction

The approach taken to carrying the ex-ante assessments of both FIs follows a procedure and key criteria set out by the European Commission in the EU Financial Regulation. The assessments are based on a mixture of primary and secondary research, with evidence collected from earlier research strands within the study.

5.2 The general case for FIs as a means of policy intervention has been promoted by Commission Services[84].

In the Commission's "A Budget for Europe 2020" policy paper[85], FIs are highlighted as a way of advancing the EU's key policy priorities, thanks to their leveraging of investment:

By working with the private sector on innovative financial instruments it is possible to magnify the impact of the EU budget, enabling a greater number of strategic investments to be made, thus enhancing the EU's growth potential. Experience in working most notably with the European Investment Bank (EIB) Group, national and international financial institutions has been positive and will be taken forward *in the next MFF. Guarantees and risk-sharing arrangements can allow the financial sector to provide more equity and lend more money to innovative companies, or to infrastructure projects. In this way, such financial instruments can also contribute to the overall development of post-crisis financial markets.*

In this regard, financial instruments can also be used to support specific policy objectives in a focused manner. For example, by directing capital towards a common set of activities (albeit across a number of final beneficiaries) which can collectively yield energy and GHG savings which will help fulfil strategic frameworks or action plans – such as the delivery of EU Research and Innovation (R&I) policy objectives in the field of energy and access to risk finance and, in particular, the support for first-of-a-kind (FOAK) large-scale energy demonstration projects in the EU.

The Commission considers[86] FIs particularly suitable for addressing sub-optimal investment situations in a wide range of policy areas whenever activities or operations are potentially capable of being financially viable, but are not yet attracting funding from market sources that is either adequate or available on reasonable terms.

Financial instruments also provide easier access to funds for companies (i.e. faster and simpler) in comparison to grant funding.

Finally, financial instruments can have an important signalling effect on the wider market, helping to demonstrate the viability and attractiveness of an investment space which in turn can attract a more sustainable and longer-term engagement from the private sector.

[84] COM(2011) 662 final: COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL: A framework for the next generation of innovative financial instruments – the EU equity and debt platforms

[85] COM(2011) 500, 29.6.2011, p. 9 and p. 11 of Part I.

[86] See *A framework for the next generation of innovative financial instruments — the EU debt and equity platforms*, COM(2011) 662, 19.10.2011.

5.3 Assessments must follow the general requirements for ex-ante evaluation within the EU Financial Regulation[87]

Article 30 of the Financial Regulation[88] requires the following considerations to be addressed with respect to any new financial intervention, even inside a pre-existing instrument:

a. the need to be met in the short or long term;

b. the added value of Union involvement;

c. the policy and management objectives to be achieved, which include measures necessary to safeguard the financial interests of the Union in the field of fraud prevention, detection, investigation, reparation and sanctions;

d. the policy options available, including the risks associated with them;

e. the results and impacts expected, in particular economic, social and environmental impacts, and the indicators and evaluation arrangement needed to measure them;

f. the most appropriate method of implementation for the preferred option(s);

g. the internal coherence of the proposed programme or activity and its relations with other relevant instruments;

h. the volume of appropriations, human resources and other administrative expenditure to be allocated with due regard for the cost-effectiveness principle; and,

i. the lessons learned from similar experiences in the past.

Arrangements for monitoring, reporting and evaluation, taking due account of the respective responsibilities of all levels of government that will be involved in the implementation of the proposed programme or activity, also need to be set out.

To fulfil these considerations, specific ex-ante evaluation criteria laid down in Paragraph 2, Article 140 of the Financial Regulation need to be applied in order to assess the extent to which the proposed instrument:

a. addresses market failures or sub-optimal investment situations which have proven to be financially viable but do not give rise to sufficient funding from market sources;

b. provides additionality: financial instruments shall not be aimed at replacing those of a Member State, private funding or another Union financial intervention;

c. ensures non-distortion of competition in the internal market and consistency with State aid rules;

d. generates a leverage effect: the Union contribution to a financial instrument shall aim at mobilizing a global investment exceeding the size of the Union contribution according to the indicators defined in advance;

e. provides an alignment of interest: when implementing financial instruments, the Commission shall ensure that there is a common interest in achieving the policy objectives defined for a financial instrument, possibly fostered by provisions such as co-investment, risk-sharing requirements or financial incentives, while preventing a conflict of interests with other activities of the entrusted entity.

[87] Regulation No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002

Please note that from 1 January 2016, a new Financial Regulation applies: Regulation (EU, EURATOM) 2015/1929 of the European Parliament and of the Council of 28 October 2015 amending Regulation (EU, EURATOM) No 966/2012 on the financial rules applicable to the general budget of the Union.

The new Financial Regulation has no implications for the ex-ante assessment of financial instruments. References to the previous regulation and delegated regulation are still made since no consolidated version is yet available.

[88] See Article 18 of the Commission Delegated Regulation (EU) No 1268/2012 of 29 October 2012 on the rules of application of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council on the financial rules applicable to the general budget of the Union

The assessment needs to have due regard to additional evaluation criteria including:

- EU added value of any new EU financial instrument and appropriate funding types needed to fill the identified investment needs;
- Possibility for reuse of revenues;
- Most efficient delivery mechanism for the financial instrument;
- Governance of the financial instruments;
- Entrusted entities which could best implement the recommended options;
- Awareness raising and scheme promotion; and,
- Anticipated economic and social outcomes which can be generated from the investments, as measured through appropriate monitoring indicators.

Finally, the ex-ante evaluation and design of the proposed facility needs to take into account the rationale, approach and results of other prominent funding instruments and programmes already being delivered in the market.

5.4 The ex-ante assessments of policy options follow the same structure

Each ex-ante assessment comprises the rationale and mechanics of each FI, together with strategic and operational objectives (where known). This is then followed by a full ex-ante assessment using the defined set of criteria (see section above). Cross references are made to a series of Annexes, containing key evidence and market analysis, to help justify the analysis and conclusions.

Much of the research conducted by ICF in the earlier stages of the study has helped to underpin the ex-ante assessments. For the reader's benefit therefore, cross-referencing to key sections (either in the main body of the report or Annexes) is used.

6 Ex-ante assessment of Policy option - European First-of-a-kind SET Project Investment Fund

6.1 Description of the proposed instrument

Goal: To incentivise Member States, institutional investors and other forms of investor to recognise the opportunities for supporting the commercialisation and deployment of leading edge, low carbon energy technologies and to increase market lending over the long-term in the sector compared to the baseline.

6.1.1 Overview

The new[89] financial instrument ("the Instrument") seeks to achieve a 'step change' in investment levels into European first-of-a-kind, commercial-scale Strategic Energy Technology (SET) projects. Such projects, which fall into Technology Readiness Levels 7-8, are currently being held back by a shortage of equity funding from the private sector. This is because these types of project fall into the so-called commercialisation "Valley of Death"[90], entailing far higher capital sums than earlier technology innovation levels, but where risks levels are much increased. The result is that a funding challenge exists, both for equity investment as well as debt finance, which can only be alleviated by the public sector taking on much greater levels of risk and uncertainty to help prove such technologies can be viable in the market.

Achieving a significant increase in investment in SET FOAK projects is a clear objective of current EU policy, particularly in light of planned revisions to the European SET Plan[91] later in 2016. Further increases in investment will also be required to fulfil both the 2020 and 2030 EU climate and energy package. There has never been a more pressing time to act.

Enabling more FOAK project demonstrations in Europe, from projects which have been prequalified by independent experts, will help improve deployment opportunities across the EU28, stimulate further investment and financing by creating viable exemplars, as well as creating jobs and investment into European SET supply chains.

The Instrument (see Figure 6.1) primarily seeks to address the limited access of SET project sponsors (final beneficiaries) in the EU-28 to sufficient levels of external (i.e. non-sponsor-provided) equity funding for FOAK projects. This problem is exacerbated because for such high risk projects, debt is not available in the volumes required, even from the public sector (exceptions being the specialist loans now offered under the InnovFin Energy Demo Projects (EDP) facility and some other public banks, e.g. the Scottish Investment Bank for tidal energy and Germany's KfW for offshore wind).

By offering equity on an asymmetric basis with other investors, and adopting a portfolio approach to spread risk, the Instrument seeks to invest in a suite of technology options relevant to different commercialisation timescales and to overcome a deep and entrenched market failure which prevents new SET innovations from coming to market in Europe.

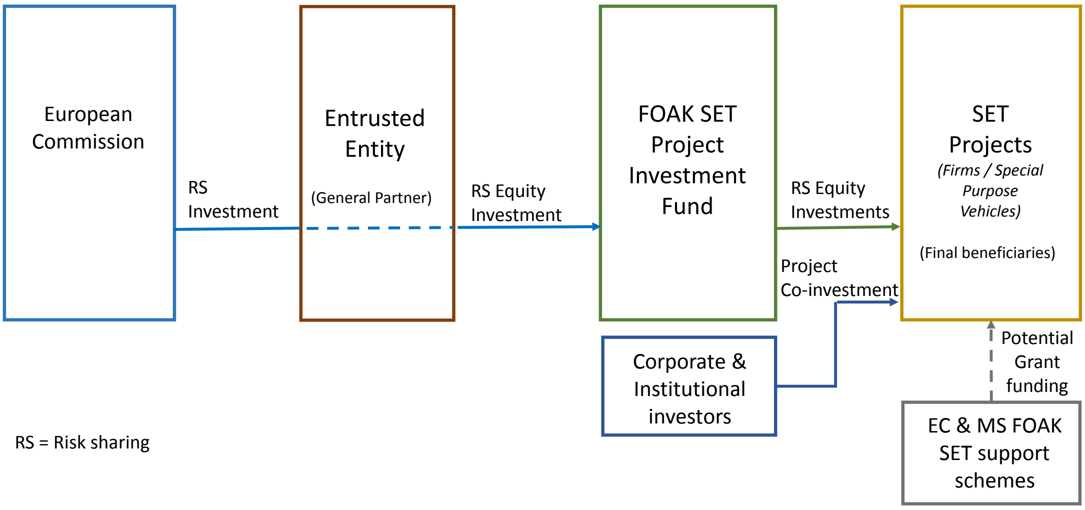
The Instrument can work with existing grant provision which dominates at this innovation level, for example, through mechanisms such as the NER 300 as well as some Member State schemes (see section 3.2, which summarises such provision). It can also sit well alongside the EDP debt facility.

[89] The instrument would fit within the Access to Risk Finance component of Horizon 2020 (InnovFin) but would constitute a new instrument, rather than any extension of existing provision.

[90] The Commercialisation Valley of Death is the point at which investment needs are greatest but so are risks associated with potential failure creating very high disincentives to participation in funding projects

[91] The 2008 Strategic Energy Technology Plan (SET-Plan) seeks to stimulate European research and innovation (R&I) for low carbon energy technologies by accelerating knowledge development, technology transfer and up-take, as well as promoting EU industrial leadership on low-carbon energy technologies in order to achieve the 2020 Climate and Energy Package.

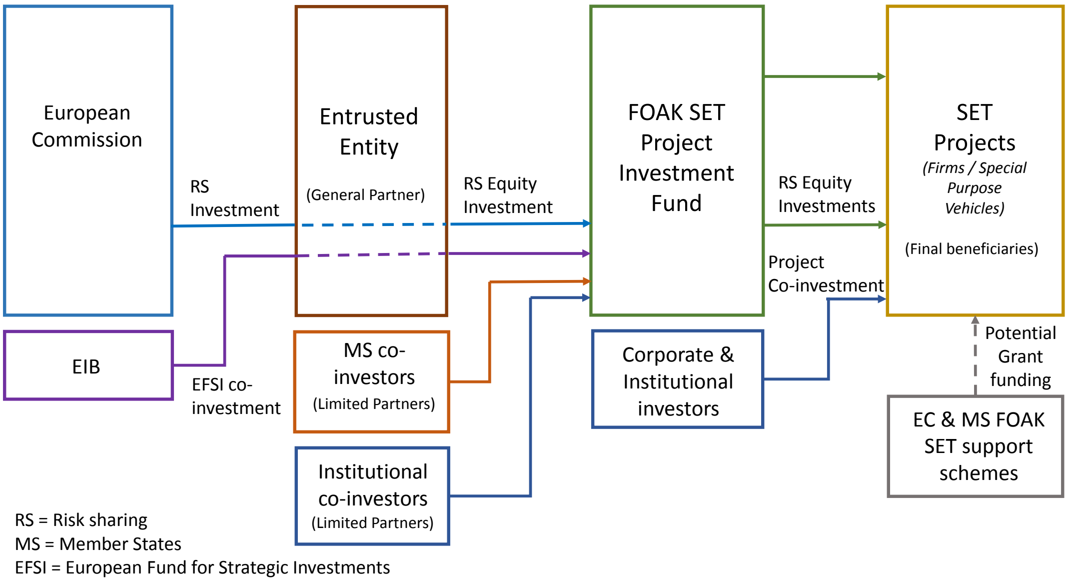
Figure 6.1 Overview of the instrument (pilot)



Source: ICF

Further, there is potential for the Instrument to stimulate co-investment into the main fund structure from the EFSI as well as Member State governments and institutional investors (as illustrated by the overview in Figure 6.2). This is explored later on.

Figure 6.2 Overview of an enlarged instrument involving other types of co-investor



Source: ICF

Establishing a pilot Fund would most likely take at least one year, and perhaps up to two, with the main fund then being rolled out after a further 2-3 years (once the concept had been proven and some initial success had been realised).

6.1.2 Strategic objectives of the scheme

The main objective of the Instrument is to provide a stream of equity funding to SET FOAK projects (final beneficiaries) in the EU (although the potential to invest in projects outside the

EU could also be explored as well as to attract potential co-investors[92]) in order to overcome a prevailing commercialisation "Valley of Death", so as to:

- support SET FOAK projects of strategic value to the EU, favouring EU-sourced technologies (for example, those that have been previously supported by Horizon 2020 and other EC mechanisms through earlier TRLs);
- incentivise a deeper pool[93] of SET investors from across the EU and further afield, such as North America, South East Asia and Australasia), due to the limited number of dedicated funds in the EU (and globally) targeting SET FOAK projects; and,
- create an important demonstration effect from EC intervention, helping to raise the profile of SET FOAK as an investable asset class and facilitating the development of a track record of investment that builds up information and expertise in the performance of SET FOAK projects amongst financial institutions. This should help to attract greater long-term funding support and stimulate more sustainable activity across the European financial sector.

6.1.3 Operational objectives of the scheme

The Instrument would seek to cover all EU28 Member States, and Horizon 2020 associated countries, although its geographical reach will be heavily determined by the type and quality of SET FOAK project applications.

The Instrument combines:

- An investment (initially in the range €250 million to €500 million[94] [95]) from the European Commission into a dedicated SET FOAK fund which is managed by an entrusted entity. Further long-term investment could come from various sources including the European Fund for Strategic Investment (EFSI), Member State governments as well as institutional investors.
- Investments made on an asymmetric basis alongside other investors into SET FOAK projects so as to provide some degree of incentive (as opposed to operating on a pari passu[96] basis) which would allow a portfolio of FOAK projects to be built across different SET sectors and risk profiles (i.e. further from market; high levelised costs of energy). Since the equity investment will support the design, construction and early operational phase of the FOAK project, the implementation and initial performance risk are substantially covered (alongside other co-investors) to the point at which debt can be raised into the project (together with the potential upside of participating in market replication activities such as licensing and sales activities).

[92] Based on ICF consultation with financial market participants, March – April 2016 [Question: "Should the equity fund be able to have reach outside the EU?]. Some investors feel any equity fund should have a more global perspective but using European innovations

[93] Based on ICF consultation with financial market participants, March – April 2016 [Question: "What kinds of institutional investor would be most interested / best placed to contribute to an EC-backed equity fund focused on FOAK projects?"], the following potential investor types were identified: pension funds; asset managers of insurance companies; private equity funds; institutional investors "with a climate change, carbon reduction interest"; "specialist and experienced renewable energy investors"; "Smaller investment houses who are specialised in the sector and have an understanding of the risks"; infrastructure funds; "Japanese trading houses"; "impact" investors; large corporates including those "seeking to do good"; "high net worths"; family offices. The public sector was mentioned by one consultee.

[94] Based on ICF discussions with financial market participants, we believe that a fund of €100 million is at too low a level to have adequate diversification of risk and would have insufficient volume to support engineering expertise and specialist staff that would be required to make an impact. With a fund size of €500 million, from the investors' point of view, that is where there is a current dearth of funds seeking investors, i.e. right in the middle of the mid-market range. A fund much smaller than this may not be viable nor efficient in terms of staff costs, cost to income ratios and all other relevant criteria of value for money. Further, it will be difficult to recruit and retain staff of calibre if it is significantly smaller than this level.

[95] Based on ICF consultation with financial market participants, March – April 2016 [Question "What is the optimal value for the proposed equity and/or debt facility?]

[96] Pari passu risk participation seeks to ensure that the same type of risks are shared in equal proportion, meaning that in the cases of losses due to the risk they share, they will be allocated on 50/50 basis to the participants in the risk sharing agreement.

- Active management of the portfolio of bankable SET FOAK projects so that project investments are scrutinised using management accounts and Key Performance Indicators from the outset so as to minimise losses to the fund portfolio.

The instrument will need to run initially for at least 10 years, starting in 2017 through to 2027 (the implementation period) including n+2 years as per Article 140(6).

Given the long-term goal of the Instrument, and because such an Instrument is believed to be most efficient when it can operate for a 10 year (or even on an 'Evergreen'[97] basis in which the EC's initial contribution would ideally be recharged with revenues from successful investment "exits")[98], a derogation under the FR will be requested to allow the Instrument to rollover into the next Multi-annual Financial Framework (MFF) period of 2021 to 2027 and potentially into the 2028 – 2035 MFF.

The maximum period of investment could potentially be set at 15 to 20 years. This would make the fund suitable for pension funds and other institutional investors who can countenance such a long-term view (for example, institutional investors are now participating in a Fund focused on renewable energy which is managed by Copenhagen Infrastructure Partners and which was part established through an 'equity-type' investment by EIB made under the European Fund for Strategic Investments (EFSI))[99].

With an initial fund size of at least €250 million (and up to €500 million) to be viable and credible in the market, the Instrument would need to invest in a minimum of ten projects[100] across different SET sectors. For a pilot fund, therefore, average investment into projects would be around €25 million. However, the size of investments could feasibly lie anywhere in the range €10 million to €100 million. The main caveat would be that, in order to minimise risk exposure, the Instrument would not be allowed to invest a sum greater than 10%[101] of the total fund value into any one FOAK project.

Eligibility for the Fund could be drawn from several core criteria, as illustrated in Box 6.1 overleaf.

The Instrument would seek to take a minimum "significant minority" investment (25-35%) in project SPVs[102], although for some investments there could be merit in increasing ownership to a "significant" (35-50%) or "majority" (51%+) stake[103] in each project. The catalytic effect of the Fund acting on such investments would therefore be to lever 2-3 times investment levels from other investors.

[97] An Evergreen fund structure is one in which the fund has an indefinite life with profits reinvested into the Instrument

[98] Based on ICF consultation with financial market participants, March – April 2016 [Question "How long should the [debt and equity] facilities be in place?"]

[99] The fund targets mezzanine and equity-type investments primarily in new, large-scale energy projects such as offshore wind, biomass and transmission schemes located mainly in Northern and Western Europe. The fund has institutional investor backing (e.g. pension funds such as Pensions Denmark) which is enabling such institutions to engage in large renewable energy infrastructure projects much earlier than they might normally. The fund's investment horizon is geared towards such long-term investors with a time horizon of 20 years. http://www.eib.org/infocentre/press/releases/all/2015/2015-152-first-financial-transaction-under-investment-plan-for-europe-in-denmark-eib-backs-innovative-renewable-energy-infrastructure-fund.htm

[100] Based on ICF consultation with financial market participants, March – April 2016 [Question "What is the minimum number of SET FOAK projects you think is needed for each facility to look credible in the market?]

[101] This would need to be reviewed by the Fund's strategic board or European Commission or both

[102] Some precedents for maximum equity levels are known from the EBRD, IFC and France (Investments for the Future scheme). All are 40% or lower. The French 'Investments for the Future' scheme places a limit of 33% on the equity investment it can make into any one project to reduce exposure and ownership issues/conflicts. While this is not a mandatory limit, it is considered good practice in order to avoid instances of malpractices in the management of a particular project.

[103] Based on ICF consultation with financial market participants, March – April 2016, the majority of whom favoured these latter two options when asked [Question: "What sort of ownership structure do you think investors / the Equity fund would wish to take in projects?"]

Box 6.1 Potential eligibility criteria for the Equity Fund

The Fund could would need to satisfy diverse criteria:

- Innovativeness of the project – is it first in world, first in the EU, first in its sector?
- Underlying economics – does the value proposition make commercial sense?
- Prospects of commercial viability and 'bankability' – has the project the potential to raise debt?
- Market replication potential – is the business model credible and further projects likely?
- Readiness for demonstration at scale – is the project ideally 'shovel ready' or near to it?
- Timeline – is the maximum time to start construction two years or less?
- Commitment from project sponsors – are sponsors able and willing to commit a significant level of investment alongside the Fund (and /or how much have they already committed to date)?

Source: ICF

The Fund would, in the main, seek to exit from its investments once FOAK projects had achieved successful commissioning, with operational performance that had been independently verified by experts. Successful demonstration will bring FOAK projects to TRL 9 status and therefore, having successfully bridged the commercialisation "Valley of Death", into the sights of a large number of potential institutional investors and financiers who at this stage in the technology's development are less risk averse. Additionally, in order to improve investor "upside" and enable the Fund to have the maximum opportunity to stay involved with successful projects as technology licensing and market replication and deployment gains are made, the Fund could for certain investments maintain an investment 'holding' position for projects that have reached TRL 9.[104] Indeed, almost all market participants consulted by ICF felt that this prolonged investment strategy was the right one to follow; conversely only two thirds felt that venturing into TRL 6, in order to enhance the Fund's pipeline and allow it to pick up innovative projects ahead of time, was worthwhile[105].

Based on collated views of various market participants, for which there was broad agreement on the level of returns, despite participants coming from quite a wide range of financial fields, the average targeted return from the Instrument would ideally be a minimum of 10-15%, with some market expectations being for 15-20% or greater from such a Fund[106].

In theory, the SET scope of the Fund could potentially be very broad, ruling no technology out, since there *"might always be an amazing technology to back"*[107]. In practice, there are strong opinions amongst financial market participants about where an SET FOAK equity fund should focus its investments (see Annex 13 for a review of market participant views on where equity funding is most needed and where it should be excluded). Key SET sectors identified by market participants as being in real need of equity investment include: advanced electricity networks; some bioenergy innovations; large-scale energy storage; and deeper water offshore wind innovations such as floating turbines. There was much less interest for ocean energy (tidal arrays and farms in particular) and other sectors such as CCS, CSP, geothermal and solar PV.

[104] The ability of the fund to continue to hold investments into project sponsors / holding companies that had successfully demonstrated their project would need to be researched further in the scoping of such a facility.

[105] Based on ICF consultation with financial market participants, March – April 2016 [Question: "Do you believe that an equity fund focused on FOAK projects should cover other TRLs?"]

[106] Based on ICF consultation with financial market participants, March – April 2016 [Question: "What level of returns would you expect to be provided from the equity facility?"]

[107] Based on ICF consultation with financial market participants, March – April 2016 [Question: "Which SET sectors do you think should be included or excluded from such facilities?"]

Pilot Fund

In terms of financial flows, for the initial pilot Fund:

- Equity investment from the fund should be provided on an asymmetric basis alongside other co-investors, into FOAK project 'Special Purpose Vehicles' (SPVs), i.e. as part of an overall investment into the equity portion of FOAK projects in which the EC's contribution does not exceed a given percentage of the overall equity deal size. The Instrument contribution will act, in most cases, as a 'cornerstone' investment which can help catalyse investment from other co-investors[108] including project sponsors themselves. It might also in some cases help to attract debt, thereby having a layering effect. The precise nature of the investment needs to be further examined, as is illustrated by a potential set of options in Box 6.2.

Box 6.2 How would the SET FOAK equity fund invest in projects?

According to one European venture capital investor[109], an ideal position would be to invest in the Top-co [holding company], alongside other equity investors, and seek returns when projects are successful. The EC's SET FOAK Fund could either:

- Co-invest into the company which owns the rights to the technology, i.e. the Fund invests in the Top-co and the money is flowed down into the SET FOAK project; or
- Co-invest alongside other equity providers in both the company and the SET FOAK project - the Fund invests in the SET FOAK project and takes a stake in the Top-co to reflect any potential upside which would accrue once the project has been successfully demonstrated. This would make the deal more attractive.

- The Fund would help project sponsors in most cases to match the equity raised, backed potentially by other sources such as debt (if appropriate and where available) and grant contributions from EC or Member State schemes (assuming State aid approved is given). In the least risky FOAK projects, the expectation would be that the Fund could combine with other equity from the project sponsor to lever debt; otherwise the Fund might well act as a sole equity provider into projects;
- The Entrusted Entity would act as the General Partner in the Fund;
- The Instrument would operate across a target set of investment opportunities drawn from different SET sectors (see market participant survey in Annex 13 and investment needs summary in Annex 5). This investment mandate would ensure full disbursement of the Fund over a given time period (nominally 4-5 years);
- The Fund would operate with a portfolio approach investing in projects across the EU-28 (although there could be scope to extend the geographical reach for projects of strategic importance)[110]. By limiting each investment to a maximum proportion of the overall Fund portfolio value, the Instrument should enable losses to be covered across the Fund's portfolio of investments;
- The Fund is designed to reduce the investment risk faced by sponsors of SET FOAK projects and therefore to encourage their participation in deals that in the longer term are forecast to deliver both financial returns and significant decarbonised power generation (once replicated in the market), but in which equity investment (or other forms of funding which could make up the equity gap) is not possible to be obtained. The Fund is expected to increase investment and debt activity (i.e. access to finance and/or better financing conditions to the final beneficiaries, including lower pricing, longer maturities,

[108] These are likely to include large corporates (industrials, energy utilities, oil companies, etc.), SMEs, venture capital funds, private equity, family offices, 'high net worth' investors as well as potentially crowdfunding or community investment models.

[109] Based on ICF consultation with financial market participants, March – April 2016

[110] Based on ICF consultation with financial market participants, March – April 2016 [Question: "Should the equity fund be able to have reach outside the EU?"]

lower collateral or others) which in turn will help to pull through low carbon innovations into the market.

- The European Commission would seek to achieve successful deployment and exits through the fund which would enable its contribution to be 'recharged' and redeployed.

These financial flows are reflected in Figure 6.1 above.

Given the challenges of defining an initial fund size and hoping to populate a pilot Fund with suitable FOAK projects, an alternative approach to establishing a pilot Fund might involve the use of a Reverse Fund-Building concept. This is outlined in more detail in Box 6.3 below.

Box 6.3 Reverse Fund-Building

The reverse fund-building concept comprises of the following approach:

- Pilot funds are made available by the European Commission to invest on a project-by-project (direct) basis.
- Once the target/pilot portfolio of projects (for example, consisting of 4-5 projects, from across a handful of SET sectors, each requiring over a minimum €10-20m total project value) has been built, the directly invested equity would be transferred to a Fund created at that point in time.
- These initial projects therefore seed the Fund and allow it to then have visibility in the market.

The advantages of such an approach, inter alia, include:

- It allows for immediate actions to be taken in identifying, shortlisting and investing in FOAK projects versus needing to wait for the Fund be set and operational in order to invest.
- The existence of seed projects in the Fund from its inception could then be expected to be key to attract institutional or corporate investors to the Fund by immediately raising the profile of FOAK project funding needs and by enabling actual bankable financial structures to be reviewed. This

The reverse fund-building concept would need to be explored in more detail in scoping the Fund.

Enlarged fund open to co-investment

If there is sufficient interest from other co-investors, such as the EFSI, Member State governments (where there is strategic interest in supporting the low carbon supply side) and/or institutional investors (including those with an interest in deploying 'patient'[111] capital), the size of the equity fund could be enlarged (potentially significantly). Such contributions are illustrated in Figure 6.2 above. These co-investors would act as Limited Partners into the Fund.

Additional money invested into the Instrument would ideally be made on an asymmetric returns basis alongside the European Commission. This would catalyse and crowd in additional money by incentivising co-investors to enter the commercialisation 'Valley of Death'. Of those market participants who felt able to respond, over half felt that some form of asymmetric return would be necessary to incentivise co-investment into the Fund[112].

Under an asymmetric returns option, co-investors would be the first investors to benefit from any returns the fund provides (or be safeguarded against losses). In effect, the share of investment made by private co-investors into the Fund would rank more highly than that invested by the European Commission[113], thereby behaving less like 'normal' equity investments where all investors would lose if investments failed. This would have the advantage of incentivising private investors to commit money to help fulfil European policy objectives. The process could also work where the European Commission covers a certain proportion of the immediate losses on the overall Fund portfolio of investments, for example

[111] Whereby investors are willing to provide long term capital into a business with no expectation of obtaining a quick profit

[112] Based on ICF consultation with financial market participants, March – April 2016 [Question: "What sort of returns structure would be expected to incentivise private sector involvement?"]

[113] This could be progressed using, for example, a Class A and B share structure in which the European Commission invests in Class B shares in each project SPV and therefore takes first losses in the case of failure or investment 'write downs'

where the value of investments in particular project SPVs needs to be 'written down' because of a recorded loss in value (for example, where unforeseen challenges arise and progress is not as rapid as planned, leading to a potential need for further investment to ensure the project becomes operational). This approach has been used by the European Energy Efficiency Fund and this is further elaborated in the Evidence 1 box below. While this is shown as an illustration of what has been done elsewhere on behalf of Commission services, such a funding structure may not meet governance requirements in some jurisdictions and this approach would need to be further scrutinised.

Evidence 1 Innovative method used to incentivise co-investment

The EEE is open to investments from institutional investors, professional investors and other well informed investors within the meaning of the Luxembourg SIF law. Targeted investors have included donor agencies, governments, international financial institutions and professional private investors. The objective of EEEF is to provide commercial returns to its investors. It has established a "waterfall principle" which allow investments into three different categories of shares in the Fund, including:

- C-Shares – "which bear the highest risk ("First Loss") and serve as a risk buffer for the more senior share categories";
- B-Shares – "which rank senior to C-Shares and are remunerated on a 6m Euribor + Spread basis. Depending on the Fund's profitability, complementary dividends are possible"; and,
- A-Shares – "which rank senior to B-Shares and are also remunerated on a 6m Euribor + Spread basis, however at a lower level than B-Shares to allow for risk/return adjustments. Depending on the Fund's profitability, complementary dividends are possible".

Source: European Energy Efficiency Fund

6.2 Ex-ante assessment of the equity fund

The main findings from the ex-ante assessment are presented below, with supporting evidence in Annexes.

6.2.1 Market failures or sub-optimal investment situations addressed

Nature of the market failures

A plethora of issues and market failures are identified as specific risks to FOAK project development and must be mitigated either internally or through public sector interventions. The review of market failures and barriers for low carbon investments and the impact this is having on FOAK project funding was discussed in detail in section 4.1.

Substantial market failures and barriers inhibit investment and financing of SET FOAK demonstrators and act in one of three areas: structurally, at a macro-economic level; on the demand side; and/or within the supply side, especially in nascent and emerging supply chains. Barriers also include sub-optimal investment situations, in which the market is not interested in supporting SET FOAK projects (despite there being a positive economic rate of return) or where projects that are in principle 'investable' or 'bankable' (i.e. can generate a positive IRR) but the finance or investment is inadequate because of a project's uncertain outcome and underlying risk structure. Many of these barriers are identified as specific risks to SET FOAK project development and must be mitigated either internally or through public sector interventions.

Commercial-scale SET FOAK demonstration projects in the EU are perceived as highly risky and funding levels[114] are therefore much lower than mainstream SET financing. Despite the presence of grant funding and some debt provision, equity funding remains the most appropriate option for SET FOAK projects. However, commercial market providers of equity

[114] As determined through the initial review of market participants and then corroborated through several interviews

are reluctant to commit funding for SET FOAK projects the more so with ever expanding opportunities to fund proven low carbon technologies such as solar PV and onshore wind. The type of market participant that might be persuaded to consider supporting FOAK projects through the provision of equity is now better understood and includes specialist equity providers, producers (i.e. energy utilities, engineering companies) and potentially longer term investors such as pension funds.

The type of market participant that might be persuaded to consider supporting FOAK projects through the provision of equity is well understood and is detailed in section 3.3. As noted, the willingness of financial market participants to support SET FOAK projects has changed significantly across time, most likely due to a combination of internal and external factors.

There is potential for some market participants to invest directly in a Fund. A precedent for this type of activity has been set by the UK's ETI which is a public private partnership in which corporates are involved with a view to aligning investments with their corporate strategic interests. ICF took market soundings from investors and financiers and found that the factors that would most encourage corporates (e.g. engineering firms, energy utilities, oil majors, etc.) to participate in an equity fund included strategic interest in key SET technologies (such as access and rights to new technology), along with fostering market growth and generating future work from it were the most important factors to consider (see Figure 6.3 below). How this could be squared with a diversified fund where fund investors may well have to take a more passive role would need to be further examined in the scoping of such a fund.

The SET FOAK Fund would primarily help to significantly fill the shortfall in co-investment availability; it would also aim to support the investment strategies of other investors, establish a track record and a set of exemplar projects to demonstrate successful FOAK investments which can help to raise the visibility of this asset class.

Potential solutions and stakeholders

Given the scale of funding needed for large-scale demonstration projects and ventures, the deployment of an EU-backed equity fund should help to incentivise the participation of various actors (i.e. corporate investors, institutional investors) in SET FOAK projects by helping to share the risk of co-investment. Additionally, an equity fund could have the potential to reduce or mitigate investor risks in SET FOAK projects by spreading the risk across a portfolio and, potentially, benefitting from more stringent due diligence procedures from the outset.

Ambition level for the facility

A detailed analysis of the investment gap was set out in section 3.1.3.

The minimum size, minimum deployment scenario for SET FOAK projects in Europe requires a total investment need of at least €4.0 billion, indicating that a maximum size for the equity fund of up to €1 billion is still well below the overall market needs of more than €28 billion. Those sectors most in need of support – such as second generation biofuels, CCS, CSP, Ocean and offshore floating wind – should be targeted first by the fund (these alone require investment of between €3.0bn and €18.1bn). However, some sectors such as CCS would require a very high proportion of the available equity in the fund and this might breach the maximum deal thresholds (i.e. 10% maximum of the overall fund size).

To overcome this funding shortfall, and fulfil likely equity needs within FOAK projects, the long-term scale and ambition of such a fund concept would need to be increased (perhaps by having a set of discrete funds such as EC FOAK I, EC FOAK II, etc.).

These conclusions take no account of the opportunities to utilise other funding streams which the EC can introduce such as the NER 300 grant programme (and its successor, the Innovation Fund), or any debt facility (e.g. the Energy Demonstration Projects facility).

The opportunity for project sponsors to blend funding streams has been covered in part in section 3.2.3 where alignment of Member State funding streams was discussed. There are clear difficulties ensuring alignment of schemes, not least because of different scheme objectives, budget limits and timescales of funding competitions (at least for grant based schemes). The opportunity to achieve greater scale and alignment of funding across European and Member State schemes would be easier via financial instruments utilising continual application opportunities (i.e. projects assessed and funded where eligible on a rolling basis).

6.2.2 Additionality and EU Added Value

Achievements of EU policy objectives

The long term policy drivers for this analysis are the 2020 and 2030 Climate and Energy Package targets, i.e. a 20% renewables target for 2020, rising to 27% for 2030 as well as clear reductions in greenhouse gas emissions and improved energy efficiency. The SET plan is also an important framework for the Fund. EC policies objectives are reviewed in Annex 2.

Overall, the equity fund would contribute strongly to EU policy targets by helping to accelerate the deployment of game-changing technologies across numerous SET sectors, creating diverse significant benefits to the European economy including greenhouse gas emissions reductions, new industrial supply chains, employment growth as well as export opportunities outside the EU where markets are rapidly expanding for low carbon energy technologies.

Given the diverse set of market failures and barriers to ensuring that SET FOAK projects can achieve commercial demonstration - such as a lack of policy certainty, potential changes (i.e. reductions, termination) to fiscal (subsidy) regimes as well as regulatory obstacles (Annex 1) as well as an analysis of project risks (Annex 12) - there are a range of other interventions which both the European Commission and Member States could make to reduce market barriers and improve wider framework conditions. Innovation Finance Advisory, for example, is actively involved in the assessment of the impact of EU regulatory barriers on access-to-finance of specific projects and the identification of potential ways to mitigate/address them. However, such interventions (which are not the focus of this report and which have been widely investigated in other studies) must be introduced alongside an increased level of funding support for SET FOAK projects.

Complementarity with other forms of public interventions

There is currently no equity fund of the scale envisaged by this new Instrument available in the EU. The equity fund can provide an important and synergistic addition to the current mixture of EC mechanisms such as NER 300 (and the future Innovation Fund) and the EDP facility. It would also align well with Member State provision without creating overlaps. This is because there are only modest budgets generally available through most Member State schemes for such large projects (see section 3.2 for further details). The Fund's scale is unlikely to impact other new initiatives, certainly at the Member State level.

It also offers an excellent opportunity to complement planned mechanisms such as an investment platform under the European Fund for Strategic Investments (EFSI) which might focus on SET sectors and/or geographies in which SET deployment is desirable (see Annex 5 for further details). Such linkages could help to increase the number of investors into the fund and enlarge the fund size. This will help it to achieve greater scale and presence in the European market and to target a larger proportion of overall investment needs required by both policy makers and the private sector. Scale is also critical to enable specialised expertise of sufficient standing and calibre to be retained by the Fund. It is also the means of ensuring that Fund operating costs are efficiently managed in relation to performance and outputs.

Crowding-in of private investments (no crowding out)

The equity fund can ensure through its specialised mandate and focus, strategic oversight, proactive management and due diligence of deals that it can avoid investment situations in which private investment may be crowded out (see Box 6.4). Indeed, there is little risk of crowding out given the paucity of commercial investment activity and the absence of a strong

European investment 'community' focused on this part of the SET commercialisation pathway. Rather, the intention of the instrument is to 'crowd in' commercial investors. There might possibly be some crowding-out of Member State grant-funded support in the move to a market funded sector, which is understood as a positive effect.

Box 6.4 Crowding in of private investment would be essential for the Fund

Crowding in of private investment (and minimal crowding out) can be maximised within the equity fund in several ways:

- First, by ensuring that the strategic objectives (the mandate) for the fund are sufficiently well researched and identify key SET sectors most in need of equity investment – as well as strong interest in co-investment from project sponsors and investors.
- Second, by ensuring that the investment committee for the fund is comprised of a mixture of experts from the sector who have familiarity with the TRL 7-8 funding landscape and likely market participants and can provide expert judgement on instances in which particular potential investments may have been supported by the market without a public sector equity intervention.
- Third, by providing sufficient resources to fund a large enough investment team, backed by independent experts, to conduct market analysis and due diligence of deal flow in order to ascertain whether similar projects have been taken forward in EU Member States (and potentially other territories). These project examples could serve as valuable investment benchmarks and indicators of potential prior involvement from the private sector which would require a stronger case for public sector intervention.
- Management and staff of the Fund need to be of sufficient experience and standing to engage in constructive dialogue with sponsors and other project participants. Proactive involvement in the structuring of transactions and subsequently in the implementation and operating phases is necessary. This will also distinguish the Fund from other institutions in the financial markets.

EU added value

ICF's analysis of Member State schemes in section 3.2 showed limited provision to fulfil the very large investment needs across all SET sectors. Even when a very large EC instrument such as NER 300 is added, the combined funding provision still falls well short of the total investment needs for FOAK projects (ICF calculates this is in the order of €10 billion).

The scale of operation for such an equity fund is best delivered at the EU level in order to maximise the number of available FOAK projects, ensure the application and connectivity of all relevant sector experience and knowledge, achieve diverse investor coverage, target the widest choice of renewable resources across geographies, as well as potential Member State engagement.

There is a clear strategic need for an EU-wide instrument that can deliver substantial equity investment into SET FOAK projects. The scale of investment flows focused on any one Member State through the Instrument is likely to be greater than for a single Member State developing its own scheme. However, opportunities also exist to link into Member State funding streams through such a fund, for example via co-investment. This might attract greater levels of investment to help meet domestic strategic objectives for certain Member States.

The opportunity for successful FOAK projects to achieve market replication could bring considerable future benefits to the EU economy. Section 3.1.4 provides an illustration of the potential scale of such replication, based on consultations with FOAK project sponsors who provided sales forecasts based on a successful operational demonstration of their project and subsequent market deployment in line with their business plans.

Appropriateness of a financial instrument type of measure

There is a clear strategic need for a FI to overcome a limited amount of grant support in certain Member States. Overall, grant provision has to date had limited success in achieving

EC policy objectives. This is not just because there are not only limits on how much Member States can provide in grant funding (typically 50% of overall costs due to state aid restrictions on projects around TRL 7-8), but also because of the shortage of private sector equity (risk capital) to complement the grants.

Furthermore, the inability of the current NER 300 programme to achieve a rapid operational deployment of its 39 grant-awarded SET FOAK projects demonstrates that there are clear challenges (both financial and non-financial) to achieving financial close on large-scale FOAK projects supported by grant funding that is disbursed once plants become operational.

Notwithstanding the modest sum of €150 million currently available through the EDP facility, for certain SET FOAK projects (e.g. within the ocean energy sector), in the absence of greater debt availability for such high risk projects, equity can be used most effectively in combination with grants to bring FOAK projects to fruition. Once operational outcomes are assured, project sponsors and other co-investors can seek debt refinancing to replace equity.

Advisory service support to SME innovators and project sponsors to improve the deal pipeline is also recommended alongside a financial instrument. This is based on ICF's extensive analysis of risks acting on FOAK projects (see Annex 12). This shows a clear market need to support innovative SMEs across different SET sectors better to navigate the plethora of risks which can be foreseen and hence have more chance of bringing their innovations to market. This includes support with designing and planning a project and understanding how best to raise a complete package of funding which will enable a FOAK demonstration project to achieve financial close and become built and operational. This is the subject of an 'advisory services' option which is dealt with in section 9 of this report).

The ability of building a complete and adequate funding package is also subject to the compatibility of the different EC/Member State funding windows/streams and the timeliness of accessing these windows. Potential actions include inter alia:

- Streamlining (to the extent possible) the administrative burdens involved in accessing different funding windows/streams, enhancing the timeliness of processes, ensuring maximum possible compatibility between them (e.g. scope, requirements, etc.).
- Revisiting instruments and/or their implementation as necessary so that they are best fit-for-purpose (e.g. EDP).

Appropriate funding type

Equity was considered by all market participants interviewed by ICF in summer 2015 as an appropriate form of funding for FOAK projects; and this view was reiterated by 14 market participants consulted in early 2016[115], including in combination with debt. An EC equity fund for FOAK projects would also help to fill a market gap in Europe (see section 3.3.2).

Some of those advocating equity as a critical form of funding indicated that for some FOAK projects in some SET sectors an "all-equity" solution might be required until the technology is proven. In such cases debt may not be appropriate or suitable unless there is a path to replication and stable operating revenues are in evidence. One respondent felt that debt is not worth having unless technology risks can be offset by an EPC contractor ("debt has limited upside but unlimited downside"). However, others believe that flexibility in the funding mechanisms is important. If projects can support debt then it should be provided alongside equity.

6.2.3 Non-distortion of competition in the internal market and consistency with State aid rules

Non-distortion

The Instrument fits well with the internal market and is unlikely to distort competition.

[115] Based on ICF consultation with financial market participants, March – April 2016, many of whom had taken part in the first consultation in summer 2015 [Question: "What type of finance do you feel is most required for supporting European SET FOAK demonstration projects?"]

Compatibility with EU state aid rules

It is also consistent with EU state aid rules given the initial emphasis on an EC-backed fund. Recent changes to the EU state aid guidelines are summarised in Annex 9 (section A9.9).

The addition of Member State government co-investment into FOAK projects would need to be considered on a case-by-case basis (for example, if there was grant funding supporting a project it would need to be 50% or less), given the potential sums involved may be very different. However, the spread of investment into different projects across different territories within an equity fund would lessen potential issues arising from individual projects being favoured by particular Member States (i.e. it would not be possible for individual co-investors into the fund to dictate the fund management approach in order to favour special cases).

6.2.4 Leverage (of co-investment into both the Fund and SET FOAK projects)

Co-investment

Any equity instrument needs to stimulate a total level of co-investment that exceeds the EU's financial contribution. Leverage, in this context, is thus defined as the total investments made – either into the Fund or into SET FOAK projects (i.e. the supported beneficiaries) – divided by the EU financial contribution.

In summary, after an initial pilot phase in which the EC makes a sole contribution – as a means of testing the market demand - the fund manager would seek to raise co-investment into the Fund from non-EC sources (e.g. Member States and private co-investors) to a level at least 2-3 times the EC's contribution. At the project level, co-investment could be expected to range from two times (in cases where majority ownership is required) to four times the fund's investment (where significant minority ownership is undertaken). Equity investments into FOAK projects could also lever in debt, especially if a Fund backed by the European Commission has a strong signalling effect on the wider market. This would create an important multiplier effect of the investment.

These two different aspects of leverage are discussed in further detail below:

Co-investment into the Equity Fund

At the fund level, the initial risk capital contribution from the EC is likely to represent 100% of the fund, and this would be expected to be the case for some time during the pilot phase (i.e. for 1-2 years) before further and potentially significant contributions can be expected from other co-investors (be they from the public sector such as Member States or private investors). Here the fund's leverage effect on co-investment, at least in the initial phase of gaining co-investment, will be zero. Once the Fund is established, the expectation would be to raise co-investment to at least 2-3 times the EC's contribution from other sources.

Co-investment into FOAK projects by the Equity Fund

At the FOAK project (final beneficiary) level the need to stimulate a total level of investment that exceeds the EU contribution militates against the fund investing in more than 50% of the share capital in any one project. However, because the fund would operate on a portfolio basis, some degree of flexibility to invest in a mixture of financial structures would be available. For example, some project investments would require majority ownership (50%+ of the share capital) in order to ensure that the project went ahead (e.g. in the absence of sufficient co-investment but where the fund manager and investment committee deemed the investment to be of strategic (policy) value, whilst other projects might only need 'cornerstone' investment to catalyse co-investment (for example, a 'significant minority' ownership or around 25% of the share capital). At the project level, co-investment could be expected to range from two times (in cases where majority ownership is required) to four times the fund's investment (where significant minority ownership is undertaken).

The critical indicator – and one by which fund performance would be measured – is the overall value of the portfolio at any given point in time. This is because the value of each investment may go either up or down according to how well each FOAK project is performing. For example, a project that can get through the construction and commissioning stage and is operating well (and has good market replication potential) is likely to increase substantially in value compared to the initial investment from the fund. Conversely, a project that stalls at planning stage for some reason or fails to perform as expected at commissioning stage may well be 'written down' in value by the fund manager. The 'net asset value' (NAV) of the overall portfolio would drive the rate of return which is being sought and hence any incentive payments to the fund manager.

The role of different forms of funding in the financial structure of FOAK projects

Clearly the ability of equity to also lever in debt into FOAK projects needs to be considered, especially if an investment from a Fund backed by the European Commission has a strong signalling effect on the wider market. Therefore an equity fund may have a multiplier effect in terms of its overall impact on the market.

The total leverage of funding into projects would depend on the overall funding requirement and the role of equity, vis-à-vis the availability of grant and debt funding. An analysis of potential FOAK financing structures from real European projects was reviewed in section 3.1.2. This clearly shows in most projects the strong interplay between grants, equity and debt.

6.2.5 Alignment of interest

There is a need to align the equity fund with the interests of private co-investors whilst also ensuring that conflicts of interest or perverse incentives are avoided. Any form of risk sharing component which is built into the fund objectives and overall mandate could help to overcome concerns amongst certain co-investors about the potential risk in investing in SET FOAK projects.

Regarding annual fees for managing an equity fund, amongst the 12 market participants in ICF's market sounding exercise that expressed an opinion, eight were in favour of a management fee in the order of 1-2% plus carried interest[116]. Based on feedback received, *"anything more than that it is not deemed palatable"*.

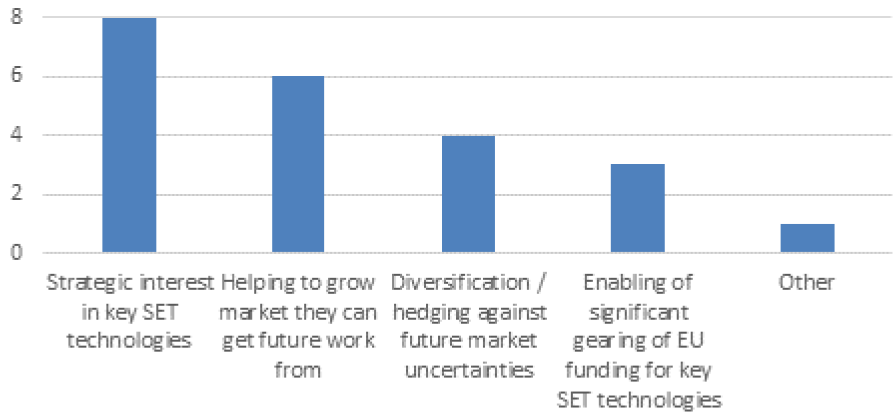
In terms of a returns structure to co-investors, an asymmetric structure was indicated as a preferable model by half the total respondents (n =10) to ICF's market sounding exercise mentioning that it is *"critical to ensure that EC absorbs first loses up to a defined maximum"* with one indicating 50% of that losses. Conversely, several respondents felt a pari passu approach was sufficient. Additionally, two respondents felt that a blend of both pari passu and asymmetric returns was needed because the balance depends on the risk level of the technology and how far it is from being commercial.

A minimum of a 10% to 15% rate of return is expected by most interviewees (n=9), with three respondents considering higher returns, in the order of 15%-20%. Expected rates of return would also depend greatly on the investors involved (i.e. their expectations) and how untested the FOAK projects are.

Institutional investors taking a long term view (e.g. patient capital) and committed to making a difference to the decarbonisation policy agenda may be persuaded to come on board such a fund because it would help to play an important role in the market. There would also be strategic reasons for corporates to co-invest in an equity fund. ICF took market soundings from investors and financiers and found that strategic interest in key SET technologies along with fostering market growth and generating future work from it were the most important factors to consider (see Figure 6.3 below).

[116] Carried interest or 'carry' is a share of profits that general partner of an equity fund would be eligible to receive once all limited partners had received the target profits, as set out in the fund mandate and contract between investors.

Figure 6.3 Factors which might encourage corporates to support an EC-backed equity fund



Q5 - What might encourage corporates (engineering firms, oil majors, energy utilities) to participate in an EC-backed equity fund focused on FOAK projects? (sample=12). Note 1: "other" includes limited exposure and risk so that more investors as attracted. Note 2: Interviewees were able to select multiple factors (thus replies do not add up to 12).

Source: ICF survey of market participants, March - April 2016

6.2.6 Other evaluation criteria

Reuse of revenues

Reuse of revenues from the Instrument can either pay out to the European Commission and other co-investors in the fund and/or help grow the fund (in an Evergreen situation). Reflows from the fund would depend on the fund mandate, the investment time horizon, the willingness of co-investors to take their returns at any given time, as well as the lock-in period for co-investors since the recycling of funds is an important feature of FIs compared to grants which are spent only once.

If the Fund concept is workable and delivers the financial returns which are acceptable to private co-investors, subsequent FOAK funds could be established. The concept would therefore be able to evolve over time to direct its capital towards the SET FOAK projects which are most in need of funding (i.e. those with the greatest risks coupled with good market replication opportunities). This would require the EC to confirm the use of the EC budget over subsequent multi-annual financial frameworks (MFF) because the fund would end up straddling several MFFs.

Given the state of SET sectors and their different investment needs, having time limited funds would be sensible in order to ensure that changes to a fund's mandate could be introduced – for example, if certain SET sectors were no longer deemed to require such public investment. This structure would also give private investors the opportunity to exit.

Revenues could be used to pay back co-investors into the fund. Those who are willing to continue, including the European Commission as a 'cornerstone' investor, could use profits from the first fund to establish subsequent funds. This concept provides the maximum opportunities to keep targeting those SET sectors and projects suffering from the largest market failures and hence in most need of funding.

Delivery mechanism

The most efficient mode of delivering the Instrument is through a managed fund structure led by an experienced investment manager (General Partner) responsible for bringing Limited Partners on board. Consultees felt a third party asset manager might be better placed to oversee such a fund. This will ensure maximum flexibility in the sums of money invested in order to be as responsive to market needs as possible and to allow for additional increases in budget. This would place it in a similar position to other equity funds such as the European Energy Efficiency Fund delivered by Deutsche Bank.

Given the need to both plan effectively the appropriate delivery structure and go out to open tender for such a mechanism to ensure the best candidates were aware of this management opportunity, a new delivery is likely to take 12-18 months to establish.

As previously noted, there might be a lack of co-investors in the EU willing to invest in such an equity fund due to the scale of financial requirements as well as the higher risk nature of FOAK projects (based on current attitudes towards equity investment into high risk FOAK projects from European VCs, including schemes such as Swedish Industrifonden and feedback from market participants that several VCs had exited the SET area). This would require a greater pool of global investors to invest to achieve the critical mass necessary to ensure a portfolio approach. The use of "asymmetric" returns could be used to ensure the public sector took more of risk, allowing private investors more of the return. This could be a fair public sector compromise, since increased tax returns, job creation and progress towards environmental targets will be achieved from a successfully delivered fund.

Governance

The most effective sort of governance structure for an equity fund would comprise a multi-layered approach in which there is sufficient strategic and legal oversight. A potential structure could comprise of the following (where some individuals could work in more than one capacity):

- Supervisory Board (3 people)
- Management Board (3-4 people)
- Investment Committee (3 people)
- Investment Manager (5-6 people)

The governance structure could mimic a fund such as the European Energy Efficiency Fund (EEEF) which is also investing in projects, albeit at much more modest levels that the proposed FOAK Equity Fund. Evidence 2 box below provides a good overview of the different Boards which are in place to ensure strategic oversight and legal representation for the fund.

Evidence 2 European Energy Efficiency Fund (EEEF)

The European Energy Efficiency Fund (EEEF) S.A. is a public private partnership defined as a SICAV-SIF (a "société d'investissement à capital variable")[117]. It was initiated by the European Commission in cooperation with the EIB and the Investment manager is Deutsche Bank.

The EEEF has a Supervisory Board which represents the Fund's shareholders (EC, EIB, Cassa Depositi e Prestiti, Deutsche Bank). It permanently supervises the fund management and provides strategic advice to the Management Board on how the Fund's activities should be developed. It is appointed by the General Meeting of Shareholders.

Fund shareholders are represented by the Management Board. This oversees the Fund's activities and has oversight for strategic decisions. It is the legal representative of the Fund and, in compliance with EEEF's founding documents and applicable laws and regulations, it has exclusive powers to administer and manage the Fund.

The Investment Manager conducts the Fund's business on behalf of the Management Board and the Investment Committee.

A Technical Assistance Facility is also managed at 'arm's length' by the Investment Manager.

Source: European Energy Efficiency Fund

One issue, which needs to be kept in mind with respect to private equity and VC funds is governance. Often such funds, albeit managed from a financial centre like London, Paris, etc., will be domiciled in a tax-haven, e.g. Channel Islands, Cayman Islands, British Virgin Islands, etc. This raises the question as to whose money is it and why is it domiciled in a tax-

[117] Governed by Luxembourg law of February 13, 2007 (as amended)

haven in the first place? In this context, the OECD and its member countries are attempting to regularize national and international tax collection mechanisms such that tax is raised in the country either at source or where a service is provided, and to minimize tax avoidance. Potential benefit to entities (i.e. limited partners) domiciled in tax havens would need to be examined closely, vis-à-vis leakage of financial and economic benefits to Europe.

Delivery entity

There are differences of opinion as to which institution would be best placed to manage and deliver an EC-backed equity fund for SET FOAK projects (see Evidence 3 box). An important requirement is that there is strong strategic alignment between the proposed manager and the EC's strategic policy objectives. Crucially, there has to be a complete lack of potential conflict of interest in the management of such a financial mechanism if it is going to be a success in the market. Part of this challenge will be setting the right objectives for the fund. As one market participant put it: *"Where the fund starts from is really critical - is it an investment play or strategic case? What is the driver for the fund? The vision needs to be clear."*

Evidence 3 Market opinions are mixed as to who is best placed to deliver a FOAK equity fund

In terms of an equity fund, a professional asset manager was indicated by almost half (n=6) of those who responded as the best sort of institution for managing and delivering such an equity fund. Factors noted included the necessity of putting together a very credible management team with sectoral/industrial knowledge and technical expertise.

The European Investment Fund (EIF) was ranked as the second best option (n = 3) with opinions that argued that such an institution would understand better the political objectives of the fund compared to private actors and be more capable of fulfilling the overall mandate of such a fund.

Finally, two respondents felt that either an asset manager or the EIF would work. Just one respondent thought that an investment bank was a preferable manager.

Source: ICF survey of market participants, March – April 2016

Since funding FOAK projects is capital intensive and risky, one respondent noted that investment managers might be tempted to be too risk averse in order to avoid losses that would result in no money in the carried interest "pool". This then reiterates the importance of the strategic objectives of the fund and its TRL focus: *"Because it's so risky an area, it would be hard for an asset manager to get good returns. But you don't want this fund to invest in 'no-hopers' - technologies that investors won't touch – so you need technologies which are very nearly market ready."*

One respondent, who favoured a public institution for managing such ventures, said: *"Delivering the sector is good enough...I do not believe this will work if commercial entities are appointed to deliver it."*

Another respondent who echoed this sentiment at a more operational level, commented that there *"needs to be sufficient commercial and policy incentive to avoid funds merely being deployed for short term commercial returns."*

Interestingly, one respondent (a private sector fund manager) reported that they were successfully managing an ERDF early stage fund investing in clean technologies and low carbon innovations and delivering both financial and policy objectives. Several companies it had supported alongside other investors had been delivering FOAK projects of up to €5-10m in value. The respondent reported that they had managed to achieve the European Commission monitoring KPIs of the fund without any real issue and that overall the fund *"has worked pretty well"*.

The ability of the EIB to support such an equity fund would need confirmation. It normally invests equity through its subsidiary, the EIF[118], although it can now invest equity directly under EFSI. EIB has been undertaking new equity approaches as part of its support to the EFSI. There could be an opportunity to develop such a (high risk) equity fund, under the umbrella of the EFSI, if the EC was prepared to take a first-loss position to enable the EIB to contribute to the Fund. However, in the context of FOAK projects and the pursuit of EC objectives on SET funding, this approach might create an excessive EC budgetary contingent liability.

In summary, the key priority is for the Fund to be delivered by an experienced investment manager with sector expertise and market presence to be able to 'crowd-in' potential co-investment. Secondees from public institutions into a private sector investment manager might help to improve the understanding and ability of the manager to both fulfil and report back effectively on EC policy objectives. Conversely, a public entity may be able to act in this capacity drawing in private sector expertise to ensure sector credibility and networking. Either model should be explored.

Awareness raising and scheme promotion

High awareness levels are a pre-requisite for widespread take-up of any new financial instrument in order to ensure a sufficient pipeline of viable opportunities. Although there are a number of generic EC awareness-raising mechanisms (e.g. Cordis, Horizon 2020, InnovFin) and sector-specific mechanisms including SETIS, KIC InnoEnergy and INNEON which can signpost the Instrument, it is likely that a dedicated mechanism will also be needed to improve the awareness, including at Member State level – for example, through investment networks and Member State support schemes. The European Energy Efficiency Fund, funded by the EC, and delivered by Deutsche Bank as the investment manager, has its own site and uses it to publicise its:

- Portfolio;
- Investment categories;
- Investment process;
- Eligibility criteria; and,
- Performance.

Further, DG Energy has commissioned in September 2016 a study to focus on "building the investment community for innovative energy technology projects". The study specification clearly states that SET FOAK projects are in scope and this should greatly help to increase awareness of the opportunities for investment across European SET sectors and innovators as well as the challenges faced by project sponsors.

Monitoring & Evaluation, including indicators

The Instrument will need to report on the achievement of EC policy objectives as well as financial objectives. Reporting should be based on indicators which are SMART (Specific, Measurable, Achievable, Realistic and Timely). The set of indicators shown in Box 6.5 represents the likely minimum coverage for an equity fund.

Box 6.5 Potential SMART indicators to be used in the equity fund

- Total volume of investment required in the deal pipeline (EUR m)
- No. of agreements (equity deals) with project sponsors
- Volume of investment made available by the fund (EUR m)
- Volume of public and private investment leveraged (EUR m) by the fund ('simple leverage' – that which the facility is comprised, i.e. EC contribution: other contributions)
- Total volume of public and private investment and finance leveraged (EUR m) by the fund into FOAK projects ('multiplier' – that which the equity investment helps to catalyse in the project /

[118] The EIF is effectively a fund-of-funds and currently does not have the scale nor technical capacity or market expertise to invest directly in the types of SET FOAK projects under investigation in this study

SPV)

- No. of final beneficiaries (project sponsors supported / SPVs)
- Portfolio ‘net asset value’ (NAV)
- Total return on investment (EUR m) (Gross and net of operating costs)
- Total licensing revenues (EUR m)
- Low carbon energy produced (GWe, GWth)
- Energy savings generated (GWe)
- Emissions reductions avoided or sequestered (tons CO_2)
- Employment created (No. Full Time Equivalent jobs)
- Number and value of exits or divestments(in due course)

7 Ex-ante assessment of policy option - Energy Demonstration Projects (EDP) facility

7.1 Description of the instrument

Goal: To improve access to finance for first-of-a-kind projects with a very high credit risk and to de-risk first-of-a-kind, commercial-scale Strategic Energy Technology (SET) projects, by enabling them to be constructed and operational. The facility therefore supports the commercialisation and deployment of leading edge, low carbon energy technologies and aims to increase market lending over the long-term in the sector compared to the baseline.

7.1.1 Overview

The Energy Demonstration Projects (EDP) pilot facility (Figure 7.1) was launched by the EC and EIB on 15 June 2015 using €100m of reflows from the Risk Sharing Finance Facility (RSFF). The pilot financial instrument ("the Instrument") sits under the InnovFin family of financial products which are helping deliver the European Commission's Access to Risk Finance component of Horizon 2020. The facility was increased in size to €150 million by the European Commission for 2016 owing to a further €50 million in reflows from the RSFF legacy.

The instrument seeks to achieve a 'step change' in debt finance into European SET FOAK projects[119] using technologies not yet proven at scale, but which have the potential to be replicated widely both in the EU and globally. Such projects are having tremendous difficulties to achieve the levels of debt which conventional proven fossil-fuel technologies could raise. Added to a dearth of equity investment, this lack of debt is exacerbating the problem for project sponsors to reach a Final Investment Decision and financial close.

SET FOAK projects fall into the so-called commercialisation "Valley of Death"[120], which requires far higher capital sums than earlier technology innovation levels but where risks levels are much increased. The result is that a funding challenge exists which can only be alleviated by the public sector taking on much greater levels of risk and uncertainty to help prove such technologies can be viable in the market.

The ability of EDP to target the implementation and performance risk of a project in the design, construction and early operational phase is an important feature of its structure (although this particular phase of the project should not last any longer than 4 years).

7.1.2 Strategic objectives of the scheme

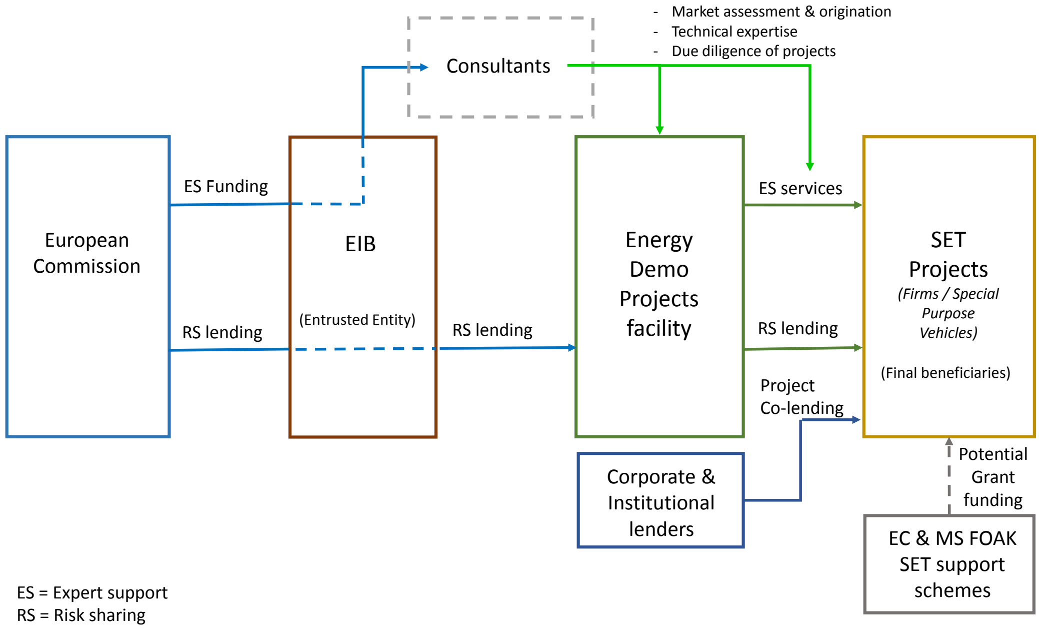
The main objectives of the EDP are to:

- improve access to finance for SET FOAK projects with a very high credit risk;
- de-risk investments by demonstrating and validating at industrial scale, the technology performance, installation time and costs, operation and maintenance costs, and reliability and lifetimes; and,
- provide a quality stamp (which reduces perceived investment risks) and generate a signalling effect to other banks and investors (including VC, PE, corporates, energy companies) to co-lend/co-invest.

[119] The EDP facility is currently mandated to look at both energy generation projects as well as innovative manufacturing facilities. This paper focused on the former since the vast majority of projects scrutinised by the study have been focused on energy generation.

[120] The Commercialisation Valley of Death is the point at which investment needs are greatest but so are risks associated with potential failure creating very high disincentives to participation in funding projects

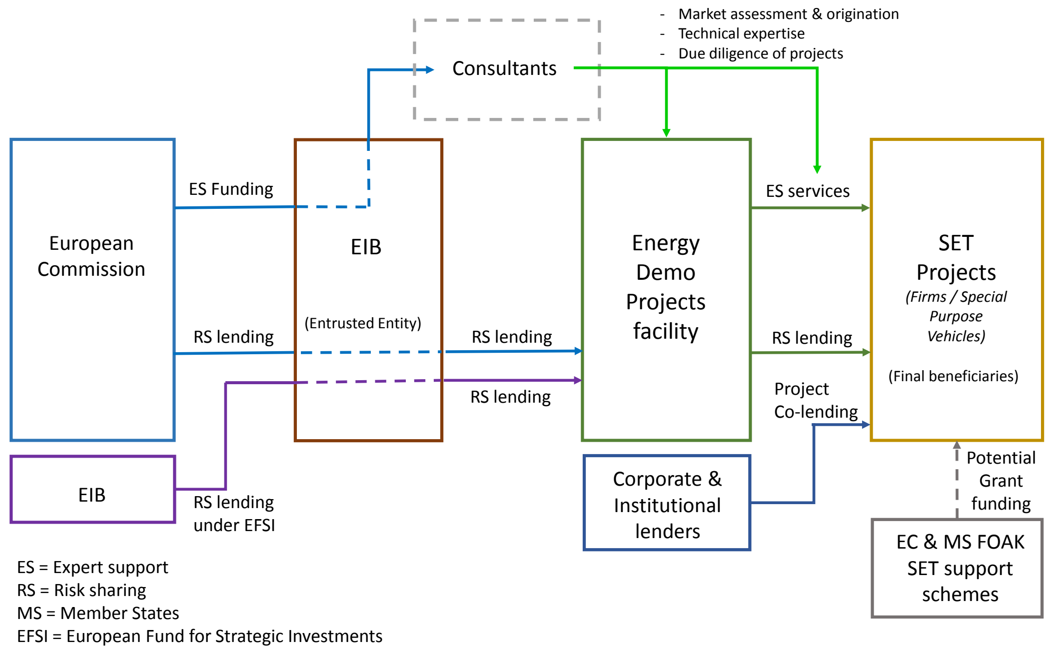
Figure 7.1 Overview of the instrument (pilot)



Source: ICF

There is potential for the EDP to stimulate co-lending into the facility from EFSI (i.e. via Investment Platforms) and potentially Member States. Given the very high risk nature of FOAK projects, the appetite for institutional co-lending into the facility itself (as opposed to co-lending to FOAK projects – as illustrated in Figure 7.2) is likely to be limited because the TRL 8-9 area has been shown not to be of real interest to such institutions[121].

Figure 7.2 Overview of an enlarged instrument involving the EFSI



Source: ICF

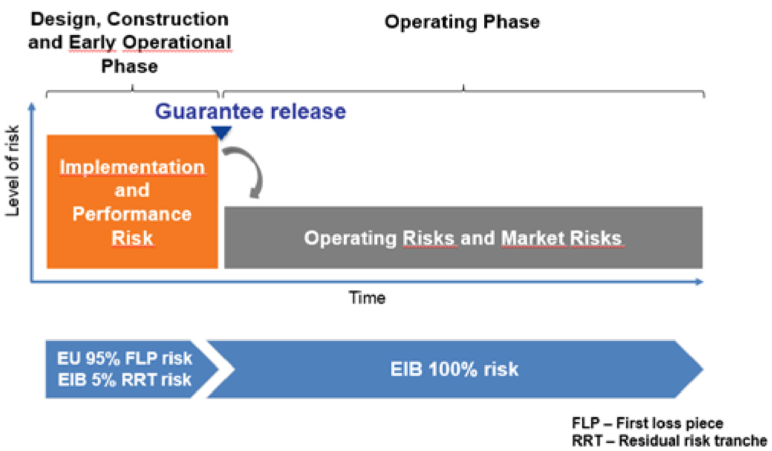
[121] ICF survey of financial market participants, Summer 2015

7.1.3 Operational objectives of the scheme

The Instrument comprises the following:

- A €150 million facility managed by EIB as the entrusted entity. Further long-term funding, which might for example double the facility to €300 million or more, could come from various sources including the European Fund for Strategic Investment (EFSI), Member State governments as well as institutional investors).
- The EDP is able to provide direct lending in the form of senior loans or 'quasi-equity'[122] risk finance of between €7.5m and up to €75m. The maximum loan maturity is 15 years.
- EIB can provide up to 50% of total project costs with the expectation of at least 25% equity from the project sponsor (or project consortium) and 25% of funding coming from other sources. Collateral requirements, which project sponsors must fulfil to receive funds, will be set by EIB on a case-by-case basis.
- Funding is made using a risk sharing, first-loss basis with other lenders (as opposed to pari passu) so as to encourage other lenders / financial institutions (e.g. banks) to join individual, high risk deals. As shown in Figure 7.3 below, the elevated risk in projects targeted by the facility is covered by the European Commission carrying 95%[123] of potential first loss piece (FLP) on a portfolio basis; the EIB covers the remaining 5% loss as a 'residual risk tranche'. Since the guarantee covers the design, construction and early operational phase, the implementation and initial performance risk (i.e. some of the highest risks in the life of a FOAK project, as illustrated in Figure 7.3) are covered. However, once successfully demonstrated and the following conditions are met (under the Technical and Financial Guarantee Release Test), the EDP guarantee is released:
  - Financial performance of the project is in line with pre-agreed cover ratios which demonstrate that the expected cash flows are being generated; and
  - A competent external advisor can validate that the project has been completed; that it has achieved a minimum level of technical performance; and it is fully operational.
- Following release of the guarantee, 100% risk for the operating phase is carried by the EIB. Here there would be an opportunity to refinance the project and get cheaper debt into the project due to it having been significantly derisked.

Figure 7.3 The EDP first loss piece works within initial phase of the project life cycle



Source: EIB, Presentation on the EDP pilot facility, RTD FOAK Workshop, Brussels, December 2015

- Active management and scrutiny of the portfolio of loans using management accounts and Key Performance Indicators from the outset so as to minimise losses to the portfolio.

[122] i.e. an instrument which allows repayments

[123] The first loss piece could be reduced from 95% down to say 75% or even 50% to increase the potential portfolio coverage

- The potential for an expert support facility (ES Facility), to help the EIB to:
  - develop a thorough understanding of financing needs in SET sectors;
  - assist in building the project pipeline, including having early discussions with potential project co-lenders (which could also help with screening deals);
  - conduct due diligence on projects which apply to the facility; and,
  - assess project performance once loans have been made.

Eligibility to the EDP is based on a number of criteria including innovativeness, replicability, readiness for demonstration at scale, timeline, prospects for bankability and commitment of sponsors. Table 7.1 below provides more information about the eligibility criteria. One of the most important criteria to ensure funding is that the project must have become bankable within a 3-4 year maximum timeframe.

Table 7.1 EDP eligibility criteria[124]

Criteria	Description
SET sector	■ renewable energy or hydrogen/fuel cells
Location	■ EU28 or Horizon 2020 associate countries
Project size	■ €15m minimum
Innovativeness	■ Innovative technologies compared to 'state-of-the-art' technologies / commercially available technologies
Replicability	■ convincing market opportunities in the EU and/or globally (including an analysis of conditions necessary for uptake in targeted countries) ■ prospects for cost-efficient $C0_2$ reduction in EU and globally
Readiness for demonstration at scale	■ TRL 7 or 8 ■ technologies validated and demonstrated through previous testing at laboratory/small scale ■ assessment of potential further R&D need for scale up to commercial application
Timeline	■ commercial operation of whole plant within maximum 4 years
Prospects of bankability	■ projected revenues sufficient to ensure the project's bankability within a timeframe of maximum 3-4 years ■ description of possible regulatory frameworks in place ensuring predictable tariff conditions / Power Purchase Agreements (PPAs) ■ presentation of project team experience ■ calculation of predicted annual energy yield
Commitment	■ at least 25% of co-financing from promoters ■ indication of co-financing levels from sponsors and/or operators

Source: EDP Eligibility Questionnaire, EIB (February 2016)

The facility will focus on energy generation (or efficiency in the case of smart grid) FOAK (TRL 7-8) projects, as well as high risk (TRL 7-8) manufacturing/production facilities in the renewables, hydrogen and fuel cells sectors.

The EDP plans to cover all EU28 Member States and Horizon 2020 associated countries, although its geographical reach will be heavily determined by the type and quality of SET FOAK project applications.

After a first screening of applications, via a questionnaire sent out to project sponsors, the EIB undertakes more extensive investigations and due diligence. This consists of standard EIB due diligence covering legal, financial and technical aspects of the projects using established procedures and documentation.

[124] InnovFin Energy Demo Projects Information Flysheet. Available at: http://www.eib.org/attachments/documents/innovfin_energy_demo_projects_flysheet_en.pdf and InnovFin Energy Demo Projects – Eligibility Questionnaire. Available at : http://www.eib.org/attachments/documents/innovfin_energy_demo_projects_eligibility_questionnaire_en.pdf

Assuming full disbursement of the fund by 2019, the EDP facility as it is currently set up would need to operate until at least 2025 to ensure repayments[125]. Furthermore, if every project was successful and able to be released from the initial guarantee (after say three successful years of operation/loan repayment) then the EC money to cover such a guarantee could start to be recycled again into supporting new projects from 2020 onwards (helping to ensure that the facility had an 'Evergreen' status).

7.2 Ex-ante assessment of the EDP facility

Key finding from the ex-ante assessment are presented in the summary section below, with supporting evidence in Annexes.

7.2.1 Market failure and the need for Intervention

Market failures or sub-optimal investment situations addressed

The evidence of widespread market failures for SET FOAK projects has already been scrutinised in depth in section 4.1. The key findings apply equally to any analysis of the EDP debt facility. It is clear that more coordinated public sector funding support is required to be directed at the commercialisation "Valley of Death", building on existing provision.

Size of the investment gap

As shown in section 3.1.3, the size of the investment needs in public support provision for commercial-scale SET FOAK projects in the EU is very large, estimated at €4.0bn to €28.5bn; while just considering those sectors deemed to have the highest unmet funding needs such as Biofuels, Bioenergy, CCS, CSP, Ocean and floating wind requires funding for FOAK projects of between €3.0bn and €18.1bn (see Annex 5 for overall investment needs analysis). The size of the total investment gap (50% of total investment need minus current public supply at EC/Member State level) is estimated at around €10 billion. Debt finance from the EDP can offer a potential lifeline to those FOAK projects that already have sufficient equity (and potentially grants too), but which can still not persuade commercial lenders to provide finance, not least due to the risk profile of their project.

Market demand for the EDP pilot facility

In contrast to the proposed Equity Fund, the EDP pilot facility has already had the opportunity to test the needs of the market. The immediate interest from sponsors in the EDP facility (see Box 7.1) is evidence that there is strong market demand for such a support mechanism from sponsors with wide ranging funding requirements (reflecting the diverse types of proposed financial structures for FOAK projects which ICF has determined – see section 3.1.2). The challenge for project sponsors is whether they will be able to meet the EDP's eligibility criteria (the stage of development of projects has already quite often fallen outside the TRL 7-8 focus of the facility); the challenge for EIB is in assessing the market risk of a project four years into the future.

As might be expected, the attrition rate from initial enquiries is high. By mid-December 2015, the EIB had rejected 17 applications (25% of enquiries to that point) while 35 applications were still under consideration. Further, several project promoters had either put their project plans on hold or had withdrawn their application from the facility altogether. In the case of two biofuels production projects, the EIB is considering how to finance projects under more mainstream EIB financing channels. In total, by February 2016, four projects were being progressed by EIB. Of these, three had also received grant awards under the NER 300 programme[126].

[125] Based on a simple model developed by ICF of straight repayments from a €150m sized facility investing in three SET sectors and all but one project based on minimum project sizes (see ICF investment needs analysis)

[126] ICF consultation with EIB, February 2016

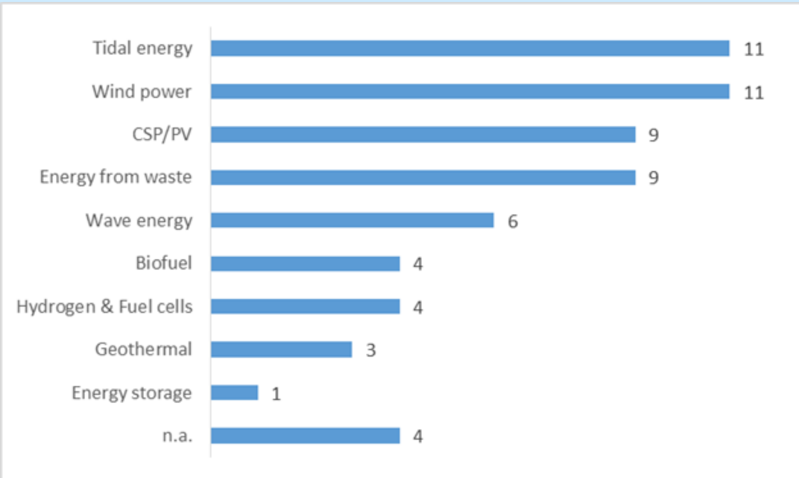
Box 7.1 Supply side interest in the InnovFin EDP facility

Following the launch of the EDP facility in May 2015, there was growing interest from project sponsors through enquiries to establish how the facility could assist their project:

- End July 2015 - 20 enquiries
- Mid-September 2015 - 41 enquiries
- Mid-December 2015 - 62 enquiries
- February 2016 - 70 enquiries

Enquiries have been from a mixture of companies, but typically start-ups and newly established SMEs, although some applicants have been energy utilities. SET coverage has been broad, with applications for projects involving technologies from six SET sectors: biowaste-to-energy, CSP, wind power (including floating wind turbines), geothermal energy, solar PV, and tidal and wave energy. Applications have come from almost half the EU-28 (as well as Horizon 2020 countries): Belgium, Cyprus, Finland, France, Hungary, Italy, Germany, Netherlands, Portugal, Spain, Sweden, UK and Norway.[127]

The sectoral breakdown of applicants to the EDP facility shows that tidal stream energy and wave energy represent over 25% of enquiries (n = 62):



Source: EIB presentation, November 2015

Reasons cited by EIB for rejecting technology sponsors included the projects being:

- at too early a stage, with technologies not yet demonstrated at prototype stage (and hence not yet at the critical TRLs 7-8); and/or,
- insufficiently innovative; and/or,
- of an unsuitable size for the facility (either too big or requiring too little financial support).

According to EIB, the concrete project proposals received have generated a robust evidence base and thus allowed EIB to feel justified that there is a market for the EDP facility[128].

Ambition level for the facility

Summary

Given the scale of market need, a €150m debt facility is considered insufficiently sized to have much impact in the market. Overall, the funding limits (both minimum and maximum) which the EDP has to work within at this scale of facility also restricts its deals. This means that its fit with the financing needs of the wider market appears very difficult to achieve. Further, the time period for release of guarantees (as projects prove they are operating as

[127] ICF consultation with EIB, February 2016

[128] ICF consultation with EIB, February 2016

forecast) will limit the number of future deals that can be made before 2020, especially if some projects fail to proceed as planned (which is highly likely since they are FOAK).

Doubling the size of the debt facility will give it the opportunity to assist more SET sectors and different scales of FOAK project; it will also have a larger portfolio (potentially catalysing total project funding close to €1bn). This is more favourable for balancing risk and offsetting potential losses. A facility sized between €250m and €500m was favoured by those market participants who thought a debt facility was required (although market participants were more persuaded by an equity fund) and the most responses felt a minimum of ten deals were required to look credible in the market.

The ability to achieve scale up the total size of the EDP facility would only be possible through exploiting a mechanism such as the EFSI and the Investment Platforms being developed to enable sectoral focus and pooling of financing from across Member States (e.g. through national promotional banks).

Another way to increase the number of projects supported would be reduce the share of potential losses the EC carries on a portfolio basis from the current 95% to say 75% or 50%. This might be less preferable to attracting co-finance; the timescales involved in releasing the EC guarantee might also have a marginal impact on scaling up target projects.

The evidence for this is shown in the section below.

Evidence to support enlargement of the EDP facility

The €150m budget for the EDP facility means that it intends to finance around six FOAK projects[129]. ICF has used actual FOAK project examples[130] to simulate the disbursement of funds for this initial sum, in order to understand better how the facility might work in practice. This includes gaining an understanding of important aspects regarding, inter alia: likely debt:equity ratios; potential leverage; and illustrative release dates for the EC guarantee.

[129] ICF consultation with EIB, February 2016

[130] In terms of megawatt capacity and investment needs; financial structuring of each project is hypothetical but based on realistic debt:equity assumptions given the nature of the projects and likely sponsorship organisations.

Figure 7.4 details six hypothetical FOAK projects across three SET sectors with a three year disbursement timescale. While this shows that the facility is able to catalyse total project funding worth €465m including €125m of debt from other lenders and €190m of equity, it is insufficiently sized to have much impact in the market. This is partially because there are likely to be minimum deal sizes below which private sector co-lenders are unlikely to come in and yet for the largest deals the facility will be restricted to what it can lend (without using up a very large portion of the total facility funding).

Furthermore, the time period for the release of guarantees from individual projects will severely restrict the number of future deals that can be made before 2020, especially if some projects fail to proceed as planned (which is highly likely since they are FOAK).

This simulation illustrates that the maximum allowable funding size per deal of €75m is never used (€40m for a tidal stream farm is the maximum loaned). This is primarily because such an action would skew the fund unrealistically towards one project and hence greatly increase portfolio risk – something a risk committee would not allow. Overall, the funding limits (both minimum and maximum) which the EDP has to work within greatly restricts its deals which also means that its fit with the financing needs of the wider market appears very difficult to achieve.

Figure 7.4 Simulated disbursement of EDP €150m risk sharing facility

	SET sector - project type	Project size (€m)	EDP loan size (€m) (Min €7.5m to Max €75m)	EDP loan to project size (Max 50% intervention)	Other lenders (€m)	Loan to total project capex	Equity investment required (€m)	Total equity as % of project capex	Loan date	Assumptions about co-lenders / co-investors
Project 1	Wind - floating turbine array	125	25	20%	50	60%	50	40%	2016	Sub-investment grade banks willing to lend through corporates
Project 2	Wind - floating turbine array	125	30	24%	40	56%	55	44%	2017	Other banks willing to lend through corporates
Project 3	Ocean - tidal stream array	20	10	50%	0	53%	10	50%	2016	No other lenders: all equity
Project 4	Ocean - tidal stream array	20	10	50%	5	78%	5	25%	2017	Corporate debt
Project 5	Ocean - tidal stream farm	100	40	40%	10	50%	50	50%	2018	Corporate debt
Project 6	Geothermal - EGS	75	35	47%	20	74%	20	27%	2017	Corporate debt
	Total	**465** *Total FOAK project funding (€m)*	***150*** *Size of facility required (€m)*		***125*** *Total debt leveraged (€m)*		**190** *Total equity leveraged (€m)**		*Fund fully disbursed over 3 years*	

* Note public risk capital from grants included, e.g. NER 300

Notes: 3 SET sectors covered. All but one project based on minimum project sizes (see Investment Needs). Exception is Project 5: tidal stream farm

Total funding catalysed (€ m)	**315**
Total simple leverage	**2.1**
Total debt catalysed (€ m)	**125**
Total equity catalysed (€ m)	**190**

Source: ICF

Figure 7.5 helps to show how an enlarged facility (using the initial same six deals shown above) could increase its project coverage to 12 FOAK projects in seven SET sectors. Once again, the maximum allowable funding size per deal of €75m is never used (€50m for a CSP project is the maximum loaned). Because projects covering CCS are not eligible for the EDP facility, this would mean that projects covering biofuels production – and potentially other very large FOAK projects such as innovative CSP projects - would have to seek substantial levels of additional debt (and equity) to achieve financial close.

However, the scale of the catalysed funding is clear from an enlarged facility, with total project funding of €1.2bn. This demonstrates that a larger portfolio not only provides much greater opportunities for FOAK projects and potentially offers the EDP to tackle a greater range of project sizes; it also spreads risk much more effectively across a broader suite of projects, some of which can raise substantial amounts of debt into their projects because of the intrinsically lower risk.

Figure 7.5 Simulated disbursement of EDP €300m risk sharing facility

	SET Sector	Project size (€m)	EDP loan size (€m) (Min €7.5m to Max €75m)	EIB loan to project size (Max 50% intervention)	Other lenders (€m)	Loan to total project capex	Equity investment required (€m)	Total equity as % of project capex	Loan date	Assumptions about co-lenders / co-investors
Project 1	Wind - floating turbine array	125	25	20%	50	60%	50	40%	2016	Sub-investment grade banks willing to lend through corporates
Project 2	Wind - floating turbine array	125	30	24%	40	56%	55	44%	2017	Other banks willing to lend through corporates
Project 3	Ocean - tidal stream array	20	10	50%	0	53%	10	50%	2017	No other lenders: all equity
Project 4	Ocean - tidal stream array	20	10	50%	5	78%	5	25%	2018	Corporate debt
Project 5	Ocean - tidal stream farm	100	40	40%	10	50%	50	50%	2019	Corporate debt
Project 6	Geothermal - EGS	75	35	47%	20	74%	20	27%	2017	Corporate debt
Project 7	CSP	185	50	27%	50	54%	85	46%	2018	Corporate debt
Project 8	CSP & storage	330	40	12%	80	36%	210	64%	2019	Other banks willing to lend but substantial equity provided
Project 9	AEN - Smart grid	30	7.5	25%	15	76%	7.5	25%	2017	Other bank lending via Distribution System Operator (DSO)
Project 10	AEN - Smart grid	30	10	33%	10	68%	10	33%	2018	Other bank lending via Distribution System Operator (DSO)
Project 11	Large scale energy storage	15	7.5	50%	0	53%	7.5	50%	2019	No other lenders: all equity
Project 12	Biofuels generation (2nd gen)	150	35	23%	65	67%	50	33%	2018	Other banks willing to lend through corporates
	Total	**1205** *Total FOAK project funding (€m)*	***300*** *Size of facility required (€m)*		***345*** *Total debt leveraged (€m)*		**560** *Total equity leveraged (€m)**		***Fund fully disbursed over 4 years***	

* Note public risk capital from grants included, e.g. NER 300

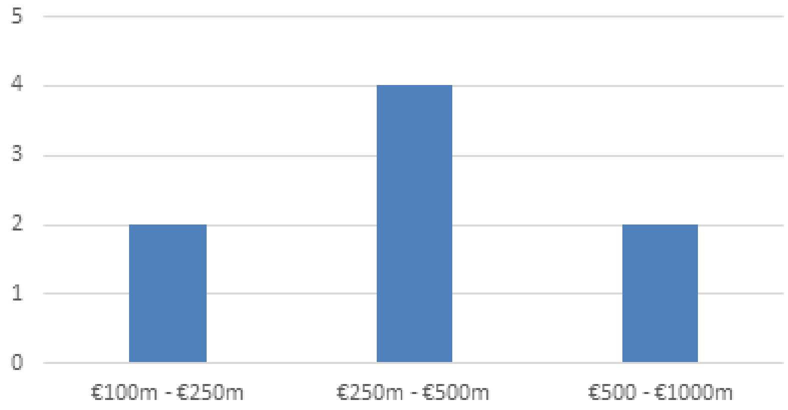
Notes: 7 SET sectors covered. All but two projects based on minimum project sizes (see Investment Needs). Exceptions are Project 5: tidal stream farm and Project 8: CSP & storage

Total funding catalysed (€ m)	**905**
Total simple leverage	**3.0**
Total debt catalysed (€ m)	**345**
Total equity catalysed (€ m)	**560**

Source: ICF

ICF took market soundings from financial market participants on the optimal size of a debt facility[131]. While the total number of responses was small (n=6), indicating less appetite in the market for a debt instrument compared to an equity instrument, a debt facility sized at €250-500m was marginally favoured (see Figure 7.6):

Figure 7.6 Optimal size for a FOAK debt facility



Source: ICF survey of market participants, March – April 2016. n = 6. Respondents could provide more than one size range.

The optimal value for a debt facility *"depends on the perspective"*: private equity firms for example would anticipate a bigger fund, whereas project developers would prefer a smaller one.

The same market participants were asked to provide an estimate of the minimum number of deals which the debt facility would need to look credible in the market.[132] Of the nine who commented, the number cited varied from 3 to 15 with ten deals considered the ideal number by the most (n=4), followed by five projects (n=2).

7.2.2 Additionality and EU Added Value

There are several components to assessing additionality and added value. The following subsections explore each dimension in turn.

Achievement of EU policy objectives

Annex 2 has reviewed in detail the set of EU policy objectives for which the EDP instrument would be contributing to. The long term policy drivers for the EDP facility include the 2020 and 2030 Climate and Energy Package targets. The facility would contribute strongly to these targets by helping to accelerate deployment of game-changing technologies.

Complementarity with other forms of public intervention

Annex 6 has set out the different mechanisms already present in the EU and Member State context being directed at SET FOAK projects. Horizon 2020 helps to generate a potential pipeline of opportunities which the EDP facility can further support. The fact that many EDP applications to date have been rejected because finance was being sought for projects at too early a stage implies a clear need for Horizon 2020, together with the NER 300 grant funding programme and other Member State innovation schemes (some of which have been reducing their later stage support), to continue to adequately support projects to get their technologies to the end of TRL 6 and into the large-scale, first commercial project domain. The introduction of sectoral Investment Platforms under the EFSI offers an opportunity to dovetail the EDP provision with other potential financial partners.

[131] ICF survey of market participants, March – April 2016. [Qu.6 "What is the optimal value for the proposed equity and/or debt facility? (sample=12 for equity and 8 for debt)]

[132] ICF survey of market participants, March – April 2016. [Qu.9 "What is the minimum number of SET FOAK projects you think is needed for each facility to look credible in the market? (sample=9 for debt)]

In summary, there is currently no specialist debt facility targeting SET FOAK projects, and any enlargement of the current facility would therefore make it even more pertinent due to the size of the funding gap for such projects. The EDP will therefore not substitute or replace other public financial interventions in the SET area, at either the EU or Member State level. On the contrary, such a debt facility could work in unison with existing grant provision (at EC and Member State level) as well as with a potential SET FOAK equity fund.

Crowding-in of private investments (no crowding out)

The EIB expects the EDP facility to "crowd private finance into a high-risk area", similarly to the InnovFin Large Projects facility[133]. In order to crowd in private finance and avoid crowding out, the EDP will need to target genuine SET FOAK projects. Further, these projects will be those which struggle to achieve financial close because alternative funding options have been exhausted despite there being strong market drivers to demonstrate and deploy the technology. Deals in which debt can be raised, even at an elevated price, should be minimised as this implies crowding out.

EU added value

The scale of operation for a debt facility is best delivered at the EU level in order to maximise the available projects, range of financial institutions, renewable resources across geographies as well as potential Member State engagement. An EU-wide intervention would add value for the following reasons:

- The scale of financial flows and leverage focused on SET FOAK projects through EDP is likely (at least for a significant number of the smallest Member States) to be greater than for a single Member State developing its own scheme. This is because EDP is backed by an AAA rated international financial institution (IFI).
- Market signalling – a risk sharing facility will help overcome co-lender concerns about the potential risk in performance of SET FOAK project loans. The market signalling impacts of an EU-wide instrument will also create a track record to attract more private finance into this sector.
- Potential to reduce EU grant dependency and increase the leverage of grants – mobilising the power of capital markets to achieve scale and credibility into the SET FOAK market. A shift towards loan finance for such projects, using the private sector, may help to reduce grant dependency and direct resources towards projects which can justify the receipt of loan finance. This would help to reduce public expenditure by the EU (and Member States) on tackling the SET FOAK funding challenge.

Appropriateness of a FI type of measure

Since debt finance is not widely available for most European SET FOAK sectors, a financial instrument that can attract other co-lenders would help fill part of the current funding gap. This would be particularly the case for those SET FOAK projects which benefit from strong potential market demand and have sufficient levels of equity (or potentially require additional equity which might be supplied by an EC Equity Fund) but which are failing to raise sufficient debt from commercial lenders. Additionally, projects which have the support of a large EPC contractor who can cover technology risk, as well as projects which can demonstrate less commercial risk than other projects (e.g. feedstock contracts in place; offtake agreements signed; long-term subsidies guaranteed, etc.), would be good candidates, given the risk aversion of the banking sector to FOAK project financing.

ICF's extensive analysis of risks acting on FOAK projects (see Annex 12), shows that there is clear market need to support innovative SMEs across different SET sectors to more ably navigate the plethora of risks which can be foreseen and hence have a much better change of bringing their innovations to market. This is the subject of an 'advisory services' option which is dealt with in more detail in section 9 of this report.

[133] ICF consultation with EIB, February 2016

Appropriate funding type

The Instrument is ideal for SET FOAK projects which have sufficient equity levels already established; where this is not the case the facility is much less relevant because such high risk projects first require considerable levels of equity investment. ICF found that financial market participants had mixed opinions on the use of debt in FOAK projects: less than half the respondents considered it worthwhile – and then only in combination with substantial amounts of equity (see Evidence 4 box below).

Evidence 4 While equity is preferred to debt, the two can be an ideal mix in SET FOAK projects

While equity was considered by consultees to an ICF survey (n=14) as the most appropriate type of funding for SET FOAK projects, with the majority considering equity as the only really viable funding option (n=8), others felt that ideally equity should be combined with debt, if at all possible (n=6). Until the technology is proven and there is a clear path to replication, debt is not regarded as 'bankable'. One respondent felt that raising debt is not 'bankable' unless the technology risk can be offset by an EPC contractor (*"debt has limited upside but unlimited downside"*). However, other consultees believe that flexibility in the funding mechanisms is important.

Source: ICF survey of financial market participants, March – April 2016

The minimum debt amount or exposure that a bank would normally accept for a "project finance" or "cash-flow secured" funding would be around €20m. The time and cost of due diligence does not justify a lesser amount. Any lender to such a FOAK project would probably require a debt/equity structure of around 50/50, meaning that with a €20m minimum debt the minimum total project value in the EDP would be €40m. This characteristic feature of private co-lenders will reduce the number of potential projects (i.e. those requiring lower levels of debt funding) which the facility can realistically back (unless the EIB chooses to debt finance the FOAK project on its own or in cases where the EIB provides a guarantee to another bank which persuades it to join); conversely, the limited financial scale of the facility will reduce the number of much larger deals which it can feasibly support because it would then start to skew the portfolio to a few deals.

Debt is considered by financial market participants to be far more worthwhile once the technology is proven and there is a clear path to replication. That said, there may be opportunities in different sectors to use debt if risk ratings are slightly more favourable than for other projects.

The presence of an EC equity fund for FOAK projects would certainly enhance the value of the EDP since there could be potential to provide both equity and debt to SMEs.

7.2.3 Non-distortion of competition in the internal market and consistency with State aid rules

Non-distortion

The Instrument fits well with the internal market and is unlikely to distort competition, although deals would need to be carefully assessed to ensure that private finance was not being crowded out.

Compatibility with EU state aid rules

Changes to the EU state aid guidelines are summarised in Annex 9 (section A9.9). The facility is consistent with these rules given the initial emphasis on an EC-backed fund. However, the potential addition of Member State government co-lending into the EDP (for example, via an EFSI Investment Platform) would need to be considered, especially if such lending was then ring-fenced for the sole purpose of supporting FOAK projects from the donor Member State. In such cases, it may well be necessary for the donor Member State to apply for a general block exemption and demonstrate that the funding is a critical ingredient in the overall funding structure of important SET FOAK projects at their national level.

7.2.4 Leverage (of co-lending into SET FOAK projects)

Total financial leverage into FOAK projects depends on the overall funding requirement and role of debt, vis-à-vis the availability of grant support and equity debt investment as well as other forms of funding. An illustration of typical financial structures for different types of SET project was discussed in section 3.1.2.

The section on the EDP's facility 'ambition level' above illustrated the potential disbursement of the EDP under two simulations (a facility size of €150m and €300m lending to different SET project types and sizes). Table 7.2 provides a breakdown of simple and total leverage (i.e. the multiplier) from projects benefiting from EDP loans under these two simulations. The simulations suggest a larger facility, with a portfolio of 12 projects which will improve the EDP's market credibility, achieves a higher multiplier because larger projects can be considered.

Table 7.2 Summary of simple leverage and total leverage (multiplier) for EDP

EDP facility size	Projects supported	Total debt catalysed	Simple leverage	Total funding catalysed	Total leverage (multiplier)	Total project funding
€150m	6	€125m	0.83x	€315m	2.1x	€465m
€300m	12	€345m	1.15x	€905m	3.0x	€1205m

Source: ICF

These estimates are considered conservative and the actual breakdown of debt and equity across SET projects would require real life deals to confirm such findings. However, since the EIB has stated[134] that it is likely to limit lending to around 35% of total financing (i.e. total debt) need, this would improve leverage, potentially up to 2-3 overall across the EDP portfolio.

7.2.5 Alignment of interest

There is a need to align the EDP facility mandate with the interests of co-lenders. Any form of risk sharing component which is built into the fund objectives and overall mandate should seek to overcome concerns amongst co-lenders about the potential risks they face in particular SET FOAK deals.

The EIB will need to be very transparent about several aspects of the EDP's operation to gain market confidence including its investment mandate and the SET sectors it wishes to focus on. Indeed, since there is an EC objective for InnovFin and EDP to assume higher losses compared to the former Risk Sharing Finance Facility (RSFF) under FP7[135], co-lenders should be made aware of the EDP's appetite for riskier deals.

Obviously project risks will still exist after a finance deal is agreed, so the challenge will be to ensure that there are sufficient numbers of co-lenders to absorb potential losses whilst also adhering to minimum deal sizes (for each co-lender). Understanding this optimal situation (i.e. the SET FOAK project financing range where co-lenders are happy to join) is a critical aspect of EDP becoming a successful and sustainable operation. The EIB will need to be very transparent about several aspects of the EDP's operation to gain market confidence including its investment mandate and the SET sectors it wishes to focus on.

7.2.6 Other evaluation criteria

Reuse of revenues

Reuse of revenues (i.e. debt repayments) from the FI can help to extend the lending of the facility over time as new SET FOAK priorities emerge, directing debt towards those projects which are most in need of funding and can fulfil the eligibility criteria of the facility. This

[134] EIB presentation on EDP, DG RTD workshop, Brussels, 8th December 2015

[135] The RSFF was evaluated as not taking sufficient risks on its overall portfolio

assumes that reflows from loan repayments occur and that the suite of FOAK projects supported do not use up all the EC guarantee to cover the first-loss piece[136].

Revenues could be used to extend facility lending to ensure continued coverage on deals where debt is required. Significant losses on the facility may require continued 'topping up' from the European Commission to ensure that its guarantee is available to cover the first-loss piece.

Extending the facility's EC guarantee would require confirmation that the EC budget could be spread over subsequent multi-annual financial frameworks (MFF) because the facility would end up straddling several MFFs.

Delivery mechanism

The most efficient mode of delivering the Instrument is through a centrally managed facility, managed by an experienced financial institution, since this provides pan-EU coverage and the maximum opportunities to bring co-lending from different territories. EIB's current management of the facility allows it to use its reputation and brand to attract co-lenders.

Governance

The most effective sort of governance structure would comprise of a multi-layered structure in which there is sufficient strategic and legal oversight. The EIB follows such a structure for the EDP facility.

The EIB governance structure already comprises of several Committees which seek to ensure that international best practices in governance are followed. There is no reason why this approach should not be continued, especially given the EIB's AAA status as an international financial institution. Any alternative delivery entity would need to ensure that a similar level of oversight is introduced to avoid conflicts of interest and sufficient deal scrutiny is undertaken.

Delivery Entity

It is important for an experienced facility manager to be able to understand fully the funding landscape for FOAK projects and the market participants who are involved. The delivery entity could theoretically be drawn from the private sector. However, given that EIB already delivers the InnovFin suite of support products on behalf of the EC and is the entrusted entity delivering EFSI, it makes sense for the facility to continue to be managed by them. It may make sense to use private sector expertise (perhaps on secondment) to ensure complete SET sector coverage and credibility as well as networking.

The current EDP facility is being delivered by EIB as a centrally managed fund. EIB has established a long track record in supporting innovative project financing through the RSFF and lately via the InnovFin Large Projects facility. It is clearly important for there to be strong strategic alignment between the proposed EDP facility manager and the EC's strategic policy objectives. The EIB has been recognised as being one organisation well capable of achieving this role. It also has the benefit of having specialist staff and good contacts in project financing across its overall operations.

Based on market soundings by ICF[137], there was a wide spread of views on the best type of institution to manage and deliver such a debt facility. A third of respondents felt that a development bank such as EIB was best placed; an equal number had a preference for an asset manager. The remaining replies covered combinations of institutions (development bank and asset manager was indicated by one and commercial banks, investment banks and asset manager by another). The prevailing view was that there was a need to ensure that the "best in the class" institution is appointed.

[136] Even if the guarantee was used up, the EC would need to decide whether there was strategic policy value in continuing to run the facility and continue to 'top up' the guarantee from the Horizon 2020 Access to Risk Finance budget

[137] ICF survey of market participants, March – April 2016. [Qu.15 "What sort of institution would be best placed to manage and deliver each option, assuming inherent sector knowledge and experience?(sample=12 for debt)]

Awareness raising and scheme promotion

The high initial demand for the EDP facility demonstrates that the current awareness raising channels, such as Horizon 2020 and InnovFin (under which the facility currently sits), are working well to raise awareness. As the scheme develops, further thought should be given to how to link more closely into the investment and financial communities. EC awareness-raising mechanisms (e.g. Cordis) and sector-specific mechanisms including SETIS, KIC InnoEnergy and INNEON could signpost the debt Instrument.

Monitoring & Evaluation, including indicators

The FI will need to report on the achievement of EC policy objectives as well as financial objectives. Reporting should be based on indicators which are SMART (Specific, Measurable, Achievable, Realistic and Timely). The set of indicators shown in Box 7.2 represents the likely minimum coverage for the EDP facility.

Box 7.2 Potential SMART indicators to be used in the EDP facility

- Total volume of investment required in the deal pipeline (EUR m)
- No. of agreements (debt deals) with project sponsors
- Volume of finance made available by the facility (EUR m)
- Percentage of facility spent (%)
- Average loan size per project (EUR m)
- Volume of public and private investment leveraged (EUR m) by the fund ('simple leverage' – that which the facility is comprised, i.e. EC contribution: other contributions)
- Total volume of public and private finance (and potential investment) leveraged (EUR m) by the fund into FOAK projects ('multiplier' – that which the EDP's debt financing helps to catalyse in the project / SPV)
- No. of final beneficiaries (project sponsors supported / SPVs)
- Total debt service on loans (EUR m)
- Average time of guarantee release (Months)
- Total returns on loan (EUR m) Gross and net of operating expenses)
- Low carbon energy produced (Gwe, GWth)
- Energy savings generated (Gwe)
- Emissions reductions avoided or sequestered (tons CO_2)
- Employment created (No. Full Time Equivalent jobs)
- Number and value of exits or exposures sold down

8 Comparison of financial instrument options

8.1 Approach

In order to understand the relative positioning of each option, a transparent weighting and scoring system has been used, giving equal weight to each criterion; and for each criterion equal weight given to each indicator. Each indicator has been defined such that a high score (rather than a low score) is desirable.

Table 8.1 The comparison of options will focus on the value for money provided, measured in terms of economy, efficiency and effectiveness

Criteria	Indicators	Scoring
Economy	Adequacy of the scale of funds to achieve objectives[138]	H, M, L
	Alignment of interest with other parties (other lenders / investors)	H, M, L
	Availability of efficient delivery mechanism	H, M, L
Efficiency	Value added and additionality of funding	H, M, L
	Leverage of investment from public[139] and private sources (including administration costs)	H, M, L
Effectiveness	Ability to address market failures or sub-optimal investment situations	H, M, L
	Achievement of intended policy objectives (assumes equal weight is attached to the objectives of each option, unless advised otherwise)	H, M, L
	Avoidance of market distortion	H, M, L

Source: ICF. Scoring: High = 5 points; High – Medium = 4 points; Medium = 3 points; Medium – Low = 2 points; Low = 1 point

8.2 Comparison of a proposed EC equity fund and the EDP facility

When the two financial instrument options are compared and scored (Table 8.2), it is apparent that the potential scale and availability of funding and delivery mechanism would be broadly similar, as would the potential efficiency and value added from both instruments.

The co-investment in individual FOAK project deals could yield potentially greater upside for an equity fund due to the potential for fund returns from successful exits. For the debt facility, the necessary spread of risk to fulfil the lending criteria requires potentially larger numbers of debt providers to become involved. There are also issues around the costs of institutional debt providers being involved in providing small sums (i.e. anything less than €20m of debt per co-lender might not be palatable due to higher costs of due diligence).

Overall, both facilities appear to suit well the needs of the market and help provide the necessary equity and debt that is required for SET FOAK projects. Indeed, there is clear complementarity between the two mechanisms such that combining both instruments could enhance their overall effectiveness in the market.

[138] Based on current planned size of Instrument (or proposed Instrument) relative to overall market need for FOAK

[139] Includes EFSI and potential Member States

Table 8.2 Assessment of value for money provided across the proposed Equity fund and EDP facility

Criteria	Indicators	Equity fund	Score	Comments/justification	EDP facility	Score	Comments/justification
Economy	Adequacy of the scale of funds to achieve objectives	High	5	Fund size of at least €250m and up to €500m would suit the SET FOAK project equity demand	High	5	Fund size of at least €250m and up to €500m would suit the SET FOAK project demand
	Alignment of interest with other parties	High	5	Strategic reasons for corporates to co-invest into fund & deals	Med	3	Risk sharing component but deal sizes and risks challenging
	Availability of efficient delivery mechanism	Med	3	Requires expert fund manager to be found	High	5	Centrally managed delivery already achieved through EIB
Efficiency	Value added & additionality of funding	High	5	Clear strategic need and little risk of crowding out investors	High	5	EDP provides the only specialist debt facility for FOAK projects
	Leverage of investment from public and private sources	Med - High	4	Co-investment & investment upside from exits	Med	3	Modest multiplier: dependent on co-lender availability
Effectiveness	Ability to address market failures or sub-optimal investment situations	High	5	Clear need to overcome shortage of grant support and absence of debt	High	5	Ideal for SET FOAK projects which have requisite levels of equity investment
	Achievement of intended policy objectives	Med - High	4	Strong demonstration effects and upside from deployment	Med - High	4	Strong demonstration effects and upside from deployment
	Avoidance of market distortion	High	5	Good fit with internal market and unlikely to distort competition.	Med	3	Need to ensure private debt finance not being crowded out
Total scores		High	36 / 40		High	33 / 40	

Source: ICF. Scoring: High = 33 – 40 points; Medium - High 25 – 32 points; Medium = 17 – 24 points; Medium – Low = 9 – 16 points; Low = 8 points

9 Building synergies among existing and potentially new financial instruments supporting SET FOAK projects

9.1 Introduction

There appears to be a compelling case for a more coordinated and unified provision of support to SET FOAK projects and their sponsoring organisations. The rationale for such action is four-fold:

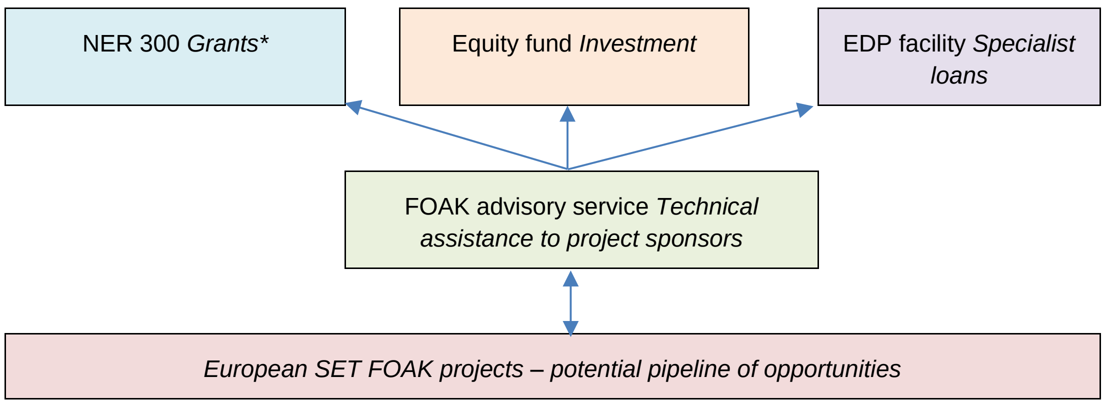
- First, the current investment needs for SET FOAK projects are enormous - potentially up to €29bn to 2020;
- Second, demanding EC policy objectives around climate and energy, as well as energy security and competitiveness, require new low carbon technologies to be successfully demonstrated and deployed rapidly in order to help achieve EC targets and contribute to the growth in the EC economy;
- Third, the current provision of funding at the EC and Member State level is fragmented (and often subject to quite rapid change), making it much harder for project sponsors to plan ahead, know where to go for funding support, and to take advantage of different funding channels which might best suit their individual SET innovations;
- Fourth, while financial market participants are able to bring considerable expertise to bear in the development, financing and deployment of SET FOAK projects, the current pool of expertise in Europe (and globally) is fragmented. The pool has also reduced in size over the past five years as many investors / financiers have decided not to focus on this part of the market any longer. Bringing together investors and financiers into a more formalised ‘community of practice’ would make it easier for innovators to engage and for suitable financing models to be deployed.

A more joined up approach to servicing the needs of European SET innovators (e.g. those at TRL 5 and 6) and FOAK project sponsors (at TRL 7-8) would help to align EC and Member State funding streams. It would also bring together highly qualified expertise from different institutions into a virtual pool of talent which could assist in understanding and acting on the key barriers to deployment of SET FOAK projects.

9.2 Proposed structure for a more joined up EC service offer to innovators

Figure 9.1 illustrates a vision for a more integrated and seamless offer to SET FOAK project sponsors (and indeed those innovators with ideas currently at earlier TRLs). It seeks to raise the profile of different support mechanisms (either actual, planned or which could potentially be introduced).

Figure 9.1 Vision for an integrated EC funding offer to SET FOAK projects to meet market need



*Source: ICF. *Note: the use of financial instruments are to be explored under the Innovation Fund*

Dealing with each of the above in turn:

NER 300: an EC grant scheme to support SET FOAK projects (renewables and CCS) which includes the potential to provide upfront funding based on key milestones. The current programme, delivered by DG Climate Action and Member States, has awarded grants worth over €2 billion to 39 projects. The scheme is to be enlarged to cover energy intensive industries and renamed the Innovation Fund.

Equity fund: a new concept offering investment into SET FOAK project Special Purpose Vehicles (SPVs) and/or the holding company for the intellectual property. Run by an investment manager, the fund would seek to help overcome the equity gap for projects.

Energy Demonstration Projects pilot facility: a debt facility delivered by EIB which is providing specialist loan support to FOAK projects. Currently backed by €150m from the European Commission to cover a first-loss piece ("FLP") mechanism to cover portfolio losses. While to date no such deals have been transacted, the facility has ambitions to increase in future.

FOAK Advisory Service: a concept providing advice and technical and financial assistance to FOAK project sponsors leveraging on the existing Advisory Services. The FOAK Advisory Service would be able to signpost sponsors to the EC funding mechanisms, and improve the bankability of the projects. Innovation Finance Advisory and The Hub (see Section 9.3) already provide an advisory mechanism although not exclusively dedicated to the SET sector. Acting as a "one stop shop" as it is currently devised, it could:

- provide immediate feedback to potential applicants as to the most suitable support measures. As one market participant[140] in favour of such a facility commented, *"a 20 minute conversation to get inside your project very quickly - for example, what is the value proposition at different TRLs and what funding best suits the TRL? - would be ideal because projects don't want to chase ghosts"* but the individual *"has to be an informed person at the EU end"*;
- act as a de facto EU SET FOAK 'deal sourcing' facility with the potential to also advise non-EU project promoters on the best routes into demonstrating their SET innovation in the EU marketplace;
- facilitate the completion of a standard application whereby if a project offers intended outcomes the project could be easily prequalified;
- provide advice on structuring of the SET projects in order to improve their access to finance and overall bankability of SET projects, in particular but not limited to business and financial risk structuring;
- provide advice to EU project sponsors (promoters) on project feasibility, planning and permitting, and FEED studies including information on regulatory frameworks;
- offer expertise and the best approaches to raising finance and/or investment from suitable market participants;
- give feedback to sponsors on their draft financial plans and advice on potential financing models suitable for different technology types;
- act as a formal link, and potential 'fast track' mechanism, to any EC equity and debt provision for FOAK projects, as well as to the National Contact Points for the NER 300 grant mechanism (since NER 300 is delivered via Member States and the future Innovation Fund may have the same delivery mechanism);
- when appropriate and as required by EU funding sources or by sponsors, provide on-going support (including, but not limited to, identifying and devising adjustments and remedial actions to implementation plans) in the investment, commissioning and operational phases; and, finally,

[140] ICF survey of financial market participants, March – April 2016

- the Advisory Service could provide technical assistance and information on the regulatory framework for investment that might pertain to financial market participants with less familiarity of the SET FOAK funding space.

9.3 Existing advisory service provision

Two advisory service mechanisms at the EC level have been established in recent years. These are summarised in the section below.

9.3.1 Innovation Finance Advisory Service

Innovation Finance Advisory is a joint EIB-European Commission initiative under Horizon 2020 (Figure 9.2) to assist eligible public and private counterparts to improve the bankability and investment-readiness of large, complex, innovative projects that need substantial long-term investments.

Figure 9.2 Innovation Finance Advisory within the InnovFin Programme

Beneficiaries are from both the private and public segments (large and small corporates, RDI clusters, industry associations, Financial market associations, European Commission, Member States, government agencies), and also public-private and semi-public organisations (foundations, NGOs, research institutes). The projects supported cover a wide range of sectors, from large research infrastructure projects, healthcare, to mid-caps projects in renewable energy, and also SMEs in EU Member States and Associated Countries[141].

Innovation Finance Advisory services are provided independently of the EIB's lending/investment decisions. Accordingly Innovation Finance Advisory assesses all potential financing sources including, but not limited to, EIB funding.

9.3.2 European Investment Advisory Hub (EIAH)

The European Investment Advisory Hub, EIAH (the 'Hub") is a joint-initiative by the European Commission and the EIB to respond to the Second Pillar of the Investment Plan for Europe. The Hub aims to support investment in the real economy. It offers a single access point to a 360° degree offer of advisory and technical assistance services which include services provided through Innovation Finance Advisory. Its final goal is to enhance the technical and financial capacity of private actors and public authorities in EU Member States to identify, prioritise, prepare, structure, aggregate and implement strategic projects.

The EIAH provides access to a wide range of advisory services and technical expertise. It is not limited to EIB-financed projects. The Hub also has the mandate to manage a network of

141 http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/3cpart/h2020-hi-list-ac_en.pdf

National Promotional Banks and Managing Authorities. The various partners involved can together contribute to the delivery of a complete advisory services model.

The Hub includes three components:

- A single point of entry allowing the access to a wide range of advisory and technical assistance programmes provided by high-level experts;
- A cooperation platform to disseminate expertise among various stakeholders; and,
- To strengthen and address new needs by broadening the existing services or creating new ones.

Beneficiaries include public authorities, project promoters and private companies who all receive technical support to develop their projects, become investment-ready, obtain information and advice on funding sources, and find technical and financial expertise.

9.3.3 Conclusions

The scope of the Advisory Service provided to SET should be explored in more detail jointly with the EIB to ensure the advisory solution is fit-for-purpose.

The Innovation Finance Advisory Service (available under the InnovFin Programme and under the Hub) and the Hub itself are mechanisms supporting project promoters to enhance their access to financing for their projects. For this purpose, Innovation Finance Advisory Service offers access to finance advisory, while the EIAH acts as a single access point to a broader array of advisory services across the entire project cycle.

The two mechanisms are not sector-specific, and are open to various types of projects in terms of size and technologies. They both advise both the public and the private sectors in accessing resources and expertise.

Given the existence of a robust and experienced 360°Advisory Service, with strong cross sector and financial expertise, the possibility of building on the already existing expertise of Innovation Finance Advisory and the Hub by expanding its capacity and scope should be explored as first option.

10 Conclusions

10.1 The SET FOAK funding challenge and rationale for intervention

Financing is a critical link between innovation and successful commercialisation. However, SET FOAK projects in Europe face tremendous challenges in raising sufficient funding to achieve financial close, achieve construction, become fully operational, and thereby prove to the market the efficient operational performance of leading-edge SET innovations. The scale of finance required for such projects has hitherto failed to be fully recognised by policy makers.

Investment needs to 2020 across all EU SET FOAK projects are substantial, estimated at between €4.0bn[142] and €28.5bn[143] (equivalent to around half of the current SET-Plan need[144]) – see Table 3.2 – and sectoral investment needs differ widely. For example, the lack of any full-chain CCS FOAK projects in Europe, despite an ambition to have around nine CCS projects funded and operational by 2015, means that just one or two such successfully commissioned projects could help to fundamentally change market sentiment on CCS in the EU; while the deployment of four to five tidal stream arrays could also help to greatly lower risk perceptions for the ocean energy sector.

In contrast to this significant future investment need, when measured across both EU support schemes (such as the NER 300 at €2.1 billion) and available through key Member State support schemes, ICF estimates that total current grant, debt and equity provision for FOAK projects at EU and Member State level is around €4 billion. This leaves a public funding shortfall of around €10 billion to achieve maximum levels of FOAK demonstration projects[145].

The failure to prove technologies at commercial scale creates large negative consequences. It limits the opportunities to reduce the Levelised Cost of Energy (LCOE) for emerging low carbon technologies in the European energy supply market; it greatly reduces the potential for such technologies to help Europe achieve its climate and energy targets; it impacts on the potential demonstration effect that successful SET FOAK projects would have on the financial markets, both in the EU and globally; and it hinders the growth of a European industrial supply side that can generate economic and social benefits to the European economy. There are therefore clear and compelling reasons to resolve this funding problem.

10.2 Blending of funding streams to achieve financial close

SET FOAK projects are a very high risk asset class in which there has been limited interest to date from the market, with the exception in some SET sectors of those corporate project sponsors who either have intrinsically linked business interests, such as energy utilities, or are used to investing in innovation as part of their business strategy (e.g. multi-national engineering companies). A major reason for the lack of interest is the vast array of commercial opportunities in the EU and globally to invest and finance proven SET

[142] A minimum size of SET FOAK plant combined with a minimum deployment scenario across all nine SET sectors

[143] For those SET sectors with the highest unmet funding needs, the equivalent figures are €3.0bn to €18.1bn

[144] To address the gaps in the financing of demonstration, deployment and market take up of emerging low carbon energy technologies in relation to the SET-Plan requires at least around €60bn in technology development over the period 2010-2020 across various SET sectors including bioenergy (€9bn); solar PV and concentrating solar power (€16bn), wind (€6bn), CCS (€13 billion) and the electricity grid (€2 billion). Source: JRC, 2013. Joint Research Centre Scientific and Policy Reports R & D Investment in the Technologies of the European Strategic Energy Technology Plan. Brussels, 2.5.2013 SWD(2013) 157 final. Available at: http://ec.europa.eu/energy/technology/strategy/doc/swf_2013_0157_en.pdf

[145] Analysis is based on a bottom-up aggregation of major funding streams for FOAK project sponsors. Public sector intervention for FOAK projects could reasonably be expected to provide 50% funding, i.e. between €2bn and €14.25bn of the overall investment need range. Grant provision for FOAK is estimated at around €3bn through schemes dominated by NER 300 and France's PIA; loan provision is estimated at less than €500m (€150m via InnovFin's Energy Demo Project (EDP) facility as well as France's PIA's scheme and Germany's KfW provision); and equity provision is estimated at less than €500m (mainly via European Investment Fund into early stage cleantech companies during 2007-13 and now through InnovFin's SME Venture Capital scheme, and France's PIA scheme)

innovations (for example, first generation solar PV, onshore wind, mass burn biomass, etc.). These opportunities are able to deliver required returns to institutions and private investors without carrying much risk, at least from a technological or business perspective[146].

ICF's interviews with banks (investment, retail, universal) found that the use of debt funding is not widely available for SET FOAK projects, i.e. prudent lenders are neither willing nor able to take exposures on projects of unproven debt carrying capacity. One reason is that increasing regulatory and capital adequacy requirements imposed on banks and insurance companies have reduced their willingness to take risk, impacting investment activities which might have otherwise been considered. This reinforces the need for public sector supply of debt.

SET FOAK projects have complex financing needs and large variations in financing structures exist, even within sectors, due to the different technology types, scale, track record of sponsors, etc. (see Figure 3.1)

Financial structures[147] from 32 different sponsors show that:

- grants (i.e. public sector risk capital) play a very important role overall in many SET FOAK deal structures, with projects typically forecasting between 10-30% or much higher amounts in some isolated cases (e.g. for bioenergy, bio-pyrolysis, CSP, geothermal, wind); grants are perceived as particularly important for ocean energy, generally making up the balance with equity and, infrequently, debt;
- equity investment is forecast between 10-30% in many projects, but is particularly high for several solar PV and ocean energy projects while being absent in other projects;
- debt requirements can be very large, varying from 10% of total funding to more than 70%. –Based on sponsor forecasts, the ease with which FOAK projects are perceived to be able to raise debt is highest in the most mature SET sectors, i.e. wind, solar PV and geothermal[148]; although it is also perceived to be possible to raise very high levels of debt for CSP projects – in contrast, two ocean energy projects made no reference to debt;
- bond finance is of limited relevance, being hardly mentioned by sponsors[149], as is true for internal company financing; and,
- outstanding funding needs either indicate shortfalls in funding which may stall a project or else non-disclosure of key aspects of the financial structure (such as expectations of feed-in tariffs).

10.3 Market conditions which impact on the SET FOAK funding "landscape" include resource availability, regulatory frameworks and supply chains

Several market conditions which generate positive framework conditions for funding FOAK projects were identified, including:

- Resource availability, such as a viable ocean energy resource in the North West of Europe and excellent solar radiation across the Mediterranean to benefit CSP.
- Well-designed planning and permitting systems, established supply chains, testing/demonstration centres and greater public acceptance, are more likely to be in place where high penetration rates already exist, as with Solar PV, (onshore) Wind and Bioenergy. This creates more optimal market conditions for FOAK projects.

[146] Markets for most SET innovations are still subject to potentially large political risks

[147] Note that the vast majority of projects when consulted had yet to reach 'financial close', i.e. the point at which contracts are signed and the financial structure of the project is confirmed. FOAK project structures should be therefore regarded as indicative and by no means confirmation that it is possible for the sponsor to actually achieve the stated breakdown of debt, equity, etc.

[148] Geothermal energy is characterised as mature given that the first commercial geothermal power plant started operation in Italy in 1911, although it is recognised that more innovative geothermal approaches are much less mature in the market

[149] Bond finance is generally only available to refinance bank loans post-completion. It is possible that these project sponsors have insufficient knowledge as to where bond finance is most applicable and made assumptions about its potential

- Stable and predictable systems of fiscal support have a positive signalling effect to potential investors/financiers of FOAK projects since they help to accelerate deployment of technically proven and early commercial technologies. Renewable energy plants are often given priority in terms of network access and dispatch of generated electricity where fiscal support is provided.
- Consistent and supportive policy framework, including ambitious future capacity targets in National Renewable Energy Action Plans (NREAPs), plays a crucial role in fostering new developments for sectors where limited or no market deployment exists (e.g. CCS, Geothermal, LES and Ocean energy) as well as for sectors with a high level of market deployment (e.g., biomass conversion technologies).
- New European state aid regulations for energy and R&D are likely to have a positive influence on FOAK funding. For example, Member States can provide support to new innovative production plants for novel biofuels or bio-refineries; and operating and investment aid are permitted to support industrial installations equipped with CO_2 capture, transport and storage facilities.

At the same time, substantial market failures and barriers are known to inhibit investment and financing of FOAK projects, either structurally, at a macro-economic level; and/or on the demand side, impacting on investment decisions; and/or within the supply side, especially in nascent and emerging supply chains where there is often insufficient incentive to invest in new innovations, not least because of uncertain returns.

Barriers also include sub-optimal investment situations, in which the market is not interested in supporting FOAK projects (despite there being a positive economic rate of return) or where projects that are in principle bankable (i.e. can generate a positive internal rate of return, IRR), find that the finance or investment is inadequate because of a project's inherent uncertainty or underlying risk structure.

Across the EU, market conditions for SET FOAK projects vary significantly by country and SET sector. This creates a complex landscape, making it challenging to analyse and draw meaningful conclusions about any one country's role in supporting FOAK projects, especially since the SET policy environment is constantly evolving. In general, across all SET sectors and countries, the outlook can be taken as generally neutral, although in several sectors such as bioenergy, ocean and wind energy there are a number of markets demonstrating a more positive outlook; and there is at least one Member State - and more typically two or three – for each SET sector which are deemed to have positive conditions for FOAK projects.

Overall, framework conditions play a crucial role in helping to persuade or dissuade funders from committing to FOAK projects in different EU Member States. Where these conditions are not working optimally, any resulting negative impacts must be mitigated through public sector interventions.

10.4 Scale of the prize for supporting SET FOAK projects in the EU

Market replication is the prize for public support of SET FOAK projects. Replication will help to unlock capital flows from the private sector and allow such innovations to become firmly established in the market. It will bring considerable economic and environmental benefits to the EU economy, such as increased investment, employment and global export opportunities. It will also contribute to the fulfilment of carbon reduction policies and enhanced energy security.

Successful FOAK projects can achieve large future sales. Based on a survey of European FOAK project sponsors, the study found that 20 typical FOAK projects, covering eight SET sectors, required total investment costs of €1.8 billion. Potential maximum returns from successful deployment of all these projects was estimated by sponsors at €6.2 billion after two years (a multiple of over 3 times), rising to €26.9 billion after five years (a multiple of 15 times)[150]. Such figures indicate the potential rewards from concerted action to effect change in the FOAK funding landscape.

Technological successful and cash-flow positive SET FOAK projects also create a more positive profile for this high risk asset class. This will attract more market participants into the commercialisation 'Valley of Death' over the long-term: a crucial step forward for enabling EU innovations to be brought to market more successfully. This in turn will help the EU to fulfil the strategic objectives of a future integrated Strategic Energy Technology Plan (SET-Plan).[151]

10.5 Role of the public sector

The public sector plays a vital role in funding FOAK projects at EU and Member State level, mainly through grant support, whereas loans are only used in some schemes, including the recently established InnovFin Energy Demo Project (EDP) debt facility[152] and the French 'Investments for the Future' programme (PIA). Despite its prolific usage, grant provision, especially at Member State level, is often not large enough to adequately support SET FOAK project funding requirements. A further potential complication for grant support is that the time period from feasibility to operation for FOAK projects may be very long – potentially up to 10 years - making them challenging to align with public sector programme timescales. This has been seen in many projects within the NER 300 programme and at Member State level in the UK's Marine Energy Array Demonstration programme[153].

Potential funding shortfalls in key Member States are also in evidence as a result of the:

- Closure of support schemes;
- Re-orientation of schemes away from SET FOAK towards proven energy technologies;
- Re-orientation of schemes away from energy (towards, for example, digital technology); and,
- Potential uncertainty for schemes reliant on private-sector co-financing.

A high level summary of availability for different funding streams (i.e. grants, equity, debt) across SET sectors is to be found in Table 4.4. A few of the more established SET number of sectors, such as biomass, SPV and wind, are generally well served with have high availability of both grants and equity, in contrast to emerging sectors such as CSP, Geothermal, LES and Ocean. Debt has mixed availability across territories and SET sectors. CCS is particularly poorly served in the current funding landscape, not least due to the enormous costs of projects which often fall outside the funding thresholds of many support schemes.

The overall funding provision for FOAK projects, while certainly positive for projects in mature SET sectors (e.g. SPV, Wind) and in more established Member States (e.g. France, Germany, Sweden, UK), could be enhanced in other SET sectors and Member States.

For private financial market participants, the funding situation for FOAK projects is sub-optimal; and there are few incentives (such as risk-sharing mechanisms) to become more closely involved.

---

[150] Sales forecasts assume all projects become operational at the same time and that project sponsors experience no impediment in delivering their business plans. Given the very high risk nature of FOAK projects, these forecasts only represent an idealised indicator of potential market replication and take no account of failure rates.

[151] C(2015) 6317 final, *Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation*, September 2015 https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v8_0.pdf This Communication provides a stock take of success under the current SET Plan and identifies ten priority actions to accelerate the energy system transformation in Europe which need to be discussed with Member States and stakeholders.

[152] *http://www.eib.org/attachments/documents/innovfin_energy_demo_projects_flysheet_en.pdf*

[153] Siemens had to pull out of the Skerries Project in Wales for this reason

10.6 Reasons for failing to achieve a Final Investment Decision

Many SET FOAK projects, across various sectors, are unable to achieve a Final Investment Decision (FID) or financial close. The study identified several reasons for this impasse:

- A number of potential ‘showstoppers’ (high risks) can cause a project to stall or fail if not adequately tackled by experienced project managers.
- Despite a number of EU and Member State support schemes offering mainly grants (and some limited loan provision) to innovators, the scale of funding on offer at the project level is often insufficient. A large part of the problem is that few EU and Member State support schemes explicitly target the commercialisation ‘Valley of Death’ (i.e. TRL 7-8). However, the former scheme has only managed to date to achieve 3 operational projects from 39 awards; the latter currently has just €150 million with which to act across the entire FOAK market.
- Traditional investors in FOAK projects either have reduced their interest in this asset class for strategic reasons (e.g. corporate engineering companies) or else cannot simply afford to fund such projects off their balance sheet (e.g. energy utilities) and require project financing. This has not only reduced an important stream of both equity and debt, but exposed such FOAK projects to outside financial parties who do not have the same risk appetite for such deals.
- The neutral, or sometimes negative, market conditions in some SET sectors and within certain Member States (see above) will do little to convince funders to back FOAK projects in such jurisdictions.

10.7 Helping to close the SET FOAK funding gap

Without adequate funding, there is a clear threat that the EU’s leading-edge SET innovations will not progress from demonstration to commercial status to the extent desired; and the anticipated contribution that such innovations will make to achieving EC climate and energy policy objectives will be impacted greatly. This is likely to lead to increased costs of fulfilling policy objectives and economic leakage as the EU becomes less competitive.

There is an over reliance on grant support across EU and Member State schemes, even though grants alone are insufficient to meet the funding needs of the plethora of SET FOAK project types.

Achieving successful SET FOAK projects in the EU requires:

- Scale of response, i.e. support is delivered quickly, given fast-approaching policy goals;
- Sensitivity to individual project circumstances; and
- “Crowding in” of market participants at Member State and EU level.

All Market Participants consulted in this study felt that the European Commission should provide equity to support FOAK projects. Most also felt debt should be made available. For Specialist Investors, debt could be made available as mezzanine and low-interest loans; for Banks, debt could be made available as bridging finance. Further grant provision was also widely called for, both for feasibility and construction phases of FOAK projects, which enable project sponsors to overcome important initial funding needs which are often stumbling blocks to successful project implementation.

Financial instruments (FIs) can catalyse investment and finance from the private sector into SET FOAK projects, assuming they are cost efficient and are designed in a way to incentivise private actors and ‘crowd in’ funding (e.g. through first-loss mechanisms). FIs can also enable increased investments to flow through the European Fund for Strategic Investments (EFSI) as well as other financing mechanisms.

The addition of equity and debt provision creates greater options for policy makers to tailor funding most efficiently to market need, and create more sustainable funding mechanisms, as follows:

1. Equity provision - corporate sponsors are a key constituent party in the supply of equity, but utilities no longer have money to spare for such innovation funding, and major engineering companies are highly selective about what they sponsor. While levels of equity provision delivered into the European venture capital (VC) and lower mid-market private equity space by the European Investment Fund (EIF) are enormous (making the EIF the de facto largest VC and private equity (PE) investor in the EU), this equity is mainly providing early stage and expansion capital into high growth companies on a *pari passu* basis, delivered via equity funds. EIF does not provide equity into project financing vehicles, nor does it offer such equity for individual final beneficiaries (i.e. project sponsors) at the scales required by SET FOAK projects. Most importantly, equity is not offered with a first-loss covered by the European Commission which is what financial market participants believe should be on offer in a new European SET FOAK equity fund in order to 'crowd in' private investment. Levels of equity provision need to be sufficient to support at least 10 to 20 FOAK projects. The Fund and its manager should take a hands-on and proactive approach to managing the whole project cycle alongside sponsors, from identification to selection and trouble-shooting/remedial action after financial close, which would also include delivery and completion, commissioning and operations.

2. Loan provision - the recently established EDP debt facility, operated by EIB, has got off to a good start in raising its profile to FOAK sponsors, by attracting over 70 enquiries. It has signed its first loan (to an ocean energy project in Portugal) and has four further FOAK projects in advanced stages of screening and due diligence. By offering specialist loans that most private sector debt providers simply cannot provide, the EDP facility is filling a gap in the market. It is structured with a first-loss piece which allows the facility to take on more of the risk than other debt providers. However, the current size of the facility needs to be increased, both to enable at least 10 to 20 FOAK projects, across different SET sectors, to be supported.

Overall, both the proposed Equity Fund and existing EDP facilities appear to suit well the needs of the market and help provide the necessary equity and debt that is required for SET FOAK projects. Indeed, there is clear complementarity between the two mechanisms such that combining both instruments could enhance their overall effectiveness in the market.

To ensure full coverage of FOAK funding and support needs, EU action is also required in supplying:

3. Grant funding – this needs to be targeted at SET sectors where risks are greatest, i.e. where technologies are further from market, including at TRLs prior to the 'Valley of Death. It is also needed at the early stages in the life of a FOAK project to help sponsors to overcome critical funding shortfalls (since few other funders have interest at this stage) in order to achieve key milestones such as Front-end Engineering and Design (FEED) studies and planning and permitting.
4. A SET FOAK Advisory Service, comprised of sector experts, is required to help innovators and sponsors to navigate and advise on the most appropriate funding and support channels at EU and Member State level. This would have the benefit of helping to facilitate a FOAK project pipeline in the EU. Current support is provided by the Innovation Finance Advisory Service and European Investment Advisory Hub (EIAH)[154]. These are mechanisms supporting project promoters to enhance their access to financing for their projects. For this purpose, Innovation Finance Advisory Service offers access to finance advisory, while the EIAH acts as a single access point to a broader array of advisory services across the entire project cycle.

A combination of EC-backed debt and equity facilities, supported by upfront grant funding and project-specific expert advice (see Figure 9.1), would help different project types to access the most suitable forms of funding, since each offers a different form of funding support.

[154] A joint-initiative by the European Commission and the EIB to respond to the Second Pillar of the Investment Plan for Europe

Creating more formal linkages between Member State and EC schemes may help to maximise limited Member State R&D budgets in the future. This is an important finding because it suggests that national funding schemes to support late stage R&D need to be set up (and receive state aid clearance) in such a way that can allow FOAK projects to be funded appropriately, if it is deemed to be of significant economic benefit to the Member State. The risk of not having such a connection is that technology developers with potentially game-changing innovations may be unable to qualify for a national scheme that can meet their demonstration funding needs and also not be sufficiently aligned with EC schemes which might have helped to plug the finance gap.

Encouraging Producers and VC/PE funds to become more interested in FOAK project investment is likely to require various mutually-reinforcing approaches, including:

- Greater awareness of technological development needs;
- Improved connectivity across technology developers, producers and supply chains;
- More successful sector precedents to build confidence;
- Advice on appropriate deal structuring – perhaps from experienced investors who can mentor others with limited sector expertise; and,
- Appropriate financial incentives to provide rewards for taking on elevated risk levels, including equity investment structures that allow syndication on deals within an overall portfolio of FOAK projects.

10.8 Good practices from current EC and Member State schemes which could improve the effectiveness and efficiency of FOAK support schemes

10.8.1 Fundamental scheme principles are important for ensuring credibility

To be effective, any new FI at either the EC or Member State level, must try to adhere to some fundamental principles including:

- Having clear strategic and operational objectives;
- Being financially large enough to have market presence and credibility;
- Having transparent eligibility criteria;
- Being flexible enough to deal with different SET sectors and different scales of project;
- Having financing mechanisms which allow greatly flexibility to attract potential private co-financiers/investors;
- Having sufficient support, from different stakeholder groups, including economic and environmental regulators if necessary, to have visibility; and,
- Ensuring that operational costs from scheme delivery do not represent too great a percentage of overall costs.

10.8.2 The application and project monitoring process is critical to achieving strong market uptake and robust projects being funded

Some examples of good practice from our review of support schemes include:

- Ensuring clear guidance and supporting project applicants during the application and development stage is often financially worthwhile as it will greatly help to reduce poorly developed proposals and should increase the success rate significantly;
- Having a two-stage application process can create efficiencies for both applicants and fund managers and help to filter out weaker projects at an early stage;
- Ensuring project ideas are both technically and financially assessed in a thorough and robust manner, in order to identify which innovations would most likely fail under market circumstances;

- Having close technical, financial and political support throughout project implementation to create incentives, even for bigger companies, to support high risk FOAK projects;
- Employing highly qualified staff in the responsible funding scheme administration for assessing and supporting bid applicants and project sponsors; and,
- Mechanisms to help improve the knowledge of financial market participants regarding new technologies, SET areas and successful FOAK project exemplars, will help both to improve confidence in market opportunities and lower risk perceptions.

10.8.3 Non-EU support schemes provide useful lessons for tackling FOAK project funding

Observations from other schemes include:

- Ensure there is long-term political commitment – this is important to create the right market 'signals' and ensure that the scheme 'beds down' and achieves market branding and credibility;
- Adopt a very strategic market focus to understand the nature and scale of market opportunities for proposed technologies which are to be supported. This helps to reduce potentially wasteful investments on 'dead-end' innovations which will be difficult to bring to market;
- Commit sufficient resources to the challenge - any scheme specifically designed to target FOAK projects in the EU should have a minimum budget size that gives it the ability to support a large number of FOAK projects, rather than being limited to a handful;
- Work with industrial companies and the venture investment community at the earliest opportunity – this can increase the visibility of new innovations and help increase levels of "buy-in" to investment propositions (rather than coming 'to the table' late which can increase investor perceptions of risk);
- Adopt strict procedures for 'dropping' failing projects that are not delivering against their objectives is prudent, as is having robust clawback provisions which are well-defined in order to avoid any funding commitments to projects that cannot move forward;
- Working with the public and private sector to ensure a continuum of funding is on offer for the most promising innovations can avoid potential funding gaps in the commercialisation pathway;
- Be strategic about which SET technologies to target and identify early on where FOAK project support is going to yield large economic value for the EU and will enhance EU supply chains; and,
- Build a robust monitoring and evaluation framework – this will enable project outcomes and impacts to be determined. Being able to measure the overall success and value of the intervention is vital to demonstrating long-term value to stakeholders and their continued financial support for the policy objective.

11 Recommendations

Recommendation 1: Increased visibility of SET FOAK projects and their sponsors

DG RTD should work closely with DG Energy in their efforts to undertake a comprehensive mapping of SET FOAK projects and to enhance the understanding as to why such projects may not have progressed beyond the TRL 7-8 stage. This will help to build the evidence base for expanding debt and equity provision, as well as yielding case studies of successful financing, demonstration and market replication.

Recommendation 2: Overall EC provision for SET FOAK projects

DG RTD should explore the potential for a more integrated and seamless EU offer to SET FOAK project sponsors (i.e. a "one-stop shop", comprising debt, equity, grant support and any modifications to the current provision of advisory services being delivered by EIB) in order to satisfy market need.

Recommendation 3: Equity provision

The concept of a SET FOAK Equity Fund should be further explored in detail, as there is a clear need for more equity provision for FOAK projects in the EU. Based on market soundings, an initial fund size of €250 million to €500 million should be explored. This level of funding is likely to have a sufficient impact on the market with sponsors and others; it is also at a scale where recruitment and retention of high calibre staff will be possible. Since it is outside the study Terms of Reference to examine in detail how such a Fund might work, further research should also examine:

- the corporate and institutional structure for such Fund;
- the aims, objectives and investment criteria for such Fund, including investment horizons and divestment, and mechanisms for market penetration;
- where, how and under what regulation, accountability and control such a Fund be set up;
- the level of regulation that is applied to equity investment advice and fund management;
- the required qualifications and experience of staff participating in such activity.

Recommendation 4: Specialist debt provision

DG RTD should consider increasing the size of the EDP facility from €150 million (for 2016/17) to at least €250 million, and ideally €500 million, in order to offer specialist debt provision to FOAK projects at a scale that will cater to different project types and sectors. Other mechanisms should also be explored in order to allow the facility to cater to increased numbers of projects. These mechanisms could include reducing the first-loss coverage to less than the current 95% or examining whether the date of release for the guarantee on projects could be achieved sooner.

Recommendation 5: Grant provision

DG RTD should work closely with DG CLIMA to scope the new Innovation Fund in order to ensure that grant provision for SET FOAK projects is sufficiently well adapted to the needs of project sponsors. This includes identifying the key project milestones where grant support would make the most impact for sponsors in advancing their projects, up to and including Financial Close and potentially the construction phase. This recommendation arises, in particular, from the ICF analysis of SET project risks, which shows that the main 'showstoppers' occur at or before Financial Close.

Recommendation 6: Advisory services for SET FOAK project sponsors

DG RTD should consider the current provision of advisory services at the EU level to assist SET FOAK project sponsors to plan and design their projects, including finding the most appropriate funding structures to use. This will accelerate project development and catalyse a community of interest across the EU in SET FOAK projects. DG RTD should consider the existing provision of advisory services, Innovation Finance Advisory and the European

Investment Advisory Hub, and assess what reinforcements and adjustments may be necessary in order to provide the desired dedicated service to SET FOAK projects.

Annex 1 Market failures and problems related to financing of SET FOAK projects

A1.1 Introduction

There are substantial market failures and barriers which inhibit financing of first-of-a-kind demonstrators for low carbon energy investment opportunities. Market failures can act in one of three areas: structurally, at a macro-economic level, on the demand side, and within the supply side, especially in nascent and emerging supply chains in new technology areas.

Market failures and barriers can be grouped under four themes which are summarised in Table A1.1 and are briefly described below. They affect stakeholders engaged directly or indirectly in the process of bringing low carbon technologies to market. Some are internal barriers (i.e. acting within a project) while some barriers are external (i.e. wider framework conditions acting on project developers or financing organisations). Many of these barriers are identified as specific risks to FOAK project development and implementation in Annex 12 and must be mitigated either internally or through public sector interventions.

Table A1.1 Market failures and barriers to investment in low carbon energy innovations

Financial barriers	Policy and regulatory barriers	Skills, knowledge and information barriers	Technology barriers
■ High initial costs of renewables ■ Lowest oil prices in over 10 years ■ Investment needs beyond usual range of business angels / VC funds ■ Bank lending still low in Europe ■ Under-developed corporate bonds, equity and securitisation markets ■ Basel III rules have increased risk aversion ■ Lack of viable business models to aid deployment ■ Future returns from R&I hard to capture	■ Policy driven investments, so any policy uncertainty will knock confidence ■ Regulatory uncertainty (e.g. retroactive feed-in tariff changes) ■ Perverse incentives (e.g. fossil fuel subsidies) ■ Poorly designed support programmes with too stringent requirements ■ Underdeveloped secondary regulation, such as health and safety, planning permits, or environmental permits	■ Asymmetry of information between stakeholders changes risk perceptions ■ Lack of specific skills among investors, technology developers and potential clients ■ Inability of institutional investors to assess project risks properly ■ Limited experience for new technologies ■ Lack of tools for system integration (e.g. resource maps) ■ Difficulties in awarding environmental permits for complex FOAK projects	■ Technology unproven at commercial scale, so significant risk of technical failure ■ Limited sector champions in some key SET sectors ■ Nascent or disconnected supply chains prevent key technologies coming to market ■ Implementation risk for end users favours incumbent (proven) technologies ■ Long operational time for new technologies to gain market confidence before commitment to purchase ■

Source: ICF

A1.2 Financial barriers

- High initial cost is perhaps the most important factor that currently inhibits renewable energy deployment, since renewables are still in most cases more expensive than fossil fuel based generation sources, although there are now good opportunities to invest in more competitive approaches such as biomass, solar PV and onshore wind.
- Declining oil prices since mid-2014 have led to prices being at their lowest levels for over ten years. This makes investment into low carbon energy generation more challenging. Oversupply, new extraction methods (which includes fracking) and resilience to adjusting supply and demand by some oil producing nations have been key reasons for price falls[155]
- The scale of investment needed for FOAK projects is beyond the usual value range for venture capitalists. Demonstration projects for renewable energy technologies generally cost tens of millions of euros. European VCs tend to invest in smaller amounts on multiple projects to diversify risk. Owing to bad experiences with FOAK deals, and also SET deals, and the competing attraction of opportunities in other fields, fewer VC/PE investors are now active than previously and those that are, have reined in their investments compared with previous years. As one market participant consulted in this study noted: *"The depth of funding is thin as the risk appetite has gone out of the market"*. Many big European clean-tech names who were active from 2005 to 2010 have now moved into "late stage" companies, i.e., to those with revenues of over €7 million and with a product people want to buy. Producers offer the most viable solution to large-scale FOAK project financing equity requirements as they are more readily able to invest in riskier ventures. However, in some sectors, such as Ocean and CCS, even Producers have pulled back from high risk and capital intensive projects.
- Europe is still tied to conventional financial mechanisms, which limits lending - Europe is historically heavily dependent on bank intermediation for project financing. Corporate bonds, equity or securitisation markets are still only developing slowly in Europe, compared to, for example, the United States[156]. There is evidence that institutional investors have started to diversify their portfolios and look long-term, such as by focusing on renewable infrastructure, although in the main they continue to pursue low risk, conservative investment strategies. Pension funds and insurance companies are increasing their exposures in renewable energy, but rarely for FOAK projects and typically as acquirers of debt or equity portfolios from other market participants in established projects with operational benchmarks and a commercial track record.
- Regulatory barriers on banks and insurance companies have affected investment activity – since the 2008-9 Financial Crisis, Basel III rules have important implications for lending practices of banks, which constrain liquidity with a view to creating greater stability and resilience in banks. The impact of Basel III restricts the supply of long-term funding available from banks, which infrastructure and energy projects demand, and limits their willingness to take risk. Hence, they are more circumspect when reviewing funding opportunities in these sectors, and one consequence is that opportunities for financing small companies/special purpose vehicles with an innovative low carbon energy technology are passed over as being not cost-effective to pursue.
- Limiting the ability of banks to provide long-term, non-recourse project finance, has had implications for the availability of capital for infrastructure projects. The "collateral damage" is that these tightened rules have led to less willingness by banks to fund sustainable investments. At a time when many EU member States are embarking on major investments in infrastructure and energy, not least as a way to pull their economy out of recession, the Basel III requirements imposed on banks make no differentiation as

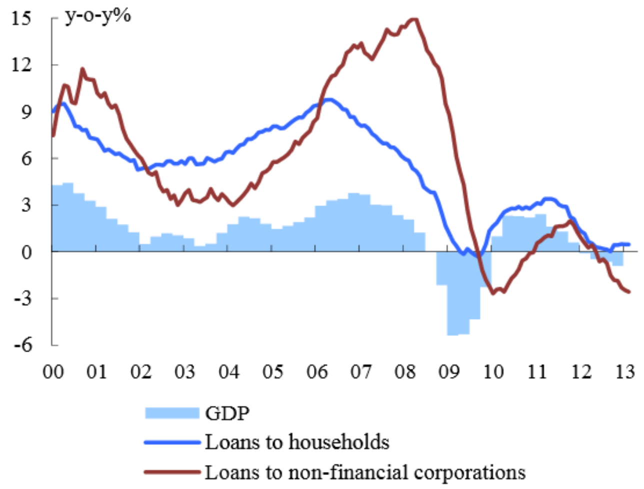
---

[155] European Commission (2016) European Economic forecast – winter 2016, European Economy 20/ February 2016, DG ECFIN. See http://ec.europa.eu/economy_finance/publications/eeip/pdf/ip020_en.pdf

[156] Note: there is no difference as to how debt is viewed in the US as in the EU. In the US there is more speculative / VC-type equity available due to generous tax breaks being available for certain technologies, research programmes, etc. Also, there is greater availability of federal or state subsidy /grant support which, if in the EU, would be seen as state-aid.

to the nature of bank's lending exposures, such that energy and infrastructure loans receive no special treatment or benefit. Similarly, the Solvency II Directive requirements for insurance undertakings also require institutional investors to adopt a more stringent, harmonised risk-based regime and new, more rigorous accounting standards. Figure A1.1 provides an illustration of lending behaviour in the Euro area between 2000 and 2013. It shows that overall bank lending to non-financial corporations (such as SMEs) was affected greatly since the economic crisis. This trend is likely to have put significant pressure not only on the financing of low carbon energy projects in general, but in particular of projects which are less attractive in terms of financial return and risk.

Figure A1.1 Bank lending to households and non-financial corporations in the Euro area



Source: European Commission (2013) European Economic forecast – spring 2013, European Economy 2/2013, DG ECFIN

The EC's most recent Economic Forecast[157] reports that despite the European economy having some positive supporting factors (e.g. reduce oil prices, financing costs) which have stimulated exports and private consumption, investment "remains hampered by economic and policy uncertainty and in some countries, excessive debt." Further it notes that given the "headwinds and substantial risks" resulting from a slowdown in emerging economies, there has been limited evidence of a "reinvigoration of investment". This suggests that the appetite to make more risky investments has once again increased after some initial positive signs of reversal in 2013 and 2014.

- A lack of viable business models to scale up project activity limits activity - smaller-scale projects require suitable investment vehicles, such as collective debt instruments, to aggregate projects and provide a viable financial stream. This is akin to the role played by Energy Service Companies (ESCOs) for energy efficiency investments, but it is not necessarily an area for local banks. The challenge is that a small SET FOAK demonstrator may require multiple projects to be deployed to make a business model viable. Therefore the ability to package small projects requires a degree of homogeneity and demonstrable rates of return which can be used in turn to raise either debt finance through traditional financial institution routes or potentially equity through more novel routes (e.g. public equity subscription through crowdfunding).
- Risk aversion related to some technologies, notably bioenergy, is strongly influenced by the volatility and lack of transparency concerning resource prices, as well as by policy uncertainty.
- The relative immaturity of the low carbon energy market compared to other sectors makes investments in less risky technologies preferable since investors might require the same expected revenues and level of accepted risks.

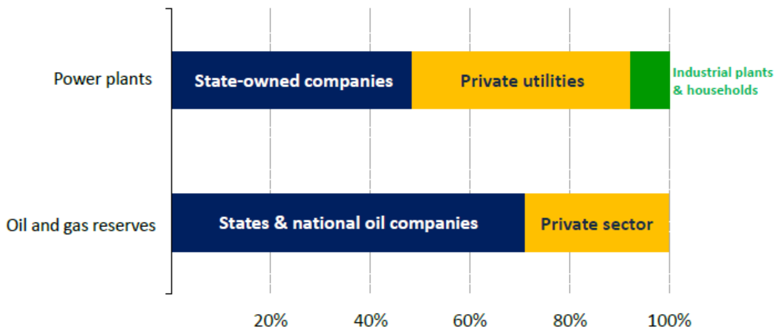
[157] European Commission (2016) European Economic forecast – winter 2016, European Economy 20/ February 2016, DG ECFIN. See http://ec.europa.eu/economy_finance/publications/eeip/pdf/ip020_en.pdf

- High risk is not compensated by sufficiently high revenues. This is a key reason why equity investors are less interested in low carbon energy projects as many such projects offer returns on investment which are below their required rates.
- Future returns from R&I are hard to capture due to uncertain economic prospects.[158]
- SET projects fall outside the comfort zone of investors - first-of-a-kind demonstrators are potentially too capital intensive for venture capitalists and too risky for private equity financing. Additionally, the lack of historical performance data prevents the insurance industry from developing products to de-risk such investments (JRC, 2013).

A1.3 Political and regulatory risks play an important role in driving investment decisions

- Policy uncertainty greatly influences the viability of projects, increasing project risk (due to the difficulty in calculating the return on investment) and hindering or changing investment decisions. Decisions to commit capital to the energy sector by private investors are shaped to a great extent by government incentives and policy measures, rather than by market signals[159]. Stable renewable energy and related energy policy is essential to encourage private sector investment for the deployment and market replication of low carbon energy technologies. Such policy needs to provide a sufficiently robust cash flow and guaranteed access to market. Rigorous implementation of the Renewable Energy Directive for example, together with clarity on longer term policy is essential to ensure necessary investments are made[160].
- Unstable regulatory structures in some Member States hinder investments. Political uncertainty, exacerbated by retroactive changes to feed in tariffs for renewables in several Member States, has harmed the development of projects (for example, solar photovoltaics, CSP and onshore wind projects in Spain), since investors are unsure of the return on their investment.
- Government control over energy sector investment in many countries increases the relevance of government policy to investment decisions. Governments own nearly half of the world's power generation capacity via state-owned companies (see Figure A1.2 below). This not only reinforces the potential issue that awareness of political and regulatory risks are foremost in investor minds; it also means that the financing of state-owned companies, and their corporate culture, is an important consideration for the deployment of new low carbon innovations.

Figure A1.2 Ownership of global power generation capacity & oil and gas reserves



Source: OECD/IEA 2014[161]

[158] IEA-RETD (2014)

[159] World Energy Investment Outlook, Special report, Edition 2014: http://www.iea.org/publications/freepublications/publication/name,86205,en.html

[160] COM (2012) 0271 A major player in the European energy market

[161] From presentation by Dr Fatih Birol "The Outlook for Global Energy Investment" presented at launch of IEA WEO Special Report "World Energy Investment Outlook", 17 June 2014. See http://www.worldenergyoutlook.org/pressmedia/recentpresentations/WEIO_Final.pdf

- The low price of carbon has increased the relative cost of renewable technologies compared to conventional fossil fuel sources, weakening the viability of SET projects (JRC, 2013).
- Perverse policy incentives such as fossil fuel subsidies distort markets and play a critical role in inhibiting investment in low carbon technologies, an issue repeatedly highlighted by the IEA to support global fossil-fuel subsidy reform[162].
- Poorly designed support programmes can create additional policy barriers. For example, if support programmes omit certain key component technologies or conditional funding may prove to be a barrier to the development of a project. Some public support schemes impose conditions which are difficult to fulfil - such as the date of project delivery - which could inhibit the development of some first-of-a-kind projects. Box A1.1 illustrates such an example in the UK for a tidal energy project.

Box A1.1 UK tidal energy project suspended due to rigidity of restrictions and conditions applied to state funded support

Project name: Skerries project
Location: Anglesey, North Wales, UK

In September 2014, Marine Current Turbines (MCT), a Siemens-owned tidal energy company at the forefront of the offshore tidal energy sector's attempt to reach full commercialisation, announced it had suspended development of a 10 MW tidal array project off the North Wales coastline. The move followed a decision by the UK government to withdraw a £10 million grant, under the Marine Energy Array Demonstration (MEAD) Fund. The UK government retracted the funding after the project was delayed beyond their agreed deadlines. MCT claimed that while the project had been making progress, the company was unable to start generating electricity by 2016 – a hard deadline and a pre-condition for grant funding. Siemens subsequently sold MCT to Atlantis Resources in 2015, retaining a 10% ownership in the holding company.

Source: Renewable energy world.com http://www.renewableenergyworld.com/rea/news/article/2014/09/siemens-tidal-energy-project-suspended?cmpid=WNL-Friday-September12-2014; *Utility week* http://www.utilityweek.co.uk/news/tidal-project-loses-10m-government-grant/1022692#.VBLXVLE1g5h

[162] http://www.iea.org/publications/worldenergyoutlook/resources/energysubsidies/

A1.4 Knowledge, information and skills barriers

Barriers associated with information asymmetries, combined with knowledge and skills deficiencies, affect different stakeholders in the energy and finance sectors, from technology companies, end-users, investors, intermediaries and government. A range of information, knowledge and skills barriers cover:

- Technology and innovation providers lack commercial / business awareness including limited knowledge of markets and potential customers. In addition, a lack of organisational skills and resources can limit the growth of companies that will bring innovative technologies and products/processes to market.
- Lack of awareness of leading edge techniques/processes amongst both investors and buyers/end users (e.g. local authorities, companies, householders). The extent to which (access to) specific skills on low carbon technologies are available among both financial investors and companies implementing and using new technologies and solutions.
- Lack of tools for facilitating uptake and integration of renewables into the energy system – including poor assessment criteria and skills as well as inadequately prepared renewable energy resource maps;
- Technology investors are unwilling to invest into a specific sector due to the perceived risks of a future market[163] - this is especially true where the market is driven (at least initially) by government policy and regulation.
- The inability of institutional investors to properly assess risk (such as technical performance, market, regulatory framework, etc.) makes it difficult for them to provide funding into this area. Structuring first-of-a-kind projects as corporate loans or through project finance requires a huge amount of product knowledge and expertise to correctly assess the risk associated with the project. There are potential risks associated with the construction of the project, *'the project's delivery methods, the capacity of contractors and the manner in which the project's contractual documentation distributes risk between suppliers and contractors'* (JRC, 2013).
- Imbalance of skills and expertise amongst co-investors impacts investment decisions. While larger financial institutions have specialist units focused on the energy sector, the ability of smaller financial entities to have similar knowledge and experience can affect levels of co-investment or finance into projects.
- Fragmentation amongst new players in emerging sectors may prevent complementary working from occurring (which could generate cost savings)[164]. The offshore wind supply chain is a good example of a nascent sector which is only just starting to collaborate and reduce costs.
- Difficulties of forecasting future biowaste generation and its localisation (particularly in light of increased competition for solid resources) is a key barrier as it influences the ability to estimate and guarantee revenue streams that will service debt provided by banks, thus causing higher debt costs.
- Lack of experience in assessing permits for demonstration projects. First-of-a-kind projects face delays and misunderstandings due to unavoidable lack of experience in permitting authorities to assess applications from such schemes. Excellent communication skills, open-mindedness and an ability to openly trade off current and future risks and benefits are needed to ensure that permitting guidelines are developed and decisions undertaken using objective criteria.
- Lack of operational and maintenance experience at large scale. First-of-a-kind projects inevitably involve operating at a scale that has not previously been experienced. The

---

[163] IEA-RETD (2014), Accelerating the commercialisation of emerging renewable energy technologies (RE-InnovationChain), [Murphy,B., T.Jennings et al.; The Carbon Trust/Element Energy] IEA Implementing Agreement EA Implementing Agreement for Renewable Energy Technology Deployment (IEA for Renewable Energy Technology Deployment (IEA - RETD), Utrecht, 2014. Available from: http://iea-retd.org/wp-content/uploads/2014/09/RE-InnovationChain-Final-Report.pdf

[164] IEA-RETD (2014)

operating and maintenance challenges can often be predicted but, as with most large projects, experience will throw up new information (and solutions).

A1.5 Technology barriers

A1.5.1 Generic technology barriers

- Technology unproven at commercial scale, so significant risk of technical failure. As with operating and maintenance, FOAK projects involve operating at a scale at which the technology under test has yet to be demonstrated. As such, the risk of technical failure is higher than for proven technologies.
- Nascent or disconnected supply chains - the supply chain not fully engaging with innovators may mean that the development of some key components is not aligned with the needs of novel low carbon energy technologies.[165]
- Incremental changes (using incumbent and less resource efficient technologies) are often favoured over radical changes, particularly where low or no cost opportunities are present. This is often the case for manufacturing facilities where there are large operational risks from larger step changes covering for example new organisational models or radical process redesign (e.g. a shift from end of pipe to integrated/cleaner production methods). Risk of technological failure could jeopardise a site's operation indefinitely.
- Long operational time without technical problems is required before investors will commit - although first-of-a-kind technologies are largely proven in a technical perspective, there is a need to make iterative improvements to technologies prior to mass deployment as well as 'clocking up' significant operational hours to demonstrate their operational longevity. Investors also require certainty that the project will work on a large scale, therefore, the technology needs to be sufficiently developed and redeveloped to ensure viability and reduce risks for investors.

A1.5.2 Specific barriers and market failures affecting energy infrastructure and smart grids

A number of market failures cover energy infrastructure, the largest of which is high initial cost. The more users that become involved in the network, the greater the benefit to all users because of the limited marginal costs of additional users. Thus, network costs will invariably fall with increased demand. A good illustration of this is the development of electric vehicle charging points and electric vehicle users in cities. Here there is a mismatch between financial market risk-return requirement and the scale of the required project. The risk revolves around who will bear the initial costs of new infrastructure in the face of uncertain demand.

The development of smart grids and meters for example, also challenges incumbent network operators and existing assets, although the same operators may perceive significant benefits in the longer term from new mechanisms to understand demand more intelligently which in turn can lead to more sophisticated business models and service offers to customers. Demand response is a good example of how the energy sector can use new infrastructure to avoid new capacity whilst creating network efficiencies.

Infrastructure market failures may exist for some critical elements that will be necessary to fully prove SET innovations, for example in the CCS sector. Here, the infrastructure market failures concern the necessary pipelines to transport carbon dioxide. This will require large investment unless existing assets (e.g. gas or oil pipelines) can be converted. The involvement of grid operators in FOAK demonstrator project funding is therefore important.

Whilst commitment to such investment is beyond the capacity of single organisations[166], mechanisms such as the Connecting Europe Facility (CEF) will help to overcome some of this infrastructure market failure. CEF involves investment in EU networks covering

---

[165] IEA-RETD (2014)

[166] IEA-RETD (2014)

transport, energy (although not energy production) and digital. Of the €29bn, most is grant-based however 10% is potentially available through financial instruments with equity and debt instruments now being considered (see Box A1.2 below).

Box A1.2 Financial instruments under the Connecting Europe Facility

Connecting Europe Facility (CEF) (2014-2020), established by Regulation 1316/2013[167], aims to invest in trans-European networks covering transport, energy (although not energy production) and telecommunications. In the energy sector, it covers electricity interconnections and grids (e.g. for offshore wind in the North Sea), oil and gas corridors as well as enabling smart grid deployment[168]. The initial total budget for the CEF, of €33.2 billion, was reduced to €30.4 billion; 2.8 billion being re-allocated to the newly established European Fund for Strategic Investments (EFSI). The revised budgetary share allocated to the energy sector is €5.4 billion[169].

To be eligible for funding under the CEF (be it for the grants and/or the financial instruments), the projects must meet the requirements set out in the CEF regulation and in the sector-specific guidelines (see regulation 347/2013 for the energy sector) and be included in the list of priority investments called 'Projects of Common Interest' (PCIs). Projects need to be submitted by Member States directly or by other stakeholders (e.g. public or private undertakings, joint undertakings, and international organisations) with the agreement of Member States. The initial list of 248 PCIs in the energy sector was adopted on 14 October 2013. The list will next be updated in 2017[170].

Support from the CEF comes under two possible forms – grants and/or financial instruments and can finance both studies and works. Most of the support under CEF is grant-based and projects are selected, among the list of PCIs, through calls for proposals. In the energy sector, three calls were issued by end 2015 for a total value of €1.4 billion; and 51 projects selected[171].

However, up to 10% of CEF funding[172] is potentially available through financial instruments. The rationale to use financial instruments under the CEF is to leverage EU funding and facilitate access to project and corporate financing for key infrastructure projects in another manner. Support from the financial instruments can come in complement to the grant support. The CEF regulation envisages two types of instruments: a debt instrument and an equity instrument[173].

The implementation status of the CEF financial instruments, which are forecast to have €580 million allocated from the energy sector CEF budget to them over the period, it (i.e. about 10%)[174], is outlined in the debt and equity instrument summary below:

Debt instrument

- Ex-ante assessment on use of financial instruments under CEF[175] presented to the CEF Coordination Committee in July 2014.
- CEF Debt instrument subsequently established with contributions from the three CEF sectors.
- Managed through indirect management and, as per the Delegation Agreement signed on 22 July 2015, the EIB is the entrusted entity.
- Total contributions to the debt instrument (from 2014 and 2015 work programmes) are €247 million, including €89 million for the energy sector. This represents 6% of the energy sector's grant value for the same years.

[167] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R1316&from=EN

[168] http://ec.europa.eu/energy/mff/facility/doc/2012/connecting-europe.pdf

[169] European Parliament (2016) Assessment of Connecting Europe Facility. Available at: http://www.europarl.europa.eu/RegData/etudes/IDAN/2016/572677/IPOL_IDA(2016)572677_EN.pdf

170 https://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest

[171] European Parliament (2016) Assessment of Connecting Europe Facility. Op.Cit.

[172] Article 14, paragraph 2 of the CEF regulation

[173] Article 14, paragraph 4 of the CEF regulation

[174] European Commission (2015) Commission Implementing Decision of 10.12.2015 establishing an Annual Work Programme 2015 for a contribution to financial instruments under the Connecting Europe Facility (CEF), C(2015) 8847 final and its annex available at: http://ec.europa.eu/transport/themes/infrastructure/reference-documents/docs/awp-cef-2015/c-2015-8847-awp-2015-annex.pdf

[175] European Commission (2014) Ex-Ante Assessment on the Potential Use of Financial Instruments within the Connecting Europe Facility. Final version (29 August 2014)

– Tools available under the debt instrument include[176]:

  - For project finance: Credit Enhancement of Project Bond, Credit enhancement of Bank Loans (subordinated or as a guarantee)
  - For corporates: Senior/Subordinated loans or Guarantees

– The EIB is currently developing its pipeline of projects, the aim being to identify projects in each Member State. As of March 2015, the number of projects in the energy sector pipeline was 28. Financing of all these projects under CEF (some of them are still in their early stages) would require a contribution by the CEF Debt instrument of €477 million (for a capex of €12.1 billion). The estimated leverage would be superior to 25[177].

– It is foreseen that the CEF Debt instrument will support its first projects in the first half of 2016.

Equity instrument

– Ex-ante assessment on the use of an Equity fund under CEF (an addendum to the more generic 2014 ex-ante assessment) presented to the CEF Coordination Committee in November 2015.

– The rationale to explore further the possibility of using an equity instrument was the increased availability of debt funding thanks to EFSI. This made a case to use equity to invest in smaller and more risky projects.

– However, it is envisaged that the main delivery mechanism for the financial instruments under CEF will remain the debt instrument especially in the energy and transport sector. The Equity fund would only be used as a last resort option.

– In the telecommunications sector, a contribution of €10 million was made in 2015 to establish a broadband fund. It is envisaged it will be implemented through direct management.

– The CEF Equity fund has not yet received contributions for the energy (and transport) sectors. It may however be used to finance PCIs in these sectors in the future. In particular, in the energy sector, it may be used to avoid major delays in the construction of PCIs.

[176] EIB (2015) EIB’s Debt Financial Instruments under the Connecting Europe Facility. Presentation for the 2015 CEF Energy Info Day, 16 March 2015. Available at: https://ec.europa.eu/inea/sites/inea/files/download/events/2015/CEF_energy_march/4eib.pdf

[177] EIB (2015) CEF Energy Info Day. Op. Cit.

Annex 2 EC policy context impacting on the FOAK funding landscape

A2.1 SET-Plan

First, the Strategic Energy Technology Plan (SET-Plan) establishes an energy technology policy for Europe that aims to support the development and deployment of more efficient and cost-effective energy technologies. Adopted by the European Union in 2008, its main objectives are to accelerate knowledge development, technology transfer and up-take, as well as promoting EU industrial leadership on low-carbon energy technologies in order to achieve the 2020 Climate and Energy Package goals. The plan comprises measures related to planning, implementation, resources and international cooperation in the field of energy technologies.

To address the gaps in the financing of demonstration, deployment and market take up of emerging low carbon energy technologies in relation to the SET-Plan requires at least around €60 billion in technology development over the period 2010-2020 across various technology research and innovation (R&I) areas including bioenergy (€9 billion); solar PV and concentrating solar power (€16 billion), wind (€6 billion), CCS (€13 billion), the electricity grid (€2 billion) and fuel cells and hydrogen (€1 billion). These investments should be shared between industry, the Member States and the European Commission[178]; they also cover the complete set of TRLs, not just at the FOAK stage (i.e. TRL 7-8).

The EC published in May 2013 a Communication on Energy Technologies and Innovation[179] in which it proposed the development of an Integrated Roadmap for the SET Plan in order to define priorities for the next six years across the entire energy system through one consistent agenda at EU level from research to market uptake by 2020, 2030 and beyond. A key objective of the Roadmap is to help provide more certainty to private investors in energy research and innovation[180].

A2.2 European policy context up to 2020

The EU climate targets for 2020, known as the '20-20-20 targets' were set by EU leaders in 2007. They comprise a 20% reduction of GHG emissions in 2020 compared to 1990, a 20% share of renewable energy in EU energy consumption in 2020 and a 20% improvement of energy efficiency.

In order to meet the targets, a set of EU policy measures have been introduced: the climate and energy package. This package of policies comprises:

- Renewable Energy Directive (2009/28/EC) – "the RED". This Directive includes national targets for renewable energy and requires Member States (MSs) to ensure either priority or guaranteed access to the grid for electricity produced from renewables grid access for renewable energy. In addition, transmission system operators (TSOs) should give priority to renewable generating installations when dispatching electricity. The RED requires that each Member State submits a National Renewable Energy Action Plan (NREAP) to the European Commission. In the NREAPs, Member States set out the sectoral targets, the technology mix they expect to use and the trajectory they will follow to meet the targets. NREAPs are therefore a key driver for European SET deployment;
- Reform of the EU Emissions Trading System (EU ETS). This reform includes a single EU-wide cap on emission allowances (instead of national caps). Industries at risk of carbon leakage will also continue to receive free allocations;

[178] JRC, 2013. Joint Research Centre Scientific and Policy Reports R & D Investment in the Technologies of the European Strategic Energy Technology Plan. Brussels, 2.5.2013 SWD(2013) 157 final. Available at: http://ec.europa.eu/energy/technology/strategy/doc/swf_2013_0157_en.pdf

[179] http://ec.europa.eu/energy/technology/strategy/doc/comm_2013_0253_en.pdf

[180] See http://setis.ec.europa.eu/set-plan-implementation/integrated-roadmap

- National targets for non EU-ETS emissions - covering the period 2013-2020 - are based on the principle of solidarity and range from a 20% emissions reduction (compared to 2005) to a 20% increase depending on Member State characteristics;
- A legal framework for carbon capture and storage (2009/31/EC). The so-called CCS Directive aims to ensure environmentally safe geological storage of CO_2.

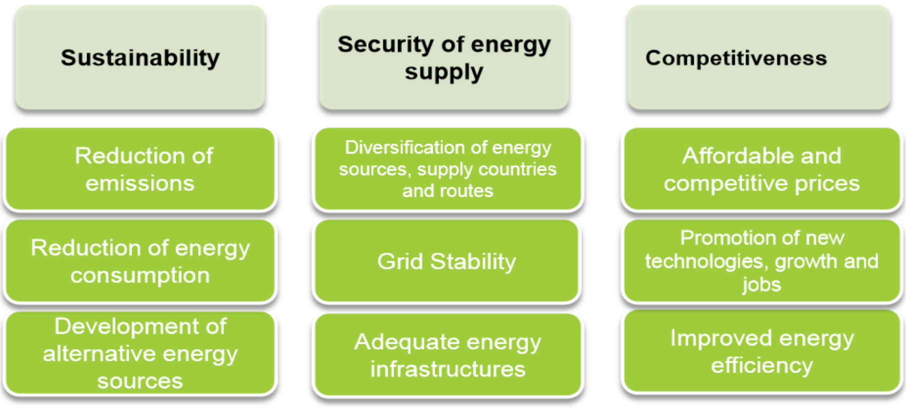
The 2030 Climate and Energy Framework should help provide certainty to investors, stimulating innovation and growth in deployment of low carbon energy technologies

In January 2014 the Commission proposed an ambitious 2030 Framework for Climate and Energy Policies ("2030 Framework")[181]. It builds on the experience of the 2020 climate and energy framework. It also takes into account the longer term perspective set out by the Commission in 2011 in the Roadmap for moving to a competitive low carbon economy in 2050 and the Energy Roadmap 2050. These documents reflect the EU's goal of reducing greenhouse gas emissions across the EU by 80-95% below 1990 levels by 2050.

EU Heads of State and governments agreed in October 2014 that the Framework would deepen the key elements of the 2020 Package by introducing binding targets for greenhouse gases of at least 40% below the 1990 level by 2030[182] and a 27% binding target for renewables by 2030, together with an indicative (non-binding) energy efficiency target of 27%[183]. The new package introduces security of the energy supply as an important consideration as well as a new governance system for Member States. For example, while the 27% renewables target is binding on the EU, it would not be binding on Member States individually. Rather, the EU target would be accomplished by commitments decided by Member States themselves. Member States will need to draw up national plans for competitive, secure and sustainable energy, demonstrating how they will meet the targets which then be reviewed by the EC[184]. In this way, Member States will have flexibility to determine which renewable energy technologies are most cost-effectively deployed in order to fulfil their 2030 targets.

The 2030 framework seeks to achieve three core objectives of sustainability, security of the energy supply and competitiveness (see Figure A2.1).

Figure A2.1 Commission objectives under the 2030 framework for climate and energy



Source: DG ENER, 2013[185]

[181] A policy framework for climate and energy in the period from 2020 to 2030. Brussels, 22.1.2014 COM(2014) 15 final

[182] This target is believed to be in line with the 2050 target and can be achieved in a cost-effective way, if the sectors covered by the EU ETS reduce their emissions by 43% compared to 2005. Emissions from sectors outside the EU ETS would need to be cut by 30% below the 2005 level.

[183] Contrary to a binding target of 30% which was demanded by several Member States, industry and the European Commission (following its review of the Energy Efficiency Directive) (http://ec.europa.eu/clima/news/articles/news_2014111202_en.htm)

[184] If plans were judged insufficient an 'iterative process' would take place to reinforce the content of respective MS plans.

[185] http://ec.europa.eu/energy/nuclear/forum/meetings/doc/2013_05_30/day1/mr_faross_green_paper_energy_2030_enef_2013.pdf

There are several potential outcomes from the 2030 Framework. First, it will ensure regulatory certainty and stability for investors and a coordinated approach among Member States which will help to unlock investment into new low carbon technologies; second, it seeks to improve the security of the EU's energy supplies and help reduce its dependency on imported fossil fuels whilst ensuring costs to consumers remain competitive; and, finally, it has helped the European Union to argue for a stronger agreement at the UN Convention on Climate Change in Paris in 2015 (COP21). The benefits from this policy position stance are clear: the EU can help to drive global action more rapidly; and strong domestic targets can also drive both European and foreign direct investment in the EU into low carbon intellectual property development, new company formation, manufacturing, and the installation of more energy efficient products. Potential economic benefits include job creation[186] and global export opportunities.

A2.3 Horizon 2020 and Access to Risk Finance

The EU provides large levels of investment into RDI for low carbon energy technologies to create future technology options and to help lower the risk profile of new technologies. Strong EU public funding support for RDI into low carbon energy technologies still exists, driven by the European SET-Plan, and the EU remains one of the most innovative global regions for low carbon energy technologies.

Under Horizon 2020, for example, around 7.7% (€5.9bn) of the total budget of nearly €80bn is allocated to activities in the category 'secure, clean and efficient energy' (including low carbon technologies falling under the SET-Plan).

Although the majority of that funding will be grant based, the new debt and equity windows under Horizon 2020 are an important mechanism for helping to drive and lever further private investment into the RDI space for low carbon energy technologies. Table A2.1 shows the budget designated to risk finance under H2020 for the period 2014 to 2017.

Table A2.1 Budget for financial instruments under Access to Risk Finance, Horizon 2020

Budget (EUR Million)	2014	2015	2016	2017
Financial Instruments	650.12	416.65	325.00	397.50

Sources: Access to Risk Finance, Revised Work Programme 2014 – 2015, July 2014, http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-finance_en.pdf ; Access to Risk Finance, Revised Work Programme 2016 – 2017, March 2016, http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-finance_en.pdf

The InnovFin package of support is geared up for supporting SMEs and larger companies in their pursuit of RDI. However, there is a need to increase the levels of support to SET FOAK projects using equity because there is currently insufficient equity going into projects to enable debt to be used. The equity fund would therefore complement other provision to FOAK projects, notably through an enlarged EDP facility.

A2.4 European Fund for Strategic Investments (EFSI)

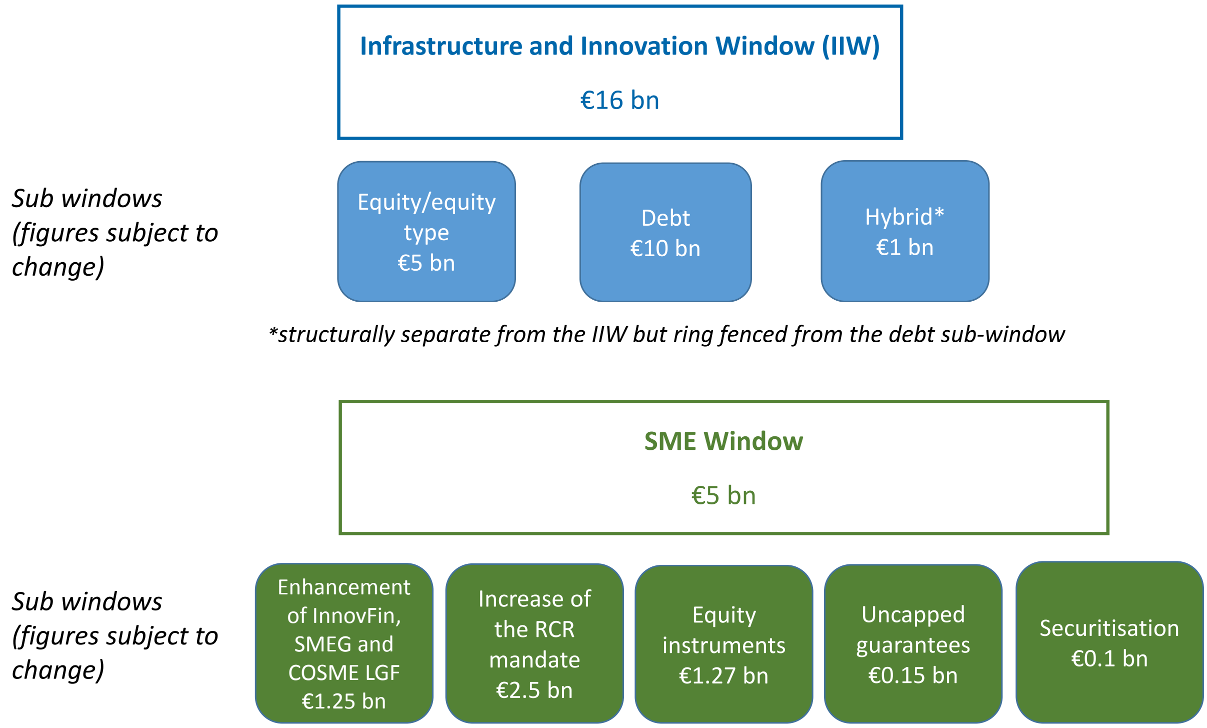
The Investment Plan for Europe, introduced by the EC and EIB in order to help overcome the current investment gap across the European economy, seeks to mobilise private financing for strategic investments. By targeting strategic and economically viable projects, EFSI seeks to stimulate economic growth and create jobs and sustained benefits for the EU. The objective is to use EC money, in the form of loans, loan guarantees and equity, to

[186] ICF in association with Cambridge Econometrics, BIO-IS, Naider and Visionary Analytics, provided a sector analysis of employment impacts of climate mitigation policy. The study involved a qualitative assessment of employment policy options to support the low carbon transition through in-depth case stud analysis. The analysis feeds into the Impact Assessment of the 2030 Climate and Energy policy framework. "*Empirical Evidence on Employment Impacts of Climate Policies*", European Commission DG CLIMA, 2013

leverage private and public money (e.g. through national investment banks in Member States) of at least €315bn over the three years to 2018.

EFSI will focus on sectors of key importance to the EU economy and areas in which the EIB already has a track record and expertise, for example in RDI, strategic infrastructure (covering, for example, energy and transport), and the expansion of renewable energy and resource efficiency projects. EFSI will provide creditor protection or a guarantee to support both long-term investments through "windows" covering 'Infrastructure and Innovation' and investments by SMEs and mid-cap firms ('SME Window') - see Figure A2.2 below.

Figure A2.2 Overview of the two Windows within the European Fund for Strategic Investments



Source: ICF based on EFSI Steering Board, EFSI Strategic Orientation, December 2015[187]

To date, EFSI's portfolio of "investments" into SET (non-FOAK) projects (including research facilities) is too small to draw any real conclusions, other than to observe that there is potential for crowding out of private finance. For example, the significant recent financing of Nobelwind in Belgium by EIB covers an offshore wind farm deploying standard 3MW turbines which are now proven and carry limited commercial risk (see Box A2.1).

[187] Available at: http://www.eib.org/attachments/strategies/efsi_steering_board_efsi_strategic_orientation_en.pdf

Box A2.1 Examples of SET 'non-FOAK' projects supported by EIB/EFSI in 2015

- Nobelwind NV offshore wind farm (aka Belwind 2) in Belgium, received a €250m loan from EIB (a "large portion" of which will be proposed for EFSI backing) into the SPV which is completely separate from Belwind NV and "created to isolate the development risk of Belwind 2". EIB funding represents around 38% of the total cost of €655m for constructing the 165MW project which reached financial close in October 2015 and is due for construction in April 2016[188,189,190].
- Abengoa's RDI II project in Spain, which is focused on advanced biotechnology / chemical processes for advanced biorefineries, advanced power systems and renewable energy, received a loan from EIB in July 2015 for €125m or 37% of the total financing costs of €340m, of which €50m was put forward to EFSI for backing with the balance (up to €75m) supported by "InnovFin – EU Finance for Innovators". Support of €30m from Spain's Instituto de Credito Oficial was also explored[191].

Under EFSI, a new form of investment approach, termed 'Investment Platforms', has been developed to support final beneficiaries. The rationale to establish such Platforms is to:

- raise the profile of particular sectors / territories among potential investors;
- create strong project pipelines in strategic sectors / territories;
- bring in the necessary geographical / thematic expertise necessary to make informed investment decisions in specific areas;
- alleviate the constraints linked to the lack of coordination on infrastructure development (which can in some cases, e.g. grid planning, lead to significantly increased project costs;
- mitigate the transaction costs associated with information sharing between financiers and project promoters;
- spread the risk of individual projects among financiers;
- adopt a long-term view on the returns of their investments, which could attract institutional investors such as insurance companies and pension funds; and,
- through all of the above, increase the opportunities for secondary market activity and thereby enhance the liquidity of investments in the sector.

Box A2.2 provides more information on the Platforms which can be organised on a geographical or thematic basis.[192]

Box A2.2 ESFI Investment Platforms

EFSI Investment Platforms are entities (with or without legal form) which invest, directly or via financial intermediaries, in a group of investment projects which are 'bundled'. A platform can take various forms such as a:

- Thematic investment fund (mono-sector platforms or multi-sector focus);
- Geographic investment fund (region or group of Member States); or
- Co-financing agreement with the EIB, whereby platform stakeholders (i.e. investors) commit, with appropriate risk-sharing provisions, to co-invest with EIB for certain types of its operations under EFSI.

[188] http://www.eib.org/infocentre/press/releases/all/2015/2015-236-eib-support-for-wind-farm-off-belgian-coast.htm
[189] http://www.4coffshore.com/windfarms/windfarms.aspx?windfarmId=BE08
[190] http://nobelwind.eu/
[191] http://www.eib.org/projects/pipeline/2014/20140587.htm & http://www.eib.org/infocentre/press/releases/all/2015/2015-153-el-bei-firma-el-primer-prestamo-bajo-el-fondo-europeo-de-inversiones-estrategicas-en-espana-en-apoyo-de-las-actividades-de-idi-de-abengoa.htm
[192] As per paragraph 4, Article 2, of the EFSI Regulation

The Investment platform then provides equity and/or debt financing to the companies or projects falling under its geographic or thematic scope. A key requirement of a platform is attract other investors beyond EFSI. Each platform will need to have its own sponsor such as a National Promotional Bank, government agency, Sovereign Wealth Fund, private investor or an individual company.

Besides bringing part of the funding, the sponsor will be responsible for establishing the platform and defining the:

- investment needs
- sectoral and geographical focus
- business case
- sources of funding
- risk-sharing agreements
- decision-making rules.

The European Investment Advisory Hub (EIAH) will provide advisory and technical assistance services during this process.

Annex 3 Overview of European exemplar SET FOAK projects

Table A3.1 consolidates by SET sector the (commercially sensitive) information received regarding the 35 exemplar projects from their sponsors via an e-survey.

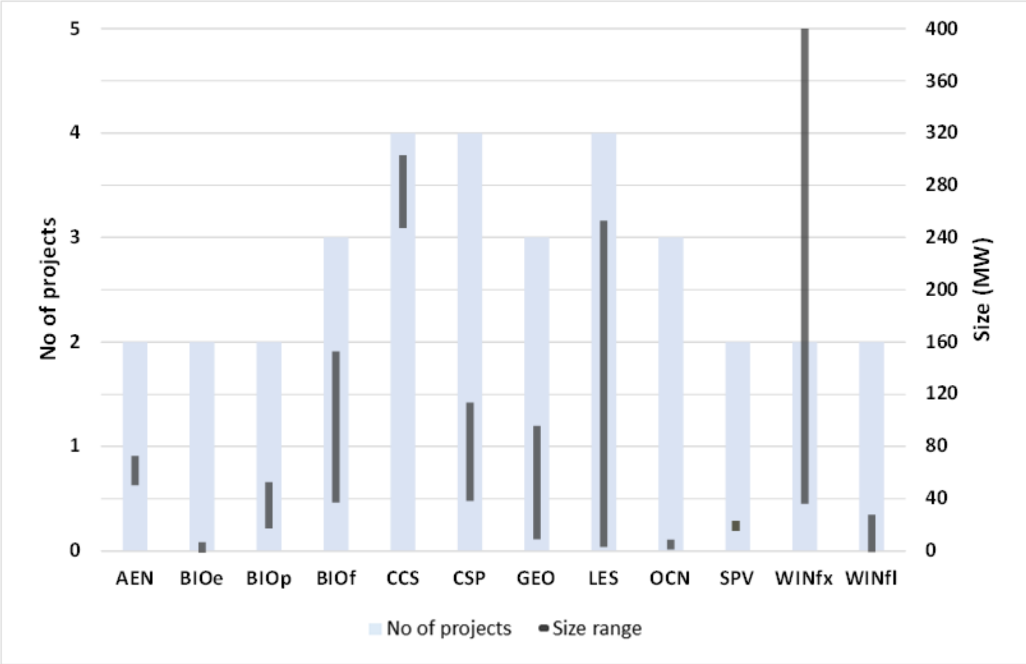
Table A3.1 Summary of FOAK projects received via project sponsor e-survey responses

SET sector	No. shortlisted projects	Typical size of developer	Size range	Total cost range	Range in Cost per MW	Range in overall risk values	Risk categories with highest values
AEN	2	No typical size	53-70 MW	€30m – €41m	€0.57m per MW – €0.58m per MW	1.75 – 2	Org risk, Tech risk, Market/ policy risk
BIO	7	< 250 employees	Diverse*	€8m – €300m	Diverse*	0.75 – 2.25	Tech risk, Market/ policy risk
CCS	4	> 1000 employees	250-300 MW	€500m – €1400m	€2m per MW – €4.24m per MW	1.75 – 4	Market/ policy risk, Env. reg. risk, Tech risk
CSP	4	< 250 employees	41-111 MW	€185m – €330m	€3.0m per MW – €4.9m per MW	2 – 3	Market/ policy risk, Org risk, Tech risk
GEO	3	< 250 employees	12-93 MW	€75m – €117m	€2.2m per MW – €9.8m per MW (heat & power combined)	2.75 – 3.25	Tech risk, Operations risk
LES	4	> 1000 employees	6 – 250 MW	€16m – €350m	€1.3m per MW – €2.8m per MW	1.25 – 3.5	Tech risk, Market/policy risk
OCN	4	< 250 employees	4 – 320 MW	€20m – €1000m	€3.1m per MW – €10m per MW	2.75 – 3.75	Tech risk, C&C risk, Ops risk
SPV	3	< 250 employees	Diverse*	€38m – €50m	Diverse*	2.25 – 2.75	Org risk, Tech risk, Market/ policy risk
WIN	4	< 250 employees	2 – 400 MW	€54m – €2000m	€1.4m per MW – €10m per MW	2.25 – 3.75	Tech risk, C&C risk

** A size range is less meaningful for biomass conversion projects, owing to the variety of processes and products of the shortlisted projects; the same is true of SPV projects, which include manufacturing projects*

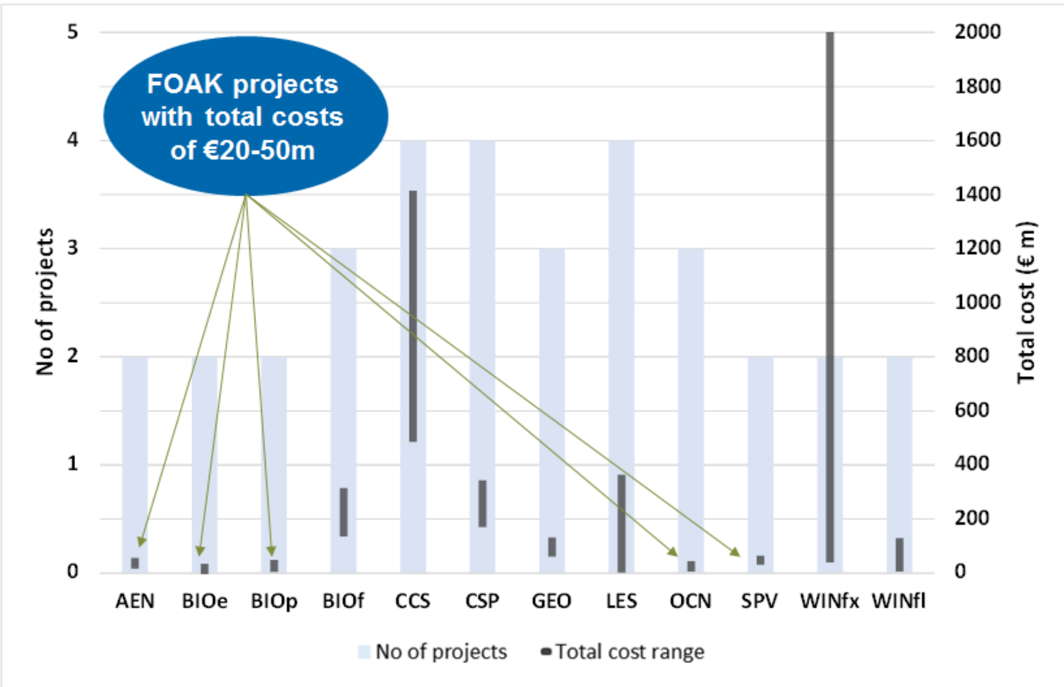
The following diagrams visually represent the majority of the shortlisted projects, consolidated by sector, according to some key metrics: project size (Figure A3.1), total cost (Figure A3.2), cost per MW (Figure A3.3) and overall risk (Figure A3.4).

Figure A3.1 There is greater variability in project size (MWe / Ktpa fuel) in some SET sectors



Source: ICF survey of developers. Note 1: BIOe: bio-energy, BIOp: pyrolysis, BIOf: 2nd generation biofuels, WINfx: fixed, WINfl: floating. Note 2: Size of BIOp and BIOf projects is in kilo tonnes of pyrolysis oil and biofuel respectively

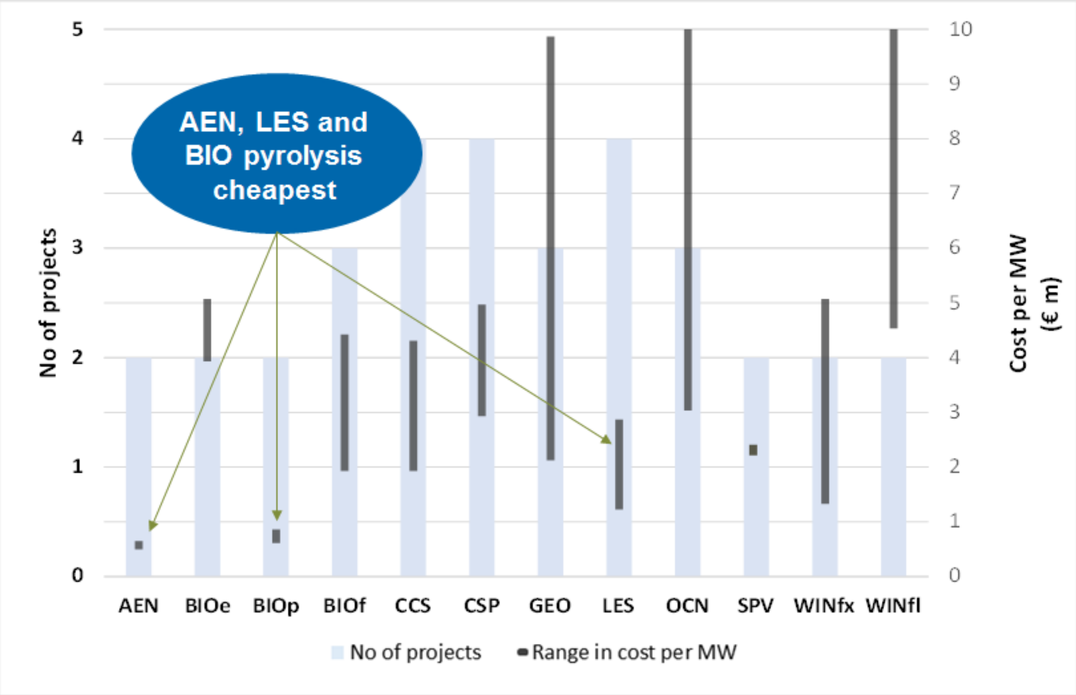
Figure A3.2 Total costs show significant funding requirements for biofuels, CCS, CSP, LES and fixed Wind projects in contrast with other sectors



Source: ICF survey of developers. Note 1: BIOe: bio-energy, BIOp: pyrolysis, BIOf: 2nd generation biofuels, WINfx: fixed, WINfl: floating

Figure A3.3 illustrates the high relative costs of technologies (€10m/MW) with little current capacity (e.g. geothermal) or else very nascent technologies (such as ocean and floating wind). There are a group of technologies all sit between €2m and €5m per MW or per Kt, including 2nd generation biofuels production, CCS and CSP.

Figure A3.3 Geothermal, Ocean & Floating Wind projects represent the highest relative costs at up to €10m per MW (or kilo tonne of pyrolysis oil or biofuel)



Source: ICF survey of developers. Note 1: BIOe: bio-energy, BIOp: pyrolysis, BIOf: 2nd generation biofuels, WINfx: fixed, WINfl: floating. Note 2: The cost of BIOp and BIOf projects is in million EUR per kt of pyrolysis oil and biofuel respectively. Note 3: geothermal projects comprise both power and heat

Figure A3.4 represents the aggregated risk levels across technologies as defined by project sponsors. Risk levels are highest for CCS, Ocean & fixed Wind.

Some anomalies are most likely due to the:

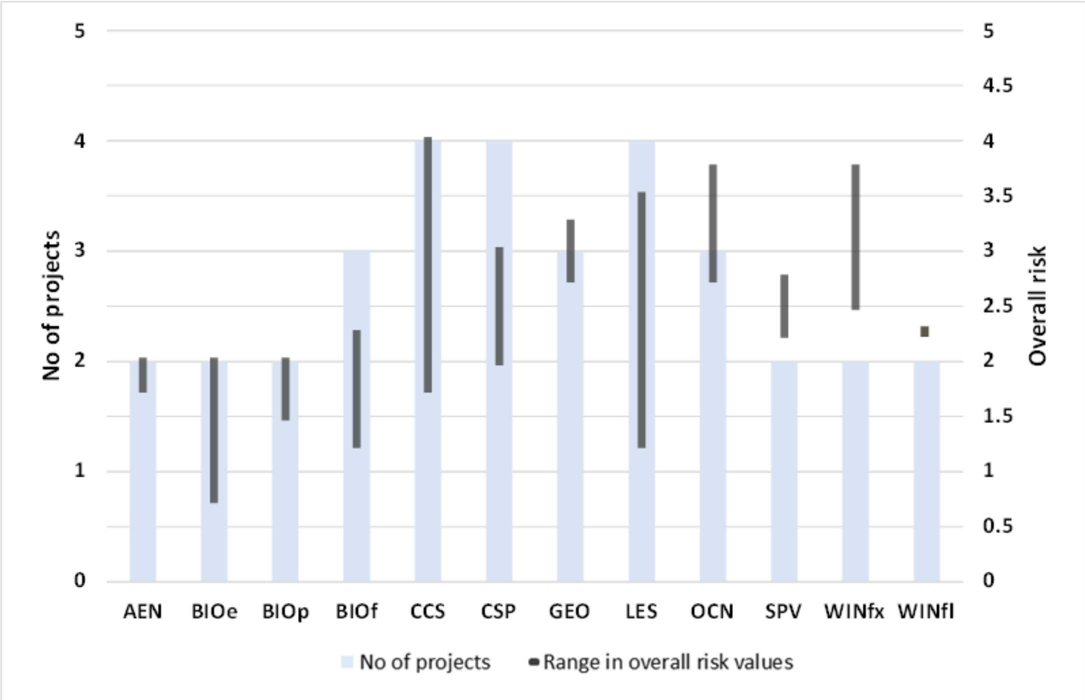
a. small sample size;

b. subjective nature of risk ratings; and,

c. potential for particularly high risk ratings for certain projects which may not be viable.

For example, the high fixed wind risk ratings reflect the scoring from one offshore wind farm using novel turbines, scored alongside an onshore wind farm located in a mountainous region.

Figure A3.4 Risk scores from technology sponsors indicate broad trends across technologies, with the lowest for Bioenergy and highest for CCS, Ocean & fixed Wind



Source: ICF survey of developers. Note 1: BIOe: bio-energy, BIOp: pyrolysis, BIOf: 2nd generation biofuels, WINfx: fixed, WINfl: floating. Note 2: One SPV project omitted as manufacturing focus very diverse; tidal lagoon project omitted from Ocean

Annex 4 Financial structures & market replication potential of SET FOAK projects

A4.1 Overview and approach

This summary presents the main results of ICF's e-survey of European First-of-a-kind (FOAK) project sponsors. This survey was rolled out during the summer of 2015 to over 200 project sponsors, of whom 52 responded.

The analysis is divided into two parts:

(i) Financial structures - This depicts the forecasts of financial needs provided by sponsors; a limited number of projects had reached financial close (where financial structures are confirmed) by the time the survey was conducted. The analysis is based on the information of the 32 project sponsors who provided sufficient breakdown of their financial structures for analysis. These include two from the AEN sector, 6 from BIO, 4 from CSP, 4 from GEO, 1 from LES, 6 from OCN, 3 from PV, and 6 from WIN. There were no applicable responses for CCS.

(ii) Replication potential – This depicts the replication potential as expected by project sponsors, in terms of number of projects, installed capacity and level of sales in the next two and five years. The analysis is based on the information provided by 20 project sponsors who provided some information on their market growth expectations (in terms of either revenue, plant size or both). These include responses from sponsors of 4 BIO projects, 1 CCS project, 1 CSP, 2 GEO, 1 LES, 8 OCN, 2 PV and 1 WIN projects.

These analyses help to illustrate the investment needs and indicative deal structures for SET FOAK projects. They also provide insights into the potential returns that funders might expect to receive.

A4.2 Financial structures

A4.2.1 Investment needs for SET FOAK projects across all sectors

Figure A4.1 depicts the number of SET FOAK projects responding to the survey (for which financial information was disclosed) and respective levels of investment need for these projects per European Member State (and Norway). It should be noted that the high investment needs in Germany relates to one single (offshore) wind project, costing €2 billion. Greece and Estonia occupy, respectively, the second and third place in terms of total investment needs among the 32 SET FOAK projects covered. Total investment needs across 31 of the 32 projects (i.e., excluding the aforementioned German offshore wind project) amounts to €3 billion or an average investment cost per project of €95 million.

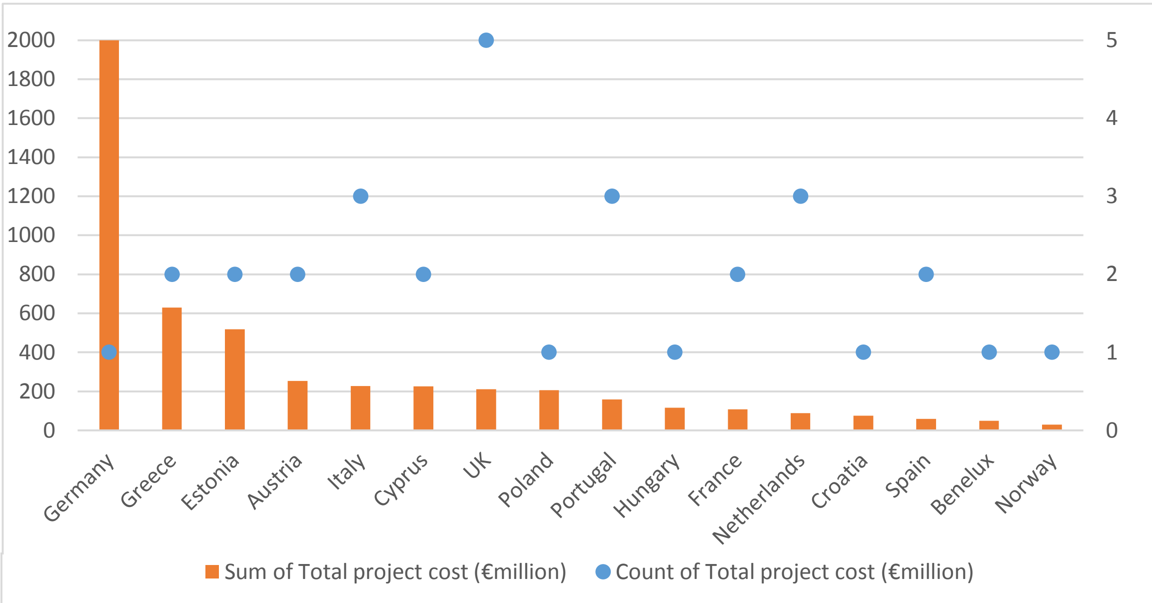


Figure A4.1 Total SET FOAK projects per country and projects' investment cost (n = 32)

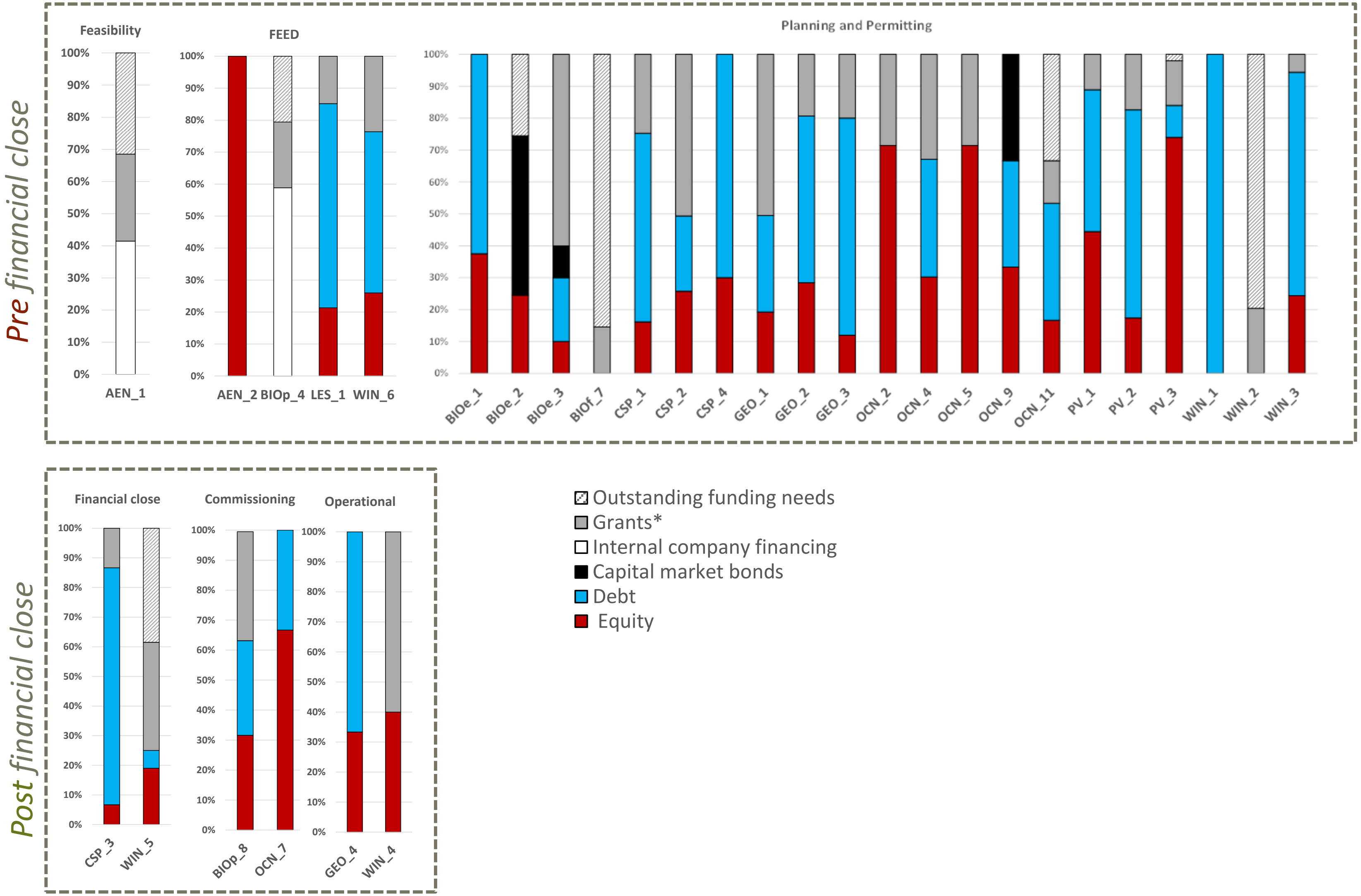
Source: ICF survey of European project sponsors, 2015

Figure A4.2 shows the forecasted financial structure of each project, according to project sponsors. These structures combine resources which have already been obtained, pending resources, and resources to which the project has not applied yet. In several cases, there is an evident outstanding funding requirement which will need to be filled if the project is to progress. It should be noted that the breakdown presented by projects which are in pre-financial close stages has higher uncertainty.

No clear trend in the debt/equity ratios could be identified through SET FOAK project development stages. Rather, a project's SET sector seems to be more of an important determinant to the debt/equity ratio.

Overall grants, across all SET sectors, appear to be a very important component of a project's funding structure. Note that in this report, grant figures combine, where relevant, both EU level and national level institutional support (and are marked with an asterisk to denote this point).

Figure A4.2 Forecasted financial structure of projects, per project development stage

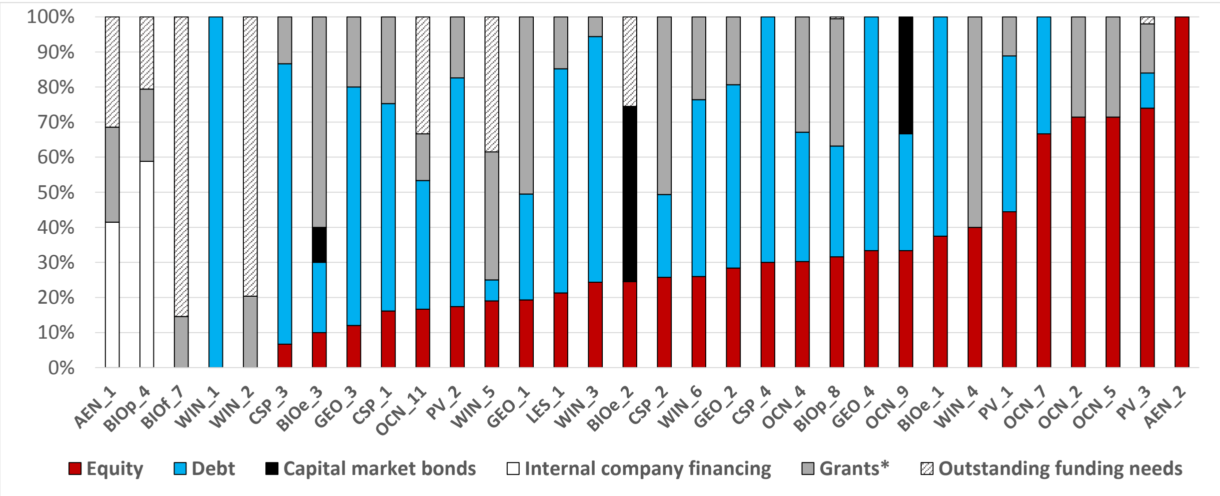


Source: ICF survey of European project sponsors, 2015

0 presents the same information as the Figure A4.2, but organized according to the amount of equity sought or obtained by each project. Financial structures[193] from 32 different sponsors show that:

- grants (i.e. public sector risk capital) play a very important role overall in many SET FOAK deal structures, with projects typically forecasting between 10-30% or much higher amounts in some isolated cases (e.g. for bioenergy, bio-pyrolysis, CSP, geothermal, wind); grants are perceived as particularly important for ocean energy, generally making up the balance with equity and, infrequently, debt;
- equity investment is forecast between 10-30% in many projects, but is particularly high for several solar PV and ocean energy projects while being absent in other projects;
- debt requirements can be very large, varying from 10% of total funding to more than 70%. –Based on sponsor forecasts, the ease with which FOAK projects are perceived to be able to raise debt is highest in the most mature SET sectors, i.e. wind, solar PV and geothermal[194]; although it is also perceived to be possible to raise very high levels of debt for CSP projects – in contrast, two ocean energy projects made no reference to debt;
- bond finance is of limited relevance, being hardly mentioned by sponsors[195], as is true for internal company financing; and,
- outstanding funding needs either indicate shortfalls in funding which may stall a project or else non-disclosure of key aspects of the financial structure (such as expectations of feed-in tariffs).

Figure A4.3 Forecasted financial structure of projects, organised by amount of equity



Source: ICF survey of European project sponsors, 2015

193 Note that the vast majority of projects when consulted had yet to reach 'financial close', i.e. the point at which contracts are signed and the financial structure of the project is confirmed. FOAK project structures should be therefore regarded as indicative and by no means confirmation that it is possible for the sponsor to actually achieve the stated breakdown of debt, equity, etc.

194 Geothermal energy is characterised as mature given that the first commercial geothermal power plant started operation in Italy in 1911, although it is recognised that more innovative geothermal approaches are much less mature in the market

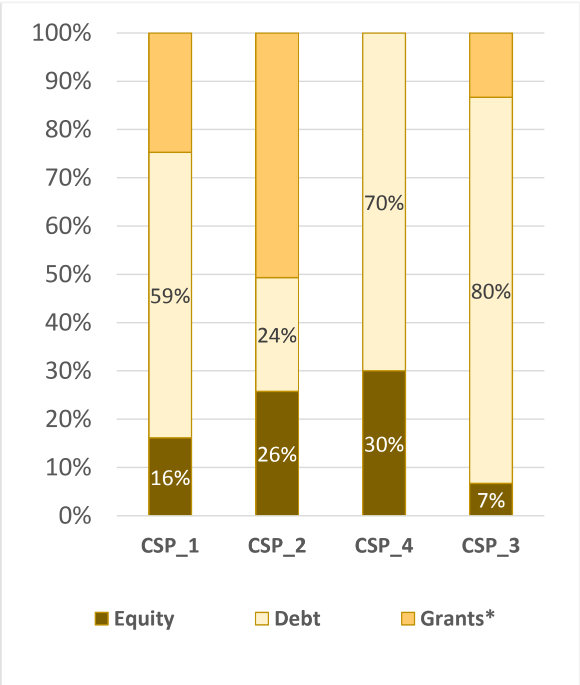
195 Bond finance is generally only available to refinance bank loans post-completion. It is possible that these project sponsors have insufficient knowledge as to where bond finance is most applicable and made assumptions about its potential

A4.2.2 Results per sector

The figures below present the financing structures, grouped per sector. The 32 projects[196] are presented in order of project development stage, with projects to the right of the charts being closer to operational stage.

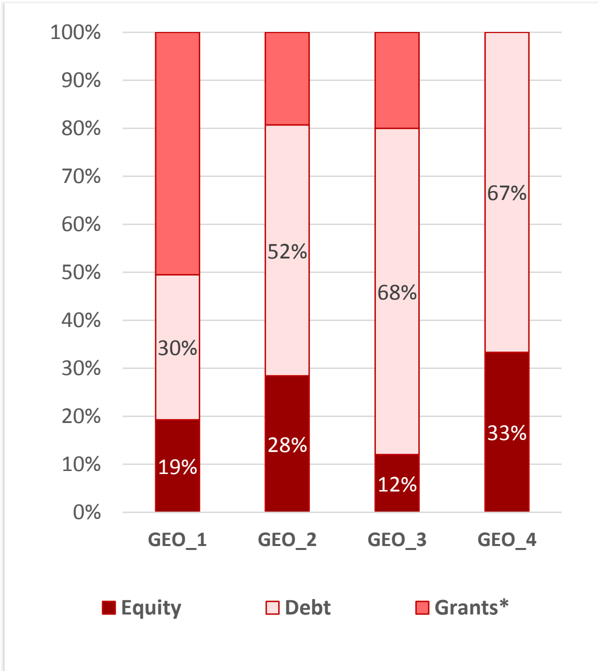
Figure A4.4 and Figure A4.5 show the financial breakdown for CSP and geothermal projects, respectively. Under CSP projects, forecasted equity participation on project funding varies between 7% and 30%. For geothermal projects, this value varies from 12% to 33%. In both sectors, grants play a significant role.

Figure A4.4 Financial structure for CSP projects



Source: ICF survey of European project sponsors, 2015

Figure A4.5 Financial structure for geothermal projects

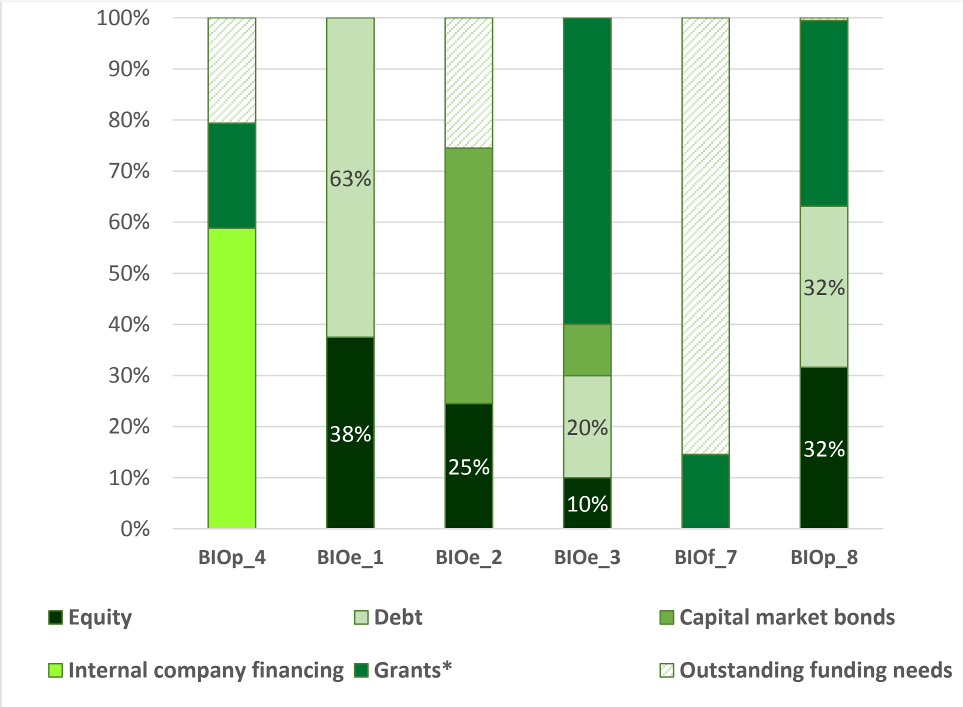


Source: ICF survey of European project sponsors, 2015

[196] The wind project WIN3 is excluded from the visual analysis due to it being an outlier.

Figure A4.6 depicts the financial structure for bioenergy projects. These projects present greater variance in funding composition, which may be explained by the very different project profiles covered (e.g. fuel production, direct combustion, pyrolysis, etc.). Among the projects analysed BIOp_8 is the only project which has reached financial close.

Figure A4.6 Financial structure for bioenergy projects

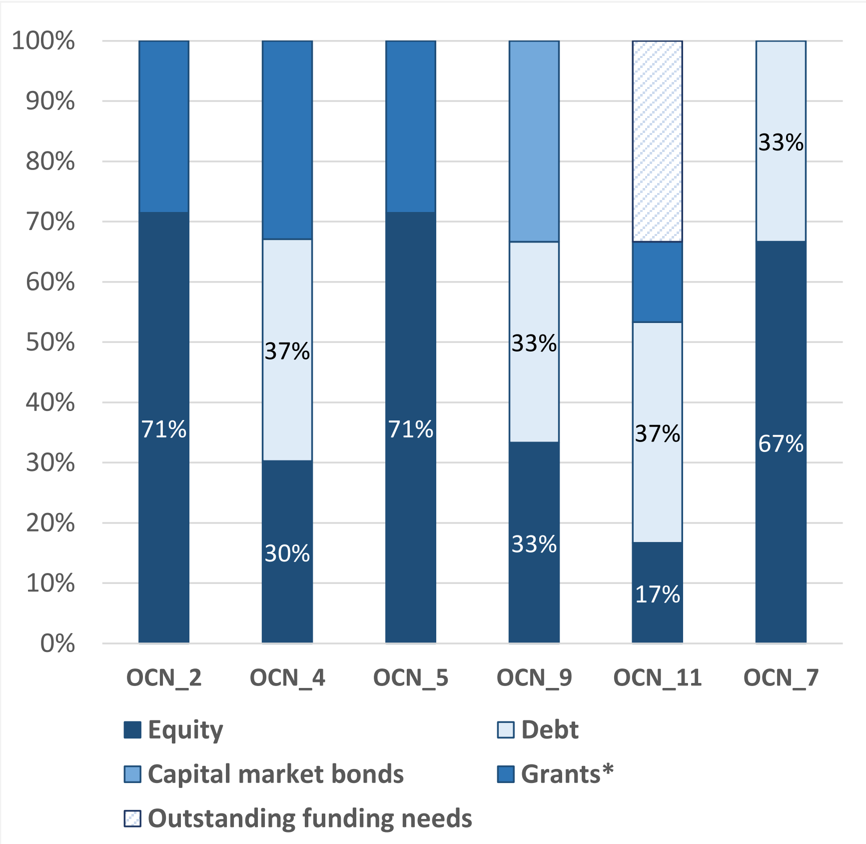


Source: ICF survey of European project sponsors, 2015

Note: BIOp – pyrolysis project; BIOe – direct combustion of biomass; BIOf- biofuel production and/ or consumption.

Figure A4.7 shows the financial breakdown for ocean energy projects. These cover both wave and tidal projects. Overall, equity investment coupled with grant funding seem to play a significant role in these projects. Debt is available in some projects only while bonds are considered in just one project.

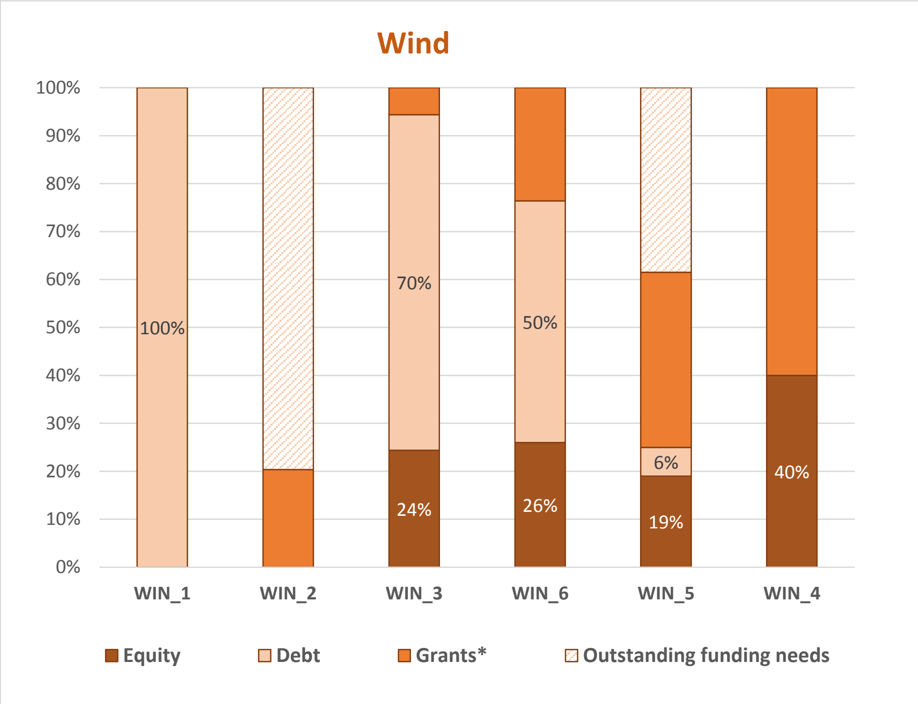
Figure A4.7 Financial structure for ocean projects



Source: ICF survey of European project sponsors, 2015

Figure A4.8 depicts the financial structure for wind projects. Within four projects, levels of equity investment range from 19% to 40% although three shows equity within a tight range of 19-26% in line with project financing equity for proven technologies. The financial balance is made up of grants and debt.

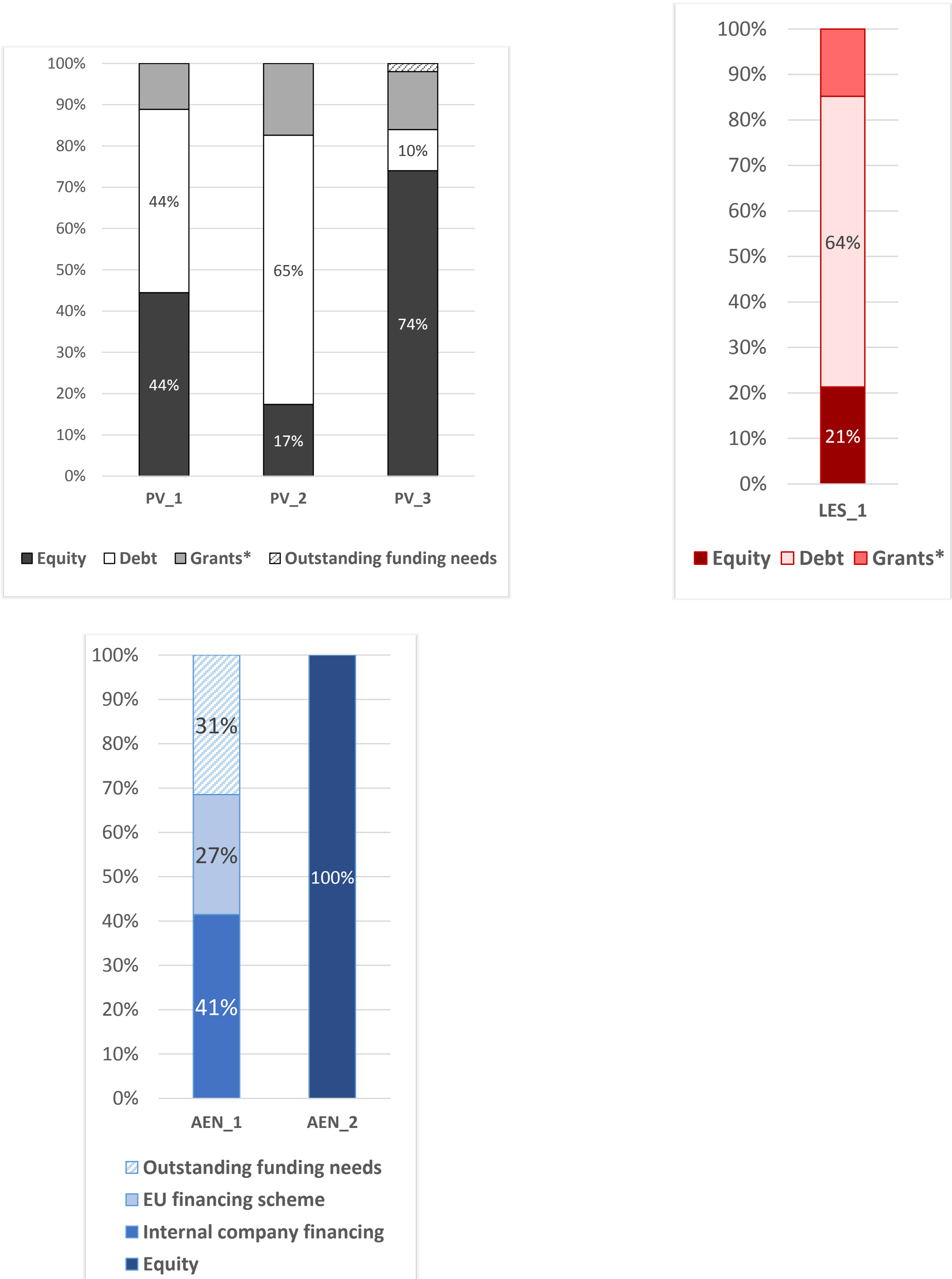
Figure A4.8 Financial structure for wind projects



Source: ICF survey of European project sponsors, 2015

There were limited project examples across a few sectors, such as advanced electricity network, PV and large energy storage, which reduced the ability to draw meaningful insights. The structures for the projects in these sectors are presented under Figure A4.9.

Figure A4.9 Financial structure for advanced electricity network, solar PV and large energy storage projects



Source: ICF survey of European project sponsors, 2015

A4.3 Market replication potential of FOAK projects

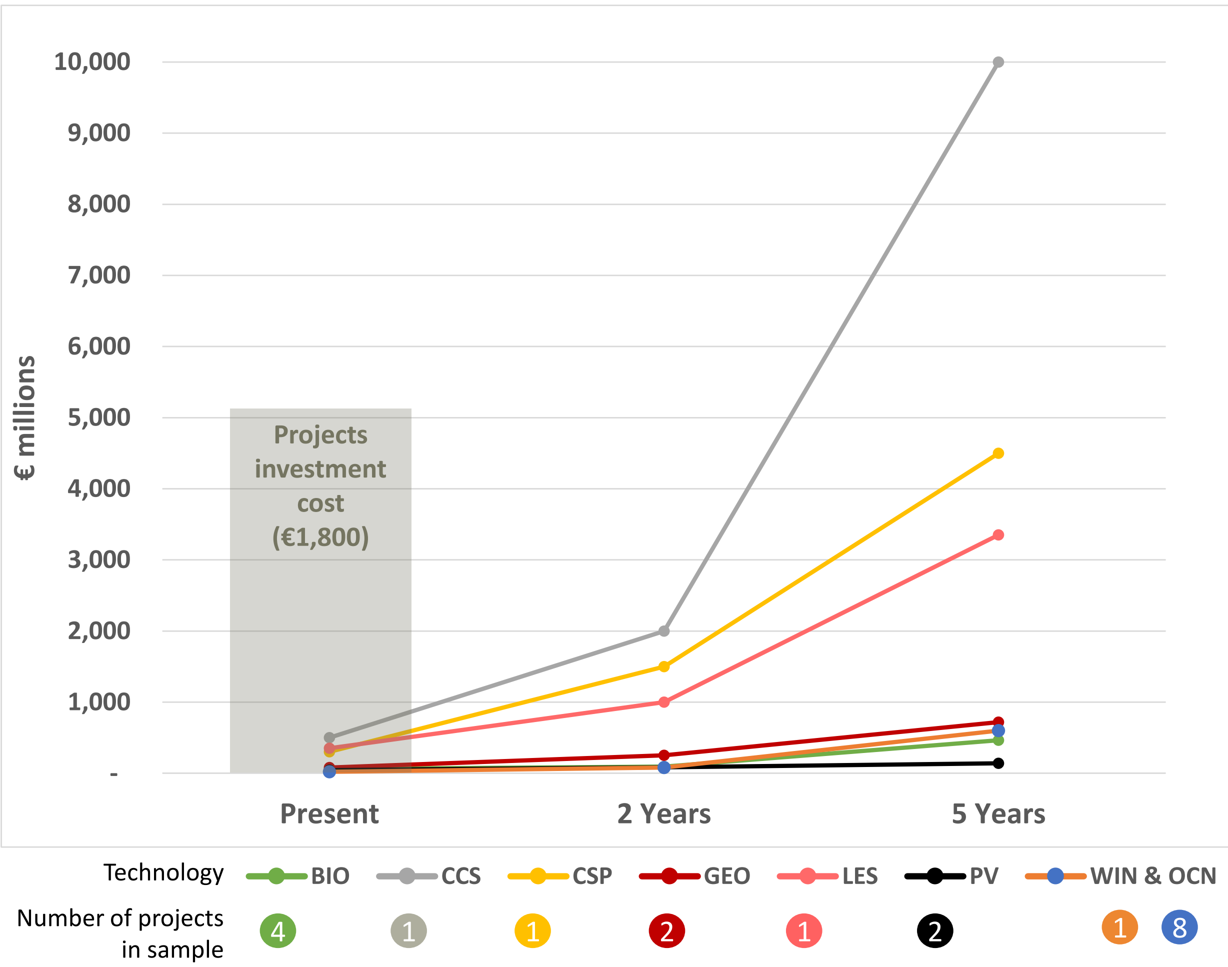
The figures presented in this section reflect 20 project sponsor views on the market replication potential of their projects. Forecasts are given in terms of number of plants, installed capacity and total sales for the coming two and five years[197].

Figure A4.10 depicts the average *present* investment cost of projects and the average forecasted sales (in *2 years* and in *5 years*) per sector. The amount of projects under each sector is shown below the figure.

Figure A4.11 disaggregates Figure A4.10 into three sectoral charts (where relevant data was available), to show how the replication expectations vary across projects in the same sector. In key sectors where the expectations are particularly high – such as CCS, CSP and LES – data was not available to perform this analysis.

It should be noted that no biofuel production plants are captured under the BIO projects, due to a lack of information.

Figure A4.10 Cost and sales projections per sector for 20 SET FOAK projects across different sectors (in €



millions)

Source: ICF survey of European project sponsors, 2015

[197] Note that the number of responses in this section varies across charts/tables because in a few cases projects were only able to provide partial information (e.g. only forecasted revenues)

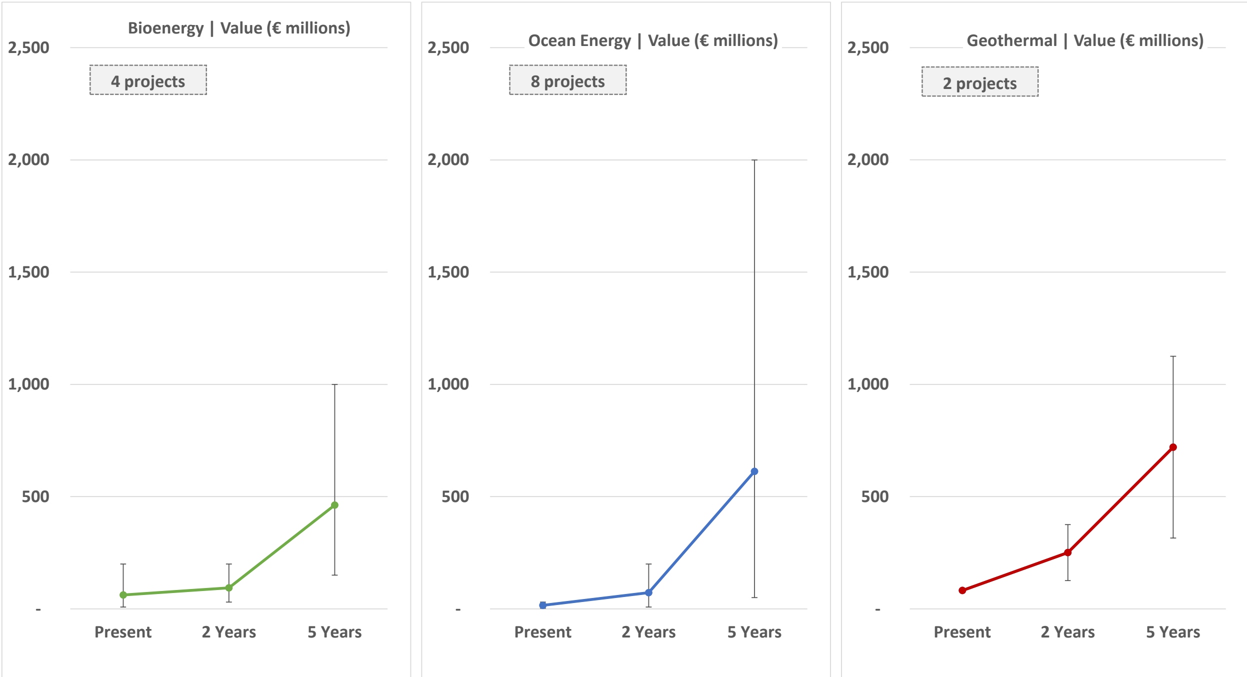


Figure A4.11 Variance within sectors: total investment cost (Present) and sales forecast (2 years and 5 years)

The tables below show the market replication potential as reported by sponsors, in terms of sales against investment, installed capacity and number of plants, within two and five years.

As indicated in Table A4.1, a total of €27 billion of revenues is expected within five years, based on an initial €1.8 billion of investment in 20 SET FOAK projects.

Table A4.2 depicts the expected sales (aggregated throughout the project lifetime) as compared to the investment cost, while Table A4.3 displays the average annual sales as a percentage of the average annual investment cost. These tables highlight the high expectations of project sponsors towards their potential returns on investment.

Table A4.4 and Table A4.5 indicate the market replication potential in terms of number of plants and installed capacity, in two and five years. Most sponsors foresee around ten times greater installed capacity in five years' time. Yet, for wind and ocean energy sponsors, this factor is around a hundred.

Finally, Figure A4.12 disaggregates the plants replication potential (presented under Table A4.4) into sectors. It shows that the replication expectations of ocean energy project sponsors are diverse. While four project sponsors foresee the amount of plants rising at least to 200 in the coming five years, three other project sponsors are more conservative and estimate the replication potential to ten to twenty new plants. Replication estimates from project sponsors in the bioenergy and geothermal sectors are in comparison more consistent.

Sector	Number of Projects	Total (million Euros)			Average (million Euros)			Maximum (million Euros)			Minimum (million Euros)		
		Cost	Sales		Cost	Sales		Cost	Sales		Cost	Sales	
		Present	2 years	5 years	Present	2 years	5 years	Present	2 years	5 years	Present	2 years	5 years
Bioenergy	4	247	375	1,850	62	94	463	200	200	1,000	8	30	150
CCS	1	500	2,000	10,000	-	-	-	-	-	-	-	-	-
CSP	1	300	1,500	4,500	300	1,500	4,500	300	1,500	4,500	300	1,500	4,500
Geothermal	2	163	501	1,440	82	251	720	88	375	1,125	75	126	315
Large Scale Storage	1	350	1,000	3,350	-	-	-	-	-	-	-	-	-
Ocean Energy	8	125	578	4,903	16	72	613	30	200	2,000	3	8	50
Photovoltaic	2	88	165	278	44	82	139	50	95	138	38	70	138
Wind	1	20	80	600	-	-	-	-	-	-	-	-	-
Total	**20**	**1,793**	**6,199**	**26,921**									

Source: ICF survey of European project sponsors, 2015

Keys

Higher value in a column

Lower value in a column

Table A4.1 Expected aggregate sales (throughout project lifetime) of projects, per sector

Sector	Number of Projects	Total Sales		Average Sales		Maximum Sales		Minimum Sales	
		2 years	5 years	2 years	5 years	2 years	5 years	2 years	5 years
Bioenergy	4	52%	649%	52%	649%	0%	400%	275%	1775%
CCS	1	300%	1900%	n/a	n/a	n/a	n/a	n/a	n/a
CSP	1	400%	1400%	400%	1400%	400%	1400%	400%	1400%
Geothermal	2	207%	783%	207%	783%	326%	1178%	68%	320%
Large Scale Storage	1	186%	857%	n/a	n/a	n/a	n/a	n/a	n/a
Ocean Energy	8	364%	3838%	364%	3838%	567%	6567%	167%	1567%
Photovoltaic	2	87%	216%	87%	216%	89%	176%	84%	263%
Wind	1	300%	2900%	n/a	n/a	n/a	n/a	n/a	n/a
Total	**20**	**246%**	**1402%**						

Source: ICF survey of European project sponsors, 2015

Keys

Higher value in a column

Lower value in a column

Table A4.2 Expected aggregate sales (throughout project lifetime) as a percentage of investment cost

Sector	Number of Projects	Total Sales		Average Sales		Maximum Sales		Minimum Sales	
		2 years	5 years	2 years	5 years	2 years	5 years	2 years	5 years
Bioenergy	4	26%	130%	26%	130%	0%	80%	138%	355%
CCS	1	150%	380%	n/a	n/a	n/a	n/a	n/a	n/a
CSP	1	200%	280%	200%	280%	200%	280%	200%	280%
Geothermal	2	104%	157%	104%	157%	163%	236%	34%	64%
Large Scale Storage	1	93%	171%	n/a	n/a	n/a	n/a	n/a	n/a
Ocean Energy	8	182%	768%	182%	768%	283%	1313%	83%	313%
Photovoltaic	2	43%	43%	43%	43%	45%	35%	42%	53%
Wind	1	150%	580%	n/a	n/a	n/a	n/a	n/a	n/a
Total	**20**	**123%**	**280%**						

Source: ICF survey of European project sponsors, 2015

Keys

Higher value in a column

Lower value in a column

Table A4.3 Annual sales as a percentage of the average annual investment cost

Table A4.4 Replication potential in terms of number of plants

Sector	Number of Projects	Units		Replication factor	
		2 years	5 years	2 years	5 years
Bioenergy	4	29	235	7	59
CCS	1	2	5	2	5
CSP	1	5	15	5	15
Geothermal	3	11	31	4	10
Large Scale Storage	2	5	14	3	7
Ocean Energy	7	92	1,245	13	178
Photovoltaic	1	4	8	4	8
Wind	2	7	100	4	50
Total	**21**	**155**	**1,653**	**5**	**41**

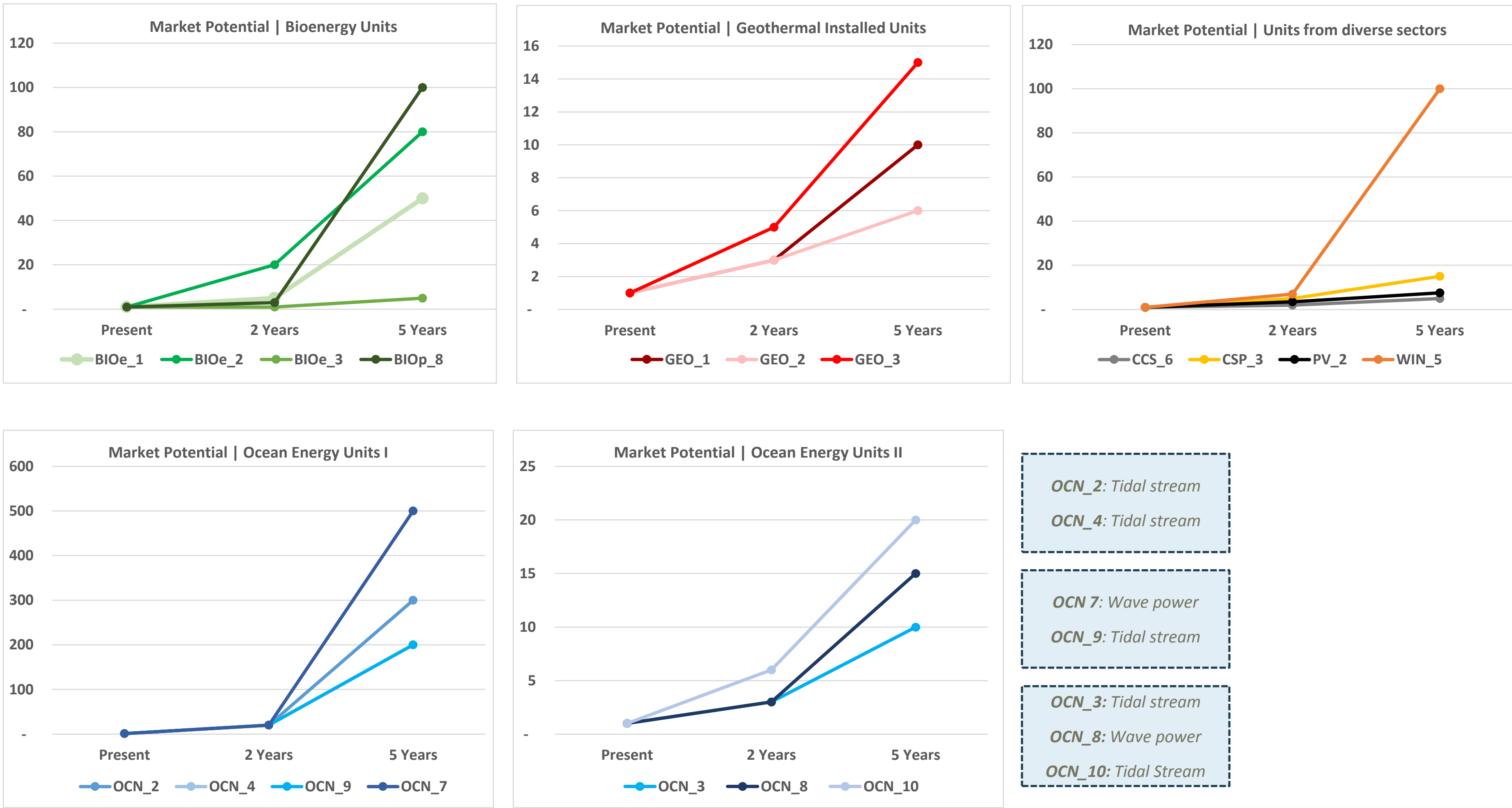
Source: ICF survey of European project sponsors, 2015

Sector	Present	Installed Capac.		Replication factor	
		2 years	5 years	2 years	5 years
Bioenergy	106	190	920	2	9
CSP	70	350	1,050	5	15
Geothermal	70	245	628	4	9
Large Scale Storage	350	950	2,900	3	8
Ocean Energy	12	160	1,553	13	125
Photovoltaic	20	70	150	4	8
Wind	2	14	200	7	100
Total	**630**	**1,980**	**7,401**	**5**	**39**

Table A4.5 Replication potential in terms of installed capacity

Source: ICF survey of European project sponsors, 2015

Figure A4.12 Expected number of new plants per sector



Annex 5 Investment needs for SET FOAK projects

This Annex summarises the investment needs across the SET sectors of interest to this study.

For each SET sector, the typical generation / production capacity of FOAK projects and indicative investment needs are identified based on ICF's survey of project sponsors and other sources.

The rationale for the type/scale and number of FOAK projects (i.e. the minimum and maximum number) which ideally need to be deployed for each sector is then set out. This includes discussion of prevailing capabilities in the EU supply chain and, where relevant, market and/or regulatory considerations.

A calculation of investments needs is then presented based on minimum/maximum capacity plant and minimum/maximum deployment. This generates a range of investment needs per SET sector.

Finally, an assessment is made of the scale of the unmet funding needs for each sector, together with justification for this outcome.

Table A5.1 Investment needs for SET FOAK projects to 2020

SET sector	Hybrid Indicative project sizes (EUR M)[6] Min size of project	Hybrid Indicative project sizes (EUR M)[6] Max size of project	Rationale for the type/scale and number of FOAK projects which need to be deployed by sector[1,7,8,9,10]	EU SET FOAK project deployment needs model to 2020 Min no of FOAK projects per sector	EU SET FOAK project deployment needs model to 2020 Max no of FOAK projects per sector	Indicative investment needs to 2020 (EUR Bn) ICF estimate (2016)	Estimate of current unmet funding needs (H, M, L)	Comment on unmet funding needs[10,11,12]
AEN	10	50	Advanced electricity networks and the 'smart grid' are in an embryonic stage of development and local / regional smart grids are now being sought, not least to help decentralised power production. A key goal could be to deploy exemplar FOAK projects in at least 50% of Member States through to all EU-28. (Many demonstration projects have already been deployed at national level but there is room for more, ref 10.) The EC Smart Grids Communication (2011) outlined the policy framework to drive future deployment. By 2020, EU needs to invest ~EUR 60 Bn in smart grids, rising to ~EUR 480 Bn by 2035. FOAK projects will clearly represent a proportion of these figures, so estimated need may be far higher than shown.	14	28	0.1 - 1.4	Medium	Energy regulators in some Member States are likely to impose sufficient incentive structures, including cost recovery from consumer bills, to help fund innovative projects and wider deployment which Distribution Network Operators (DNOs) can use to leverage investment and finance. This may be more challenging in other countries. The tariff incentives may be allocated in the form of grant support (e.g. Ofgem's Low Carbon Network Fund in the UK).
BIO (biofuels)	150	600	Second generation biofuels plants could be established in at least 4 Member States where existing supply chains are present and market conditions are supportive. Besides promising energy-driven and energy-only applications, EU also leads the development of integrated biorefineries which produce fuels, power, heat, and value-added chemicals from biomass. Several new biorefineries could also be established in a similar number of Member States. Clustering of expertise and projects might prove beneficial to the EU supply base.	5	10	0.8 - 6.0	High	Critical shortage of funding for 2nd generation biofuels due to biomass policy uncertainty, the very high capital costs of FOAK projects and now exacerbated by drastically reduced oil prices. Several 2nd generation biofuel plants applied for NER 300 funding and have yet to become operational which may imply a challenging financing landscape which is stalling financing decisions.
BIO (energy)	8	100	EU industry and utilities have actively developed bioenergy for many years, investing in new innovations and large-scale deployment, supported by numerous world-class bioenergy research institutes across a number of advanced conversion themes including pyrolysis, gasification and torrefaction. Smaller capacity (5-25MW) innovative bioenergy plants, suited for decentralised energy production, using novel pyrolysis / gasification and CHP technologies would be a likely focus for FOAK projects. A variety of technologies, feedstock types and scale of plant requires a variety of plant types to be demonstrated across different territories.	10	20	0.1 - 2.0	High	On-going need for funding of intermediate and bioenergy carrier technologies and novel thermal treatment technologies for biomass. Larger funding is generally available for larger scale, proven mass burn plant and biomass CHP plants in key Member States, such as Austria, Denmark, Germany, and UK.
CCS	500	1400	Leading European players in global CCS value chain, although much capture technology IP is owned by Japanese and American companies. Competitive advantage gained from demonstration of full chain CCS and ability to find efficiency gains from integration of proven technologies, geological assets (e.g. North Sea) and the skills/expertise of the EU energy and offshore industries. Successful 'full chain' CCS FOAK projects in the EU will create significant first-mover advantage, enabling potential global deployment and many opportunities for further financing and investment. However, lack of progress to date in building any full chain CCS plant in the EU suggests just 1-2 operational plants by 2020 would significantly change EU financing landscape for CCS and would catalyse support for CCS. Greater utilisation of carbon dioxide (CCUS) may prompt new funding opportunities increasing FOAK needs, especially for industry-related projects.	1	2	0.5 - 2.8	High	Very large funding needs, recognised by EC grant funding programmes such as the EEPR and NER 300, which have allocated over €1billion to CCS. However, the failure of many projects to either reach financial close or become built/operational, demonstrates the challenging framework conditions such as the lack of a market, challenging economics, low carbon price and significant planning/permitting issues (especially for storage). These have prevented viable business models from being deployed, impacting project developers' ability to raise funds. CCS therefore remains a grant 'play' at the moment.
CSP	185	330	Spanish firms, who have dominated the global CSP industry since the first operational plant started operations in 2007, own around 75% of installed CSP capacity globally, the balance being mainly in the United States (of which Spanish Abengoa has been a leading player). Much new build has been outside the EU and this has created an extensive Spanish supply chain which includes world class research institutes, especially in Andalucia. Demonstration of larger-scale CSP plants integrated with storage required in key Member States (e.g. Greece, Cyprus, Italy, Portugal) plus Spain (if regulatory framework was to significantly improve).	5	10	0.9 - 3.3	High	Several CSP plants applied for NER 300 funding and have yet to become operational. This suggests strong demand for funding and it is unclear how many of these plants have achieved financial close. The recent debt problems of Abengoa, a major player in the EU CSP market, could impact on market perceptions.
GEO	75	120	The EU has a handful of important suppliers capable of supplying steam turbines and turnkey systems for geothermal power plants. Traditional geothermal plants (especially high temperature) have restricted geographical reach in EU and fewer opportunities for very diverse generation technologies, implying bespoke projects and reduced replication potential. However, opportunities to exploit good geothermal resources will enable continuing demand for some FOAK projects, including more innovative Enhanced Geothermal System (EGS) projects, as well as for medium or low enthalpy projects.	3	6	0.2 - 0.7	Low	Limited opportunities exist within the EU which, combined with high capital requirements and geological risks, reduces funding opportunities. Insurance policies to cover drilling risk are available in certain countries only (e.g. France, Netherlands) and not geographically widespread. Whether this is required is debateable based on the total size of the potential resource and its geographic distribution.
LES	15	350	Finding the right business model and deployment strategy for different types of large energy storage (LES) technology is vital to achieving a financially viable solution. Majority of LES to date has been pump storage hydro. Recent smaller capacity (1-6MW) battery storage demonstration projects have been deployed in some Member	5	10	0.1 - 3.5	Medium	EU markets for overnight arbitrage which helped to stimulate previous deployment of energy storage are becoming less attractive. Frequency response / grid balancing and the challenge of integrating renewables (while minimising

SET sector	Hybrid Indicative project sizes (EUR M)[6]		Rationale for the type/scale and number of FOAK projects which need to be deployed by sector[1,7,8,9,10]	EU SET FOAK project deployment needs model to 2020		Indicative investment needs to 2020 (EUR Bn)	Estimate of current unmet funding needs (H, M, L)	Comment on unmet funding needs[10,11,12]
	Min size of project	Max size of project		Min no of FOAK projects per sector	Max no of FOAK projects per sector	ICF estimate (2016)		
			States (UK, Italy) to aid grid integration of solar and/or wind. More recently, medium capacity projects are being deployed on a commercial basis for frequency containment where the corresponding reserve product is defined (Netherlands, Ireland) (ref 10). Other storage types include Compressed Liquid Energy Storage (UK), the larger scale Compressed Air Energy Storage (Germany), and - for the longer-term - hydrogen-based chemical storage (power-to-gas, power-to-fuel) (ref 10). This last option has the potential to cater for large capacity seasonal storage with links to various end-use sectors (hydrogen from RES can be used in the mobility, chemical, heating or power sectors), providing a toll to lower their GHG emissions. Overall, there exists potential for each Member State to carry out FOAK projects using different technologies although pump storage is likely to continue to play major role (but only very limited new deployments are expected). LES demonstrations may be concentrated in particular Member States where pricing models / regulatory regimes are conducive and could help clarifying adequate reserve and balancing products and business models.					curtailment) are key drivers for current and medium-term investment in LES. Investments in up to 10MW batteries are being pursued. Besides pumped storage, other LES options are difficult to justify financially currently without a supportive regulatory framework. In the longer term, with increasing shares of RES, different technical solutions will be needed, e.g., "weekly" or seasonal storage. Energy regulators in some Member States (as for AEN) are likely to impose sufficient incentive structures to help create viable business models and aid deployment, hence the need for the Energy Union to create, with new legislation, a supportive investment environment and a level playing field for various flexibility technologies in order to unlock more deployment of storage.
OCN	20	100	Although there is not yet any commercial supply chain, diversification into the sector of European industrials (Blue chip engineering companies, shipbuilders) has started to occur and technology developers are being supported in various Member States – and in some cases bought out - by such firms. The UK has become an important cluster for the sector with excellent public sector support driving demonstration projects. Tidal turbine arrays and farms are the focus of funding and demonstration. If we assume 1-2 arrays are deployed in each promising market such as UK, France, Ireland and these are then increase scaled up to reach 10 larger farms (5-6x the size of arrays), this would help fulfil the industry's roadmap.	5	10	0.1 - 1.0	High	A massive reduction in venture and corporate funding compared to peaks in 2005-2010, coupled with significant capital scale-up needs for arrays/farms and challenging technological requirements suggests that public support (in the form of grants, equity, debt and subsidies) will have to be the mainstay of sectoral developments for the foreseeable future. The EU ocean energy industry recently stated (Ref 3) that *"Uncertainties in installation times or total electricity production mean that a significant level of financial risk remains, preventing access to debt from commercial banks. Similarly, this risk cannot be borne by operators alone, nor insured at a reasonable price. For this reason, demonstration and pre-commercial farms require a significant percentage of public capital, delivered upfront to sustain the production and installation of devices."*
SPV (generation)	35	50	Since JRC (2013) study, the 1st generation PV market and system prices globally have collapsed. Despite a world-class RDI base that continues to innovate in new PV technologies, there is limited financial rationale for investing in 1st generation solar innovations due to there being no realisable premium for introducing new innovations into the market: it has rapidly matured. Instead 2nd and 3rd generation plant could be favoured by any support assuming efficiency levels and cell longevity are achieved to improve upon 1st generation performance.	5	10	0.2 - 0.5	Low	Investor sentiment focuses on the commercial market readiness of 1st generation solar. One investor feels the pursuit of 2nd / 3rd gen is commendable if there is a "strong belief that we can do better with technologies". However, they questioned the market viability for such innovations (ref 10) and the majority of such novel innovations are at earlier stage than TRL 7-8, making them predominantly grant "plays".
SPV (manufacturing)	45	250	Since JRC (2013) study, PV manufacturing has dramatically reduced in the EU, and European module manufacturers struggle to compete with a low-cost Asian manufacturing base, mainly in China (55% market share) and Taiwan. In other words, the rapid growth of the global PV market has not resulted in a similar growth of manufacturing capacity of solar cells and modules in the EU, and the EU PV industry currently supplies only around 5% of total MWp capacity produced. Nonetheless, there exists a rationale for the EU focusing on innovative higher-performance lower-cost production technologies with GW production potential, given the very high worldwide growth projections for PV (with cumulative installed capacity expected to treble over the next 5 years), the good positioning of the EU PV industry along certain stretches of the value chain (notably in relation to equipment and inverter manufacturing), the scientific leadership of European research institutes, and the existence of specialised production clusters in Germany and the Netherlands (ref 10) despite offshoring of most manufacturing outside the EU. However, as with PV generation, the hurdle that the rationale for investment in innovation must overcome is that of achieving cost savings through innovation that match or exceed ongoing price reductions in the market.	3	5	0.1 - 1.3	Low	Opportunities for EU appear limited in the current climate, although China's current pre-eminence may not be sustainable, owing to the growing importance of shipping costs, lack of technology diversification and reliance on government subsidies (ref 10). Those firms that are well placed to develop such innovative manufacturing may well already have sufficiently strong balance sheets to fund such process innovations.
WIND (generation - fixed)	50	300	The strength and growing maturity of offshore wind supply chains, significant market growth prospects in the North Sea and Irish Sea and growing institutional interest in financing of this market is very likely to help pull through many innovations. More innovative foundations for fixed turbines are being sought for deeper offshore waters	5	10	0.3 - 3.0	Low	The offshore wind market is growing rapidly, established funds now exist and many innovations are fundable in the market: *"any EU funding would be potentially displacing private money"* (ref 11). Hence, limited opportunities to offer significant support

SET sector	Hybrid Indicative project sizes (EUR M) [6]		Rationale for the type/scale and number of FOAK projects which need to be deployed by sector [1,7,8,9,10]	EU SET FOAK project deployment needs model to 2020		Indicative investment needs to 2020 (EUR Bn)	Estimate of current unmet funding needs (H, M, L)	Comment on unmet funding needs [10,11,12]
	Min size of project	Max size of project		Min no of FOAK projects per sector	Max no of FOAK projects per sector	ICF estimate (2016)		
			due to high costs and/or challenging geological formations, with on-going research into novel foundations and installation techniques. Potential support also for FOAK projects covering novel nacelles, blades, gearboxes and transmission systems.					due to growing supply chains, clear pathways for cost reductions set out (e.g. by the UK's Offshore Wind Cost Reduction Task Force), as well as more sophisticated supply chain management driven by developers to minimise costs and better manage risk (ref 12).
WIND (manufacturing)			*Not regarded as applicable*					
WIND (generation - floating array)	125	300	Based on scale up from 1-2MW floating turbines which have been successfully demonstrated at TRL 6-7. Scale of project requirements to deploy larger scale turbines in arrays and small farms is a key objective for deep water deployment, not least to ensure EU competitive advantage is maintained versus other countries (notably Japan). Statoil has announced plans for its 30MW Hywind Scotland Pilot Park (ref 7) following successful demonstration of its 2.3MW turbine off Norway. It will consist of five 6MW floating turbines in waters over 100m of depth.	5	10	0.6 - 3.0	High	Exemplar floating array project in Portugal has already applied to the InnovFin EDP facility. International interest in this area including from Japan. Norwegian Statoil is pulling together funding for a new floating wind farm which demonstrates a market appetite. High risk will probably require diversified set of investors/financiers to make projects happen.
					EUR Billion	4.0 - 28.5		

Sources for investment needs table
1 ICF for DG RTD, Final Interim Report - Financing of FOAK projects (based on project sponsor responses) (December 2015)
2 JRC (2013) Report on Innovative Financial Instruments for the Implementation of the SET Plan, First-Of-A-Kind projects
3 Strategic Energy Technology (SET) Plan, Integrated Roadmap, Annex I Part II (2014) - https://setis.ec.europa.eu/set-plan-process/integrated-roadmap-and-action-plan
4 Draft Ocean Energy Strategic Roadmap (2015) - http://www.oceanenergy-europe.eu/index.php/policies/ocean-energy-forum/draft-strategic-roadmap
5 JRC (2014) Smart Grids Projects Outlook - http://ses.jrc.ec.europa.eu/sites/ses.jrc.ec.europa.eu/files/u24/2014/report/ld-na-26609-en-n_smart_grid_projects_outlook_2014_-_online.pdf
6 Hybrid set of indicative project sizes using refs 1, 2 and 3
7 ICF for DG RTD, D12 - Market Conditions Mapping report (2016)

8 ICF for DG GROW (July 2014), Competitiveness of the EU Renewable Energy Industry (both products and services) - Final Report (EUR 2014.5232 EN)

9 Statoil, Hywind Scotland Pilot Park. Available http://www.statoil.com/en/TechnologyInnovation/NewEnergy/RenewablePowerProduction/Offshore/HywindScotland/Pages/default.aspx?redirectShortUrl=http%3a%2f%2fwww.statoil.com%2fHywindScotland
10 Comments received from Steering group (27 April 2016)
11 ICF- commentary informed by discussions with financial market participants (June 2015 - April 2016)

12 Offshore Wind Cost Reduction Task Force report, June 2012. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66776/5584-offshore-wind-cost-reduction-task-force-report.pdf

Annex 6 Financial instruments mapping and analysis

A6.1 The study has reviewed in detail EU and Member State support schemes

The 14 schemes reviewed are shown in Table A6.1, together with the key implementing body or bodies, and on a map in Figure 2.2.

Table A6.1 EU and Member State schemes used to support SET projects

Scheme	Region/ Country	Started	Implementer
New Entrants Reserve 300 (NER 300) and proposed Innovation Fund	European Union	2010	EC/DG Climate Action/EIB
InnovFin Large Projects, and one of its umbrella schemes: the Energy Demo Projects Pilot facility	European Union	2014, 2015	EIB
European Fund for Strategic Investments (EFSI)	European Union	2015	EC/EIB
Energiteknologisk udvikiling og demonstration (Energy Technology Demonstration Programme)	Denmark	2007	*Energiestyrelsen* (Danish Energy Agency)
Markedsmodningsfonden (Market Development Fund)	Denmark	2013	*Erhvervstyrelsen* (Danish Business Authority)
Programme d'Investissements d'Avenir (PIA) (Investments for the Future programme)	France	2010	*ADEME* (Energy & Environment Management Agency)
BMUB Umweltinnovationsprogramm (Environmental Innovation Programme)	Germany	1979	KfW Bank, *BMUB* (Ministry of Environment)
ERP Innovation Programme	Germany	2007	KfW Bank
Energy transition financing initiative	Germany	2012	KfW Bank
Industrifonden	Sweden	1979	Industrifonden Fund
Programme for Demonstration and Commercialization	Sweden	2011	*Energimyndigheten* Swedish Energy Agency
Energy Technologies Institute (ETI)	UK	2007	ETI
Green Investment Bank (GIB)	UK	2012	GIB
Enova (support for introduction of new technology)	Norway	2012	Enova

The age of schemes varies widely, although schemes appear to cluster into three groups:

1. Well established schemes – a few schemes date back over 30 years (e.g. KfW BMUB Environmental Innovation Programme and Sweden's Industrifonden). These represent 'tried and tested' funding routes for companies and they have clear brand and market presence and a track record of successfully supported projects and companies;
2. Schemes established at the height of the cleantech/low carbon technology funding boom – schemes such as Denmark's EDP, Germany's ERP Innovation Programme and UK's ETI, were all set up in 2007, prior to the economic downturn and a flight away from cleantech funding in the EU venture capital space[198]; and,
3. Schemes younger than 5 years – these schemes are now starting to 'bed down' and understand the true nature of their impact on the SET supply side and the success of

[198] One of the angles which has not been investigated is the 'business model' of each scheme vis-à-vis their year of establishment. It is possible that in times of more available private sector funding, a different support structure could be put in place which may become stressed later on when less money is available for co-financing of projects.

their supported projects in the marketplace, although in some cases/individual projects it is taking longer than anticipated to see the forecast outcomes (e.g. France's PIA).

A6.2 Technology Readiness Levels supported by the schemes range from TRL 5 (prototype) s to TRL9 (proven technologies)

Schemes typically cover projects from TRL 5 (early demonstration with a strong research focus in several schemes) to TRL 9 (with its emphasis on deployed and proven technology).

Those schemes that focus primarily on projects TRLs 7 and 8 include Denmark's *Markedsmodnings-fonden*, Germany's BMUB EIP and the UK Energy Technology's Institute (ETI), though the narrow TRL focus does not necessarily make them the most suitable for SET projects as they may not have a prime focus on clean energy (as in the KfW scheme) or be equipped to supply financing in sufficient volume.

Table A6.2 provides a summary of some of the key aspects of each scheme, including their overall suitability for supporting FOAK projects. Table A6.3 looks at the SET coverage and TRLs that each scheme covers. In some cases, it was hard to define precisely the sector coverage (e.g. Sweden and Norway, where this was driven by project examples).

A6.3 Annual scheme budgets vary widely with EU schemes considerably larger

Some schemes have a small budget as they disburse small sums, albeit to create crucial incentives; for example, the BMUB EIB operates with just €25-35 million a year. In contrast, France's PIA has an annual budget of around €500 million and the UK's GIB an annual budget of up to €1 billion. In general, however, Member State support mechanisms do not provide the scale and intensity of financing support at key TRLs that is possible via the EU's ILP facility, the NER 300 and, potentially, EFSI.

A6.4 Most schemes reviewed provide different funding options depending on the TRL level of the project

Grants and reimbursable loans are often reserved for TRL 6-7 projects. However, there are several grant mechanisms which have offered support for TRL 7-8 across a broad suite of technologies including:

- Denmark - Energy Technological Development & Demonstration programme;
- France - Investments for the Future programme;
- Sweden's grants for first-of-a-kind demonstration of second generation biofuels and other energy technologies[199]; and,
- NER 300.

Equity-based financing and (risk sharing) fixed term loans and guarantees are more focused on TRL 8-9 projects, as projects/firms are often able to generate revenues from more proven technologies or less risky research which is feeding into existing operations. Equity support for innovative companies includes:

- France – through the *Écotechnologies* equity fund;
- Sweden – a venture capital (VC) fund, Industrifonden, which, until very recently, provided early stage investment into sustainable energy businesses; and,
- UK – through the Energy Technologies Institute which invests in highly innovative technology companies, but mainly through backing of specific projects.

Loan support for innovative projects includes:

- InnovFin Large Project and EFSI (which both include loan guarantees);
- Germany – KfW schemes such as the ERP Innovation Programme (which provides subsidised interest loans);
- France – Programme d'Investissements d'Avenir; and,
- Norway – Enova support for innovative energy technologies.

[199] A one-off initiative with a total budget of €95m with grants of €15-24m for 5 projects

Germany's KfW and the UK's GIB are the two examples of public banks providing support through various mechanisms into different SET sectors – for example, the GIB is investing equity into funds which take stakes in energy efficiency projects alongside direct project finance to bioenergy projects as well as refinancing of offshore wind farms.

The ability of the ILP facility to take on higher risk projects has enabled it to directly loan or provide guarantees to some projects at TRL 7-8

Table A6.2 Financial schemes supporting SET projects including first-of-a-kind in the EU and Member States

Scheme Name (delivery body)	Geographical Area	Year Started	Status	Type of Instrument	Budget	Project Funding Levels	Suitability for FOAK Projects
New Entrants Reserve 300 (NER 300) and proposed Innovation Fund (DG Climate Action, EIB, Member States)	European Union	2010	Open	Grants	€2.1bn	50 - 60% co-financing[200]	High – has attracted a wide range of applications from across the EU-28 in numerous SET sectors, although it has faced challenges in delivery, which should be rectified under Innovation Fund
InnovFin Large Projects (EIB)	European Union	2014	Open	Loans & guarantees	€25bn (to 2020)	€25m - €300m	Medium to High - track record established under RSFF, although no evidence to date that this is currently supporting FOAK projects under SET (hence rationale for establishing EDP facility)
InnovFin Energy Demo Projects Pilot (EIB)	European Union	2015	Open	Loans & guarantees	€150m for 2015-2016[201]	€7.5m - €75m	High - over 40 applications already across SET sectors
European Fund for Strategic Investments (EFSI)	European Union	2015	Open	Loans & loan guarantees	€21bn	€50m - €75m[202]	Medium to High – though this depends on the appetite for risk shown, which for current projects is not high.
Energy Technology Development and Demonstration Programme (Danish Energy Agency)	Denmark	2007	Open	Grants	€50m per year	€0.7m - €30m, although typically <€1m	High – scheme is well established, has good SET coverage and offers the potential for larger funding where appropriate. Also aligns with EC schemes such as NER 300. Funding has been halved in 2015 due to a change in government[203].
Market Development Fund	Denmark	2013	Open	Grants &	€18m (2013-	Grant funding:	Limited – Fund does not usually support

[200] The threshold for NER 300 is 50% although smaller interventions have been committed. Under the proposed Innovation Fund, up to 60% of relevant project costs may be supported

[201] Following the pilot phase in 2015-16, a decision will be taken by the EC and EIB on the size and possible new features of the facility.

[202] Unspecified. However, in the renewables and resource efficiency space, projects to date suggest that a minimum of €50-75m is put forward for a guarantee under the Fund

[203] Feedback from scheme manager

Scheme Name (delivery body)	Geographical Area	Year Started	Status	Type of Instrument	Budget	Project Funding Levels	Suitability for FOAK Projects
(*Markedsmodnings-fonden*)				guarantees	2015)	€0.4m - €1.3m Guarantees: €0.4m - €1.6m	large demonstration plants (limited to biogas projects at commercial scale) hence the majority of energy demonstration projects apply to the EUDP scheme (see above)
Investments for the Future / *Investissements d'Avenir* (ADEME)	France	2010 (to 2016/ 2017)	Open	Grants, repayable loans, equity	€3.3bn fund value (€471m/ year)	€3m or more	High – large level of funding but mixed success to date despite broad sectoral coverage.
BMUB Environment Innovation Programme (KfW)	Germany	1979	Open	Loans & investment grants	€25m/year	€1m	Limited - some early renewable projects funded. Emphasis now on energy efficiency across industry/manufacturing
ERP Innovation Programme (KfW)	Germany	2007	Open (energy Window due to close)	Loan (subordinated tranche, not collateralised, & debt tranche)	N/A	Up to €25m per project or up to €50m in loans per enterprise	Low – Support to innovative energy technologies is limited and the lack of market uptake means Window closing Dec 2015
Energy transition financing initiative (KfW)	Germany	2012	Open	Loans provide 50 - 100% of debt finance required	ca.€150m	€25m – €100m covering max 50% of project costs	Low – the commercial terms offered unlikely to attract first-of-a-kind SET projects compared with proven technologies
Industrifonden	Sweden	1979	Open	Equity capital & risk sharing loans	Fund value €430m in 2012 / Investments €40m/year	€0.6m – €11m (15-50% of ownership)	Low – Cleantech is no longer an explicit focus and projects leading to an expensive demonstration-stage project are avoided
Programme for Demonstration and Commercialisation (Swedish Energy Agency)	Sweden	2009-2011	Closed	Grants	€95m	€15m - 24m (25-50% of project cost)	High – When open the scheme helped fund several first-of-a-kind demonstrations in key SET sectors so it is a good source of lessons learned

Scheme Name (delivery body)	Geographical Area	Year Started	Status	Type of Instrument	Budget	Project Funding Levels	Suitability for FOAK Projects
Energy Technologies Institute (ETI)	UK	2007 (to 2017)	Open	Grants, debt & equity	€1.3bn budget over lifetime	Currently up to ~£60m (€85.3m)	High – novel funding concept using public and private sector funding but additional co-investment proving difficult
Green Investment Bank (GIB)	UK	2012	Open	Loans & guarantees	ca. €1bn annually	To date >£50m (€65m)	Limited – initial focus helped support some first-of-a-kind demonstrations but strategy now into proven technologies and refinancing (e.g. wind farms)
Support for the introduction of new technology (Enova)	Norway	2012	Open	Grants	Spent €224m over 3 years (2012 – 2014)	Average Grant: €5.6m Largest Grant: €190m (in 2014)	High – SET projects are eligible for support. Since they must be located in Norway few are funded, but the scheme is a good source of lessons learned.

Source: ICF. Note: N/A = no information was available.

Table A6.3 Sectoral breakdown of publicly financed instruments in support of RD&D for sustainable energy technologies

AEN = advanced electricity networks, BIO = biomass conversion, CCS = carbon capture & storage, CSP = concentrating solar power, GEO = geothermal, LES = large-scale energy storage, SPV = solar photovoltaics, WIN = wind energy; ● = TRL 7 or 8 projects eligible; O = TRL 7 or 8 projects not eligible in practice but other TRLs pursued

Instrument	Project location	AEN	BIO	CCS	CSP	GEO	LES	OCN	SPV	WIN	TRLs
NER 300 and proposed Innovation Fund	EU	●	●	●	●	●		●	●	●	7 – 8
InnovFin Large Projects	EU	●	●	●	●	●	●	●	●	●	1 – 8
InnovFin Energy Demo Projects Pilot	EU	●	●	●	●	●	●	●	●	●	7 – 8
European Fund for Strategic Investments (EFSI)	EU	●	●	●	●	●	●	●	●	●	5 – 9
Energy Technological Development & Demonstration Programme (EUDP)	Denmark	●	●	●	●	●	●	●	●	●	4 – 9
Market Development Fund	Denmark	o	●	o	o	o	o	o	o	o	5 – 9
Investissements d'Avenir	France	●	●	●	●	●	●	●	●	●	6 – 7 (grants) 7 – 8 (loans)
BMUB Environmental Innovation Programme (KfW)	Germany	o	o	o	o	o	o	o	o	o	< 7 for energy
ERP Innovation Programme (KfW)	DE	o	o	o	o	o	o	o	o	o	4 – 8 (closes Dec.)
Energy transition financing initiative (KfW)	DE										8 – 9 (EE only)
Industrifonden (private but founded with public funds)	SE						o		o		4 – 8
Swedish Energy Agency demonstration funding	SE		●					●			6 – 9 (but closed)
Energy Technologies Institute (ETI)	UK	●	●	●			●	●		●	5 – 8
Green Investment Bank	UK		o						o	o	7 – 9
Enova	NO							●		●	7 – 9

A6.5 Levels of project funding also vary widely, even within the same schemes

For first-of-a-kind projects, grant support can range from less than €1 million up to €190 million (for a project funded by Norway's Enova programme[204]). The ranges for loans, guarantees and equity support are similarly wide, we understand from conversation with scheme managers, although they were not so forthcoming with precise numbers.

For most schemes, maximum grant levels of 50% of project costs are applied (due to State aid regulation); sometimes 60% of eligible costs for a specific technology are covered (see Enova support) or even higher where public institutions such as universities or research and technology organisations (RTOs) are involved in projects.

For equity finance it is considered as good practice – for example by France's *Écotechnologies* equity fund – not to exceed support levels of around 33% so as to discourage malpractice in the management of a particular project.

Table A6.4 Overview of support types across the schemes reviewed

GRANTS	LOANS	EQUITY
Most common support	Modest funds at MS level	Rarely used mechanism
Funding limits highly variable across schemes	More tailored provision at EC level	Mainly focused on innovative SMEs not projects *per se*
Max grant funding levels 50% of eligible costs	Max loan levels 50%	Good practice to not exceed max equity level (e.g. 33% France)
Key schemes: Denmark, France, Sweden, UK, Norway EU - NER 300	Key schemes: Germany, France EU - InnovFin Large Projects; InnovFin Energy Demo Projects (EDP); EFSI	Key schemes: France, Sweden, UK EU - InnovFin Energy Demo Projects (EDP); EFSI

Source: ICF. EFSI = European Fund for Strategic Investments

A6.6 Project eligibility criteria vary widely among schemes although there are some common elements including substantial innovative content, financial credibility of partners, and demonstrable emissions reductions

The following are common eligibility criteria as well as often being important to the scoring of projects in competitions/calls:

- Degree of innovation compared to existing technologies[205] ;
- Financial strength of the selected beneficiaries/partners and the projects financial plan;
- Environmental / climate impacts (e.g. GHG emissions reductions);
- Likelihood of a commercialisation success; e.g. leverage factor for private financing support;
- Market outlook/potential (e.g. target market(s)/market segment(s), potential market share, potential turnover/volume of sales, degree of competition, etc.);
- Market replication potential;

[204] Hydro Aluminium on Karmøy received a funding commitment for investment support totalling €190m for a planned pilot plant to test a next generation energy efficient and climate friendly technology for producing primary aluminium. The ESA Surveillance Authority for EFTA approved the funding and found that it complied with state aid regulations.

[205] However, this is a criterion only for a minority of schemes (NER300, ILP, EUDP, Investissements d'Avenir, and BMUB EIP) and there is no objective standard against which to assess it.

- Added value of the project or resulting products/services developed;
- Other anticipated social and economic impacts, notably the level of economic activity and the level of direct and indirect employment; and,
- Additionality (i.e. an assessment as to whether the project would have been funded without state support including the speed of project implementation and the scale of financial support achieved without public support).

Several of the schemes reviewed make it a condition of funding that project implementers/companies have to cash-flow the project throughout its duration and provide funding only after results have been achieved. The NER 300 is probably the best example of this and creates a clear risk to project viability and completion[206].

A6.7 Market demand for support schemes and success rate of applicants vary

Some schemes report up to 300 applications per year (France's PIA); others concentrate on a small number of calls by technology and elicit (e.g. 2-6 applications per call per year for the UK ETI). These differences appear to be the result of one or more of the following factors, namely the:

- Technology-specific interests of the scheme (i.e. a broad based approach with technology neutral open calls versus technology specific calls with defined funding limits per call);
- Level of detail and effort required for project proposals during the first (or only stage of the application process) including the administrative burden;
- Eligibility criteria applied, especially the financial and technological performance standards of the applicant and the technology; and,
- Scheme's reputation in the market.

Market demand is also highly likely to be connected to the level of innovation activities in different Member States, the strength of the supply chain, as well as the nature of the market conditions and natural resource base (i.e. sunlight, wind, biomass, coastline, etc.).

From the schemes reviewed, the success rate of applicants is typically around 20-30%.

A6.8 Some Member State schemes have moved away from FOAK projects

Several schemes originally identified as being of potential interest to FOAK such as Industrifonden and the Green Investment Bank, had either moved away from FOAK type support or it did not form part of their investment strategy. In some cases (e.g. Swedish Energy Agency) the scheme had now closed for new applicants. Although this is disappointing news for the sector, this finding nonetheless provides important feedback on the 'state of play' regarding FOAK funding availability across Member States and lends weight towards having some sort of public sector intervention.

[206] NER 300 funding only provides capital when a project achieves first production (i.e. production of renewable energy or geological storage of CO_2), unless a Member State guarantees upfront funding. Private investors must therefore provide all funding, bearing all risks, in the earlier project stages. For such projects, these rates are clearly rated very high which in turn could easily lower the amount of private capital provided.

Annex 7 Overview of NER 300 Projects

Table A7.1 Summary of NER 300 project awards including current status and forecast date of entry into operation (correct as at July 2016)

#	SET sector	Technology Subsector*	Member State	Project title	Project Sponsor/Developer(s)	NER 300 call	NER 300 award (€M)	Date of entry into operation
1	Bioenergy	BIOd	NL	Woodspirit	BioMCN	1	199.0	28.11.2016 (e)
2	Bioenergy	BIOd	FR	UPM Stracel BTL	UPM group	1	170.0	31.12.2018 (e)
3	Bioenergy	BIOe	FI	Ajos BTL	Vapo	1	88.5	31.12.2016 (e)
4	Bioenergy	BIOc	SE	Gobigas phase 2	Göteborg Energi	1	58.8	31.12.2018 (e)
5	Bioenergy	BIOg	PL	CEG Plant Goswinowice	Bioagra	1	30.9	31.12.2016 (e)
6	Bioenergy	BIOg	IT	BEST	Beta Renewables	1	28.4	01.06.2013 (a)
7	Bioenergy	BIOh	DE	Verbiostraw	VERBIO Vereinigte BioEnergie AG	1	22.3	03.01.2014 (a)
8	CSP	CSPe	CY	HeliosPower	Infinia Corp	1	46.6	31.12.2018 (e)
9	CSP	CSPe	EL	Maximus	Maximum Solar Thermal Ltd	1	44.6	31.12.2018 (e)
10	CSP	CSPc	EL	Minos	NUR-MOH Heliothermal SA	1	42.0	31.12.2018 (e)
11	DRM	DRMc	BE	SLim	EDF Luminus, Energyville, Infrax, Elia, 3E	1	8.2	31.12.2015 (e)
12	Geothermal	GEOb	HU	South Hungarian EGS	E EU-FIRE kft., Mannvit kft	1	39.3	31.12.2018 (e)
13	Ocean	OCNb	UK	Sound of Islay	ScottishPower Renewables	1	20.7	31.12.2018 (e)
14	Ocean	OCNb	UK	Stroma Tidal Turbine Array	SeaGeneration (Kyle Rhea) Ltd	1	16.8	31.12.2017 (e)
15	Wind	WINa	DE	Veja Mate	K2 Management (Highland Group Holding Limited)	1	112.6	01.07.2017 (e)
16	Wind	WINa	DE	Nordsee One	Nordsee One GmbH	1	70.0	31.12.2017 (e)
17	Wind	WINd	FR	Vertimed	EDF SA	1	34.3	31.12.2018 (e)

#	SET sector	Technology Subsector*	Member State	Project title	Project Sponsor/Developer(s)	NER 300 call	NER 300 award (€M)	Date of entry into operation
18	Wind	WINd	PT	Windfloat	WindPlus SA	1	30.0	31.12.2018 (e)
19	Wind	WINf	SE	Windpark Blaiken	Blaiken Vind AB	1	15.0	01.01.2015 (e)
20	Wind	WINe	AT	Windpark Handalm	Energy Steiermark	1	11.3	31.12.2018 (e)
21	CSP	CSPc	CY	EOS GREEN ENERGY	Vimentina Limited	2	60.2	30.06.2020 (e)
22	Biomass	BIOg	DK	MET	DONG Energy, Vestforsyning A/S, Struer Forsyning A/S, Nomi I/S	2	39.3	01.07.2017 (e)
23	Biomass	BIOb	EE	TORR	Baltania OÜ	2	25.0	31.12.2016 (e)
24	Biomass	BIOa	EE	Fast pyrolysis	Fortum Eesti AS	2	6.9	30.11.2017 (e)
25	Biomass	BIOh	ES	W2B	Abengoa Bioenergy	2	29.2	30.06.2020 (e)
26	Biomass	BIOa	LV	CHP Biomass pyrolysis	Fortum Jelgava	2	3.9	18.04.2017 (e)
27	Biomass	BIOd	SE	Bio2G	EON	2	203.7	30.06.2018 (e)
28	CCS	CCSoxy	UK	White Rose	Capture Power consortium	2	300.0	30.06.2018 (e)
29	CSP	CSPc	IT	Mazara Solar	Abengoa	2	40.0	01.10.2016 (e)
30	DRM	DRMa	IT	Puglia Active Network	ENEL Distribuzione S.p.A.	2	85.0	30.06.2018 (e)
31	DRM	DRMa Green+	CY	Green+	Electricity Authority of Cyprus (EAC)	2	11.1	30.06.2020 (e)
32	Geothermal	GEOc	FR	GEOSTRAS	Fonroche Goethermie	2	16.8	30.06.2020 (e)
33	Geothermal	GEOc	HR	Geothermae	AAT Geothermae d.o.o. za proizvodnju energije	2	14.7	31.01.2017 (e)
34	Ocean	OCNc	FR	NEMO	Akuo, DCNS	2	72.1	30.06.2020 (e)
35	Ocean	OCNa	IE	WestWave	ESB	2	23.3	30.06.2018 (e)
36	Ocean	OCNa	PT	SWELL	AW-Energy	2	9.1	01.01.2020 (e)
37	Photovoltaics	PVa	PT	Santa Luzia Solar Farm	Magpower	2	8.0	01.07.2019 (e)
38	Wind	WINd	ES	FloCan5	Cobra ACS	2	34.0	30.06.2020 (e)

#	SET sector	Technology Subsector*	Member State	Project title	Project Sponsor/Developer(s)	NER 300 call	NER 300 award (€M)	Date of entry into operation
39	Wind	WINd	ES	BALEA	Ente Vasco de la Energia	2	33.4	30.06.2020 (e)
						TOTAL	**2,105**	

** Note: Technology subsectors are based on the NER 300 published technology categories which provide sub-categories for different SET sectors: BIO = Bioenergy; CCS = Carbon Capture & Storage; CSP = Concentrated Solar Power; DRM = Distributed Renewable Management; WIN = Wind energy.*

Source: Commission Implementing Decision C(2015) 6882

Annex 8 Overview of market participants

A8.1 The market participant sample provides good coverage across leading investors and financiers who are supporting the funding landscape for SET and FOAK projects in the EU

The 80 market participants were grouped together into four categories:

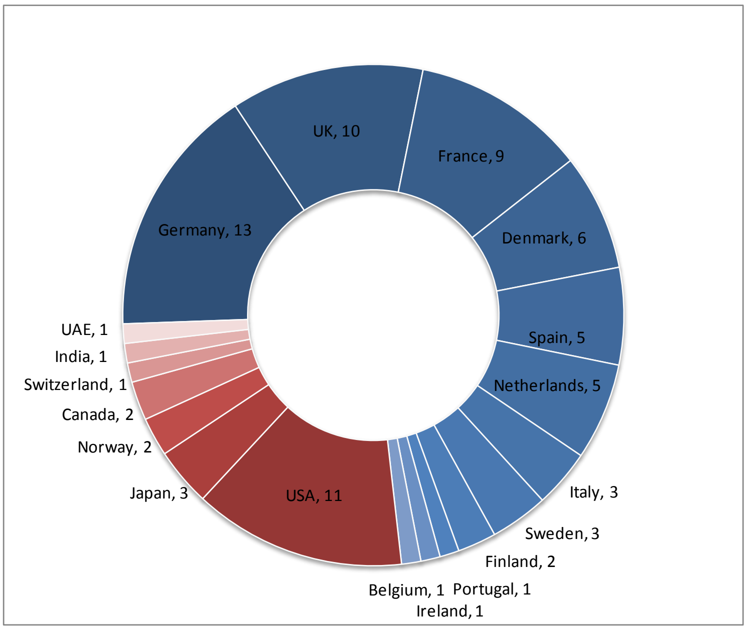
1. Specialised investors (i.e., venture capital, private equity firms) – 16
2. General investors (i.e., asset managers (2), pension funds (5), insurance companies (4), and foundations (1)) – 11;
3. Banks (i.e., public, private and project banks) – 28; and,
4. Producers (i.e., utility and energy companies, industrial conglomerates and manufacturers) – 25.

A8.2 Market participants in the sample cover both EU and non-EU countries; 12 EU Member States are represented

The 80 market participants have their headquarters in 46 cities across 18 countries, of which 12 are EU Member States (Germany, UK, France, Denmark, Spain, Netherlands, Italy, Sweden, Finland, Portugal, Ireland, Belgium), two are EEA members (Norway, Switzerland), and another four are non-EU countries (USA, Japan, UAE, India) with a global reach in their renewable energy finance. The number of market participants headquartered in each country is shown in Figure A8.1.

As well as including global centres of renewable energy finance (Germany, UK, France, Denmark, Spain, the Netherlands and the US each feature five or more market participants), several countries that feature three or fewer headquarters of market participants were included to ensure adequate coverage of countries with a more regional approach to financing renewable energy projects, such as Italy, Portugal and Sweden.

Figure A8.1 Geographical distribution of Market Participant headquarters



Source: Market Participant Description Sheets

Figure A8.1 also highlights the attention provided to non-EU countries, which represent 21 out of 80 market participants. The considerable size, reach and influence of multinationals means that renewable energy finance is sourced and has potential investors from global finance centres and conglomerates. Just over half of the non-EU market participants are headquartered in the US which features a selection of 11 market participants.

A8.3 The main SET sectors supported by market participants are wind & solar PV

For each of the SET technologies under consideration, the number of Market Participants who have made an investment/financing deal in a SET project (non-FOAK/FOAK), identified by the study team[207], is as follows:

- Advanced Electricity Networks – 29;
- Bioenergy – 51;
- Carbon Capture and Storage – 18;
- Concentrated Solar Power – 24;
- Geothermal – 12;
- Large-scale energy storage – 38;
- Ocean – 8;
- Solar photovoltaic – 62;
- Wind – 66.

At this high level, there are some clear trends:

- The dominant SET areas supported are wind and solar PV, followed by bioenergy – all three representing the three most mature renewables markets in the EU (with the exception of hydropower).
- Of medium importance in the sample are large-scale energy storage, AEN and CSP;
- Of far less interest are CCS, geothermal and ocean energy.

A8.4 Aggregate size of market participants' investments into SET projects: €40 bn

Prominent examples of investments into SET projects were identified for each market participant, with a preference for investments/financing deals which were larger in monetary terms, more recent, installed within Europe, and reflected either a given focus or diversification of the market participant's investments in asset category, geography and SET technology.

Overall, the 80 market participants have contributed €40 billion through 297 investments to 270 SET projects, of which €2 billion has been contributed through 87 investments to 85 projects identified as first-of-a-kind. Co-investors/co-financiers were identified as having invested €60 billion into the same projects.

A8.5 Individual deals in SET projects range in size from under €75 million to over €750 million; first-of-a-kind SET projects have a greater number of small deals than other SET projects

Considering individual deals, deal size is used as the key metric for investment size. This is the total monetary value of funds raised at a finance round going towards an asset, project, company loan or equity from one or in most cases a consortium of investors and lenders. The deal size is used for comparison as the breakdown of individual investments is not commonly disclosed in a transaction and similarly official sources provide finance sizes on a deal size basis.

Figure A8.2 shows the number of deals of four different size ranges (<€75m, €75m – €375m, €375m – €750m, and >€750m) for three different categories of investments:

- investments into first-of-a-kind SET projects;
- investments into non-first-of-a-kind SET projects; and,

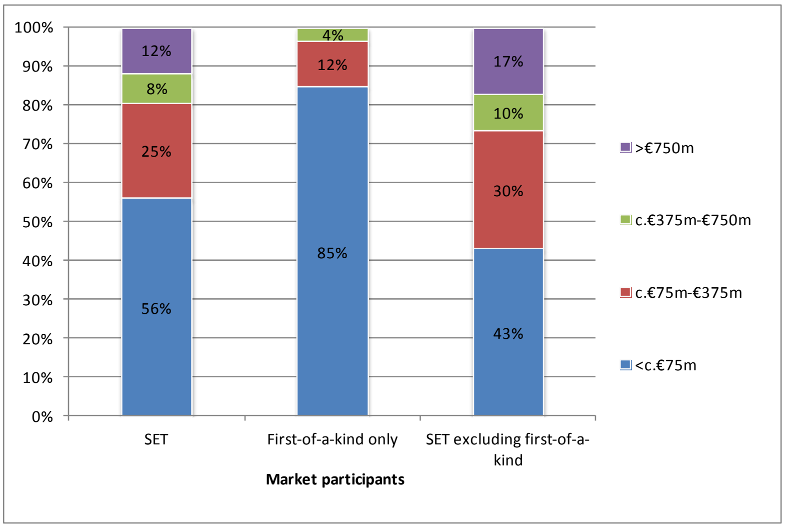
[207] The study team has sought prominent SET deals for each market participant in order to develop a picture of the funding landscape. However, a complete portfolio analysis of each market participant was not carried out.

- investments into all SET projects (shown as “SET” in the figure).

Most deals (85%) identified as FOAK projects fall into the smallest category of deal (i.e. < €75 million) although 12% of deals were between €75m and €375m, with 4% of deals also being worth up to €750m. This illustrates the high levels of funding which market participants are prepared to work with.

Conversely, the number of deals in each of the other size categories is smaller for investments into first-of-a-kind projects than for investments into all SET projects. This reflects a propensity of larger scale project financing deals for proven SET technologies such as solar PV and onshore wind.

Figure A8.2 Proportion of deals by number into first-of-a-kind and other SET projects



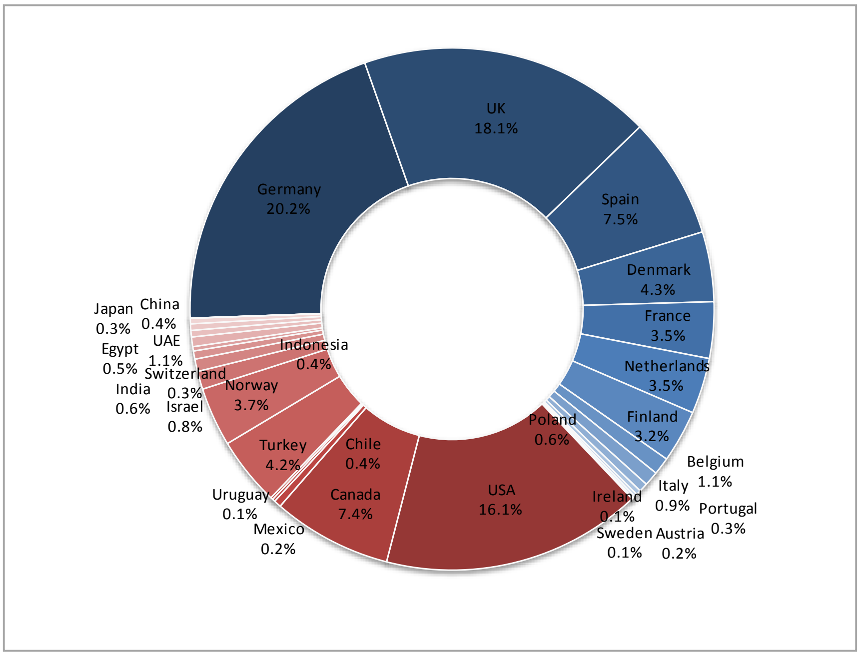
Source: Market Participant Description Sheets

A8.6 Market participants have invested mostly into SET projects located in European countries

Figure A8.3 shows the distribution of the overall value of investments by the market participants according to country of project location for the period 2006 – 2014.

The distribution is wide, both in terms of variety of EU Member States and of EU versus non-EU presence. However, it is telling that for this particular sample of market participants, Germany (20%), the United Kingdom (18%), Spain (7.5%) and Denmark (4%) together represent nearly half of all investment.

Figure A8.3 Overall value of investments (as a proportion of €40bn) by country of project location made by the Market Participants in the period 2006 – 2014[208]



Source: Market Participant Description Sheets

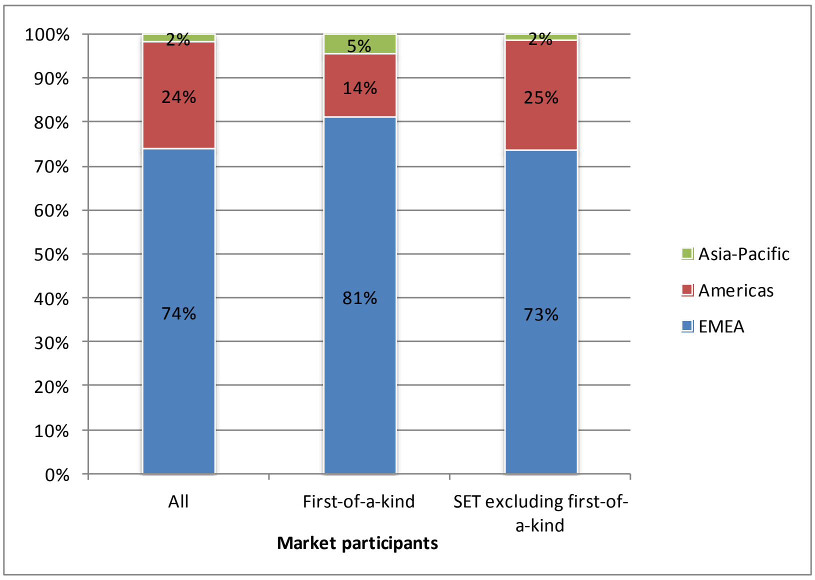
Figure A8.4 groups the countries featured in Figure A8.3 according to global region (Europe/Middle East/ Africa; Americas; and Asia Pacific) and considers investment into first-of-a-kind SET projects, non-first-of-a-kind SET and all SET projects.

In monetary value terms, 73% of the identified investments made by market participants have been into projects located in the EMEA region; with this share rising to 81% for first-of-a-kind deals. Conversely, for this sample of market participants, the Americas drops to 14% of first-of-a-kind deal values. With many of the market participants based in EMEA countries (particularly EU countries), and investing in SET projects in the EU, it is likely that there will be a preference for undertaking first-of-a-kind deals in EMEA as well as the Eurozone[209]. Certainly for equity investors (e.g. venture capital funds, corporate venture funds), it is typical to be located fairly close to investments in order to ensure efficient oversight and to provide 'hands-on' support as required.

[208] Market participants have made less than €10m in identified investments into projects in Bulgaria, Australia and Singapore

[209] Many investment funds will not invest in non-Eurozone countries

Figure A8.4 Overall value of investments (as a proportion of €40bn) by region of project location made by the Market Participants in the period 2006 – 2014



Source: Market Participant Description Sheets

A8.7 Conclusions on the selection of market participants

The sample of 80 market participants can be considered representative of the European renewable energy investment landscape relative to the global benchmark sources identified[210].

The 80 market participants offer a satisfactory range of countries, technology sectors and financing support mechanisms (e.g. equity, debt, hybrid).

The market participants identified by the study are those that have a track record of investments into SET projects including many who are making investments into innovation activities[211]. This potentially makes them more likely than other parties to take on the uncertainty of first-of-a-kind deals in a similar field, although that hypothesis is tested further in Sub-task 2.1.

[210] BNEF report "Global trends in clean energy investment q4 2014" (January 2015). Available at: http://about.bnef.com/presentations/clean-energy-investment-q4-2014-fact-pack/content/uploads/sites/4/2015/01/Q4-investment-fact-pack.pdf. Last accessed 16/04/2015; "Global trends in renewable energy investment 2014" (February 2015). Available at : http://fs-unep-centre.org/system/files/globaltrendsreport2014.pdf. Last accessed 16/04/2015; "Preqin Special Report: Renewable Energy Infrastructure" (October 2014). Available at https://www.preqin.com/docs/reports/Preqin-Special-Report-Renewable-Energy-Infrastructure-October-14.pdf. Last accessed 16/04/2015

[211] Note: "SET project" means an energy project involving one of the nine technologies of interest to this study from the SET Plan. SET projects can be either first-of-a-kind SET projects or non-first-of-a-kind SET projects.

Annex 9 Analysis of market conditions

A9.1 There is a generally neutral outlook across the EU although a few Member States have particular attraction for FOAK projects

In general, across all SET and all countries, the outlook can be taken as generally neutral, with some sectors such as biomass (BIO), ocean energy (OCN) and wind energy (WIND) showing a more positive outlook than in other sectors.

Furthermore:

- At one end of the spectrum, advanced electricity networks (AEN), large-scale energy storage (LES) and OCN have several countries that have a positive outlook and none with a negative;
- At the other end of the spectrum, CSP, solar PV (SPV) and WIND have a number of countries with a negative outlook.

It is also noteworthy that, for each SET sector, there is at least one country of particular interest, and that:

- CSP has only country of interest: IT
- OCN has two (FR, UK)
- CCS has two (NL and Norway)
- AEN has three (DE, FR, UK)
- LES has three (DE, ES, UK)
- GEO has four (DE, FR, NL and Iceland)
- WIND has five (DE, DK, FR, NL and UK)
- Biomass conversion technologies has the most: six (BG, CZ, DE, FR, IT, PL)

Clearly the most fundamental factor determining this SET market condition “landscape” is the availability of the natural resources required for the SET (e.g., the availability of a viable ocean energy resource in the North West of Europe).

However, the successful development of first-of-a-kind, commercial-stage demonstration projects for a particular SET in a particular country depends also on the presence there of a stable and supportive policy framework, and either strong or emerging supply chains. (Installed capacity is a measure of the latter. As might be expected, the market conditions sheets and the maps per SET show that most testing and demonstration facilities are located within countries that have the greatest installed capacity.) As policy frameworks vary widely, it is no surprise that capacities and capacity growth rates vary too, even between countries whose resource availabilities are similar.

A9.2 Policy frameworks are complex, support mechanisms are not FOAK-specific

Policy frameworks at European Union and Member State level for SET are very extensive and complex, and thus is it is not possible to provide an overview that captures every element in this deliverable. Further, simply listing the type and magnitude of any direct financial support mechanisms available will not provide a comprehensive understanding of non-observable market conditions at work in each of the sectors. To illustrate, in section A9.4, we provide a summary of the Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013 published by the Council of European Energy Regulators (CEER) in January 2015.

More fundamentally, a detailed review of direct financial support mechanisms may have limited impact in forming an understanding of the market conditions for first-of-a-kind, commercial-scale demonstration projects in respective SET sectors. This is because financial support mechanisms are calculated on the basis of the perceived rate of return for commercialised technologies. Clearly such support mechanisms can greatly help to accelerate the deployment of technically proven and early commercial technologies. However, there may be minimal benefits from financial support schemes to first-of-a-kind commercial-scale SET demonstration projects, other than to have a positive signalling effect to potential investors/financiers that a successful demonstration of a particular technology may find a future foothold in a supported market. (The existence and extent of the support scheme signals that the respective Member State government is committed to that SET sector, or a subsector within a SET, and wishes to increase the overall levels of deployment for that particular technology or the production of renewable energy more generally.)

Given the recent changes to state aid guidelines, we have also avoided a review of past cases. However, the potential impact of the new state aid regulations across different SET sectors is reviewed below.

A9.3 Influence of financial support schemes compared to that of other factors

In order to account accurately for the impact of the most common renewable electricity source (RES) support mechanisms, it would be necessary to contrast the levels of support that operators would actually receive in the operation period and the levels of perceived support expected when construction on a project was completed.

For large commercial projects, this information would differ on a case-by-case basis, as there are significant differences from project to project, even within the same country. In addition, as noted, RES support schemes are calculated on the basis of the perceived rate of return for commercialised technologies, and are rarely targeted towards specific technology types at the demonstration stage. Consequently, the specific, quantifiable RES support schemes currently available, as covered in the aforementioned CEER report, may be less crucial for the decision to invest in a first-of-a-kind commercial-scale SET demonstration project than other factors such as, for example, site location, the ability to achieve permitting, or proximity to technical knowledge and/or a supply chain.

We have therefore spent less time assessing direct RES support schemes and instead attempted to identify other factors which may impact the market conditions for first-of-a-kind commercial-scale SET demonstration projects in each sector across all the countries. In particular, for technologies with relatively high market deployment (e.g. solar, wind, biomass), countries with existing high penetration rates are more likely to have policies and non-observable factors (e.g. supply chains) in place and therefore more likely to have more optimal market conditions for demonstration of new developments in these sectors. Conversely, for technologies which have relatively low market deployment (e.g. ocean, geothermal, large scale energy storage) policy support plays a more crucial role in fostering support.

A9.4 Council of European Energy Regulators (CEER) Status Review of Renewable and Energy efficiency support schemes in Europe (2015)[212]

The magnitude of direct policy support mechanisms (e.g. FiTs) is often used as a proxy for the attractiveness of different countries' investment environments and thus the bankability of projects. However, calculating the bankability of projects requires substantial knowledge on a Member State level of not only the factors affecting the development of the SET project in question but also the supply chains and the infrastructure in place and, not least, the "counterfactual" scenario which the project is being measured against.

The counterfactual is particularly important because direct policy support mechanisms are set within an existing regulatory regime to incentivise optimal investment behaviour and will feed off other existing legislation, including the complexities of securing planning permission, gaining environmental and other permits, as well as other factors.

A quantitative analysis that provided comprehensive information on the level of bankability of SET projects would require a breakdown of the existing regulatory regime on a country basis, including the costs of financing. A high level of, for example, FiTs in one country does not necessarily signify that the market conditions are better within that country – it is equally

[212] http://www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Electricity/Tab4/C14-SDE-44-03_Status%20Review%20on%20RES%20Support%20Schemes_15-Jan-2015.pdf

(if not more) likely that high levels of subsidy support are required to overcome non-observable and less transparent barriers.

The CEER Status Review provides some evidence which illustrates that high levels of direct policy support are not directly correlated with attractive market conditions. It also provides an indication of the difficulties in sourcing the data on comparable policy measures.

Data from 23 national regulatory authorities in the EU and EEA[213] were collected in mid-2014 on support schemes for national renewable energy sources and summarised on a comparable basis. Key highlights from the report include:

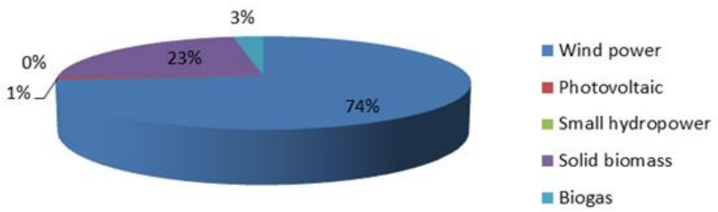
- Instruments used to promote RES include:
  - Investment grants;
  - Feed-in tariffs (FiTs);
  - Feed-in premiums (FiPs);
  - Green certificates; and,
  - Calls for tender (which is often coupled with the above types of support).
- Most RES support schemes are funded through non-tax levies or possible pass down of RES costs from the supplier to consumers;
- RES electricity is generally sold through the same channels as conventional electricity and often subject to the same electricity balancing responsibilities;
- In the majority of the 23 countries surveyed, RES plants are given priority in terms of network access and dispatch of generated electricity.

The CEER Status Review also provides the proportion of total gross electricity produced which received RES support in 2012 (making no distinction between different RES). Across the 23 countries surveyed, this proportion corresponded to 12.6% on average, ranging from less than 1% in Norway to more than 55% in Denmark. There is no correlation between the proportion of gross electricity which receives RES support in a given country and the supportiveness of market conditions in that country, since we have considered market conditions by sector by country.

It is possible that, if the report contained a breakdown of the share of supported electricity against *sector-specific* production of electricity (including by SET), a correlation between supportive market conditions and supported sector-specific electricity generation might have been found. For instance, Figure A9.1 shows that the share of wind energy generation in gross electricity production in Denmark is very high (74%), and we have identified Denmark as a country of particular interest in relation to wind energy. Assuming that the share of supported electricity at least partially covers the share of electricity generated by wind, an argument could be made that where these two are correlated there exists a supportive market environment. Unfortunately, it has not been possible to investigate this further, given the data available.

[213] Countries included Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden and the United Kingdom.

Figure A9.1 Gross electricity production per sector in Denmark (share, 2012)



Source: Geographic Information System, EurObserv'ER[214]

A9.5 Scope of the CEER Status Review with respect to RES support

The overview of RES electricity support instruments for the surveyed countries in the CEER report covers six of the SET sectors covered by our current study (i.e. Bioenergy, Geothermal, Large-scale energy storage/hydro, Ocean, Solar and Wind) and an "Other" category which covers renewable energy technologies not included in the other six sectors. For the reporting years of 2012 and 2013, this overview illustrates a preponderance of the use of FiTs. Tables in the annex of the report provide the full breakdown of the main support instruments across technology type, although no differentiation is made as to the scale (in kW or MW) of the technologies which are supported. This report can therefore not yield any substantive insights on the market conditions for demonstration of commercial-scale FOAK projects.

It should be noted that the focus of the CEER Status Review focuses on direct RES policy support for electricity. Indirect policy measures, including planning permission restraints for various technology types (e.g., eligible sites for onshore and offshore wind turbines, environmental impact assessment requirements; and blending requirements for biofuels), are not included.

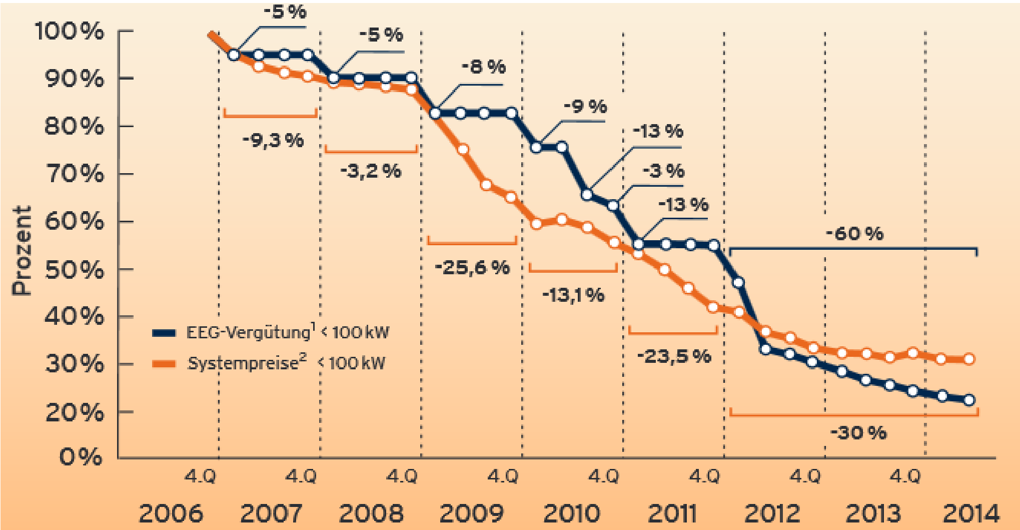
A9.6 Changes to RES support

The CEER Status Review provides further information on impending changes to policy support for RES electricity (e.g., in 2014) for some of the surveyed Member States. In total, 21 out of the surveyed 23 countries indicated that there had either been recent changes or that there were impending changes due to take effect in the near future.

This is of particular interest, as it indicates an ever-changing policy environment, evolving in response to developments in national strategies, technology innovations and cost reductions for commercial systems. This is illustrated very well by the reduction of FiTs in Germany, where the level of FiTs for solar PV has been gradually reduced to reflect the fall in PV system prices (Figure A9.2).

[214] http://www.energies-renouvelables.org/observ-er/sig/erec/sig.asp

Figure A9.2 Reduction of FiTs in Germany compared to reduction in PV system prices



Key: [1] Feed-in-Tariffs: in Q2 of 2012, tariffs were adapted as a result of legislative change in the Erneuerbare-Energien-Gesetz (EEG); [2] System prices; [3] Provisional numbers from 01/2014

Source: German Solar Industry Association, 2014 based on data from BSW-Solar, Bundesnetzagentur[215]

The CEER Status Review also gives changes in the weighted average support level of FiTs by technology for 2012 and 2013. For example, the minimum level of support provided for solar technologies decreased from €14.5/MWh in 2012 to €10.6/MWh in 2013 (both rates for Estonia), while the maximum support level also reduced from €462.1/MWh in 2012 to €448.0/MWh in 2013 (both for the Czech Republic).[216] Interestingly, solar technologies are the only category for which there are clear reductions to both the minimum and maximum levels of support, indicating a widespread recognition of large system cost reductions for this technology.

It is also important to note that lower levels of direct RES support are not necessarily indicative of worse market conditions for specific technology types due to the different regimes which countries operate. A good illustration of this is the new Contracts for Difference (CfD) regime in the UK which was introduced to help fulfil the UK's renewable energy directive target. The CfD aims to drive down the cost of renewable energy deployment through annual auctions in which competitive bids amongst project developers help to lower costs to consumers. A CfD is designed to give the electricity generator a stable and pre-agreed price (called the "strike price") over the lifetime of the contract which in turn helps to reduce investor risk whilst incentivising technically proven but near-commercial solutions to be implemented.

A company set up by the UK government to administer the CfD, the Low Carbon Contracts Company (LCCC), aims to ensure investor confidence in the new scheme and minimise costs to consumers. LCCC will pay the price difference to generators when prices fall below the strike below. Conversely, it will receive the difference when prices go higher than the strike price. This principle is illustrated in Figure A9.3 where the top up to the strike price (in green) is in addition to the reference price.

To date, the majority of CfDs across 31 projects have been awarded for onshore (>12 projects) and offshore wind (7 projects), solar PV (4 projects), biomass (1 project)[217]. Technologies are divided into Pot 1 (established technologies) and Pot 2 (less established technologies which include biomass CHP, geothermal, offshore wind and ocean energy).

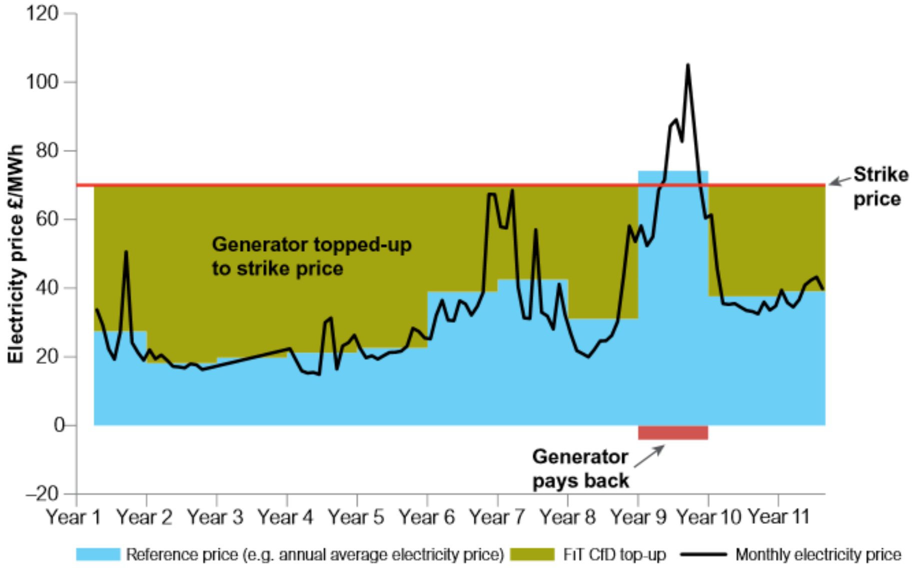
[215] http://www.solarwirtschaft.de/fileadmin/media/Grafiken/pdf/kosten_foerderung_solarstrom.pdf

[216] Note that this RES support figures do not appear to have been corrected for inflation

[217] LCCC, Annual report – 2014/15, https://lowcarboncontracts.uk/sites/default/files/publications/LCCC_AR_web_aw.pdf

The relative balance of these awards across SET areas are an indication of relative risk levels as perceived by financial markets for new technologies.

Figure A9.3 How a baseload feed-in tariff with a Contract for Difference aims to work



Source: UK DECC, Planning our Electricity Future, July 2011[218]

Whilst competition in the auction process has managed to drive down the costs of renewables in the UK, it remains too early to tell how successful the mechanism will be overall. Potential drawbacks of a CfD in the UK context include:

- Applicants must fulfil a set of criteria (varying according to technology) to prove an advanced stage of development, – for example, planning permission, grid connection, an offtake agreement, and certification where appropriate -, which may be very challenging and costly to achieve;
- Its suitability for small FOAK project developers. For example, the UK contract is understood to be over 600 pages long. Given the complexity of CfD support, coupled with the fact that projects must be well developed at the point of applications, means that most CfD contracts are likely to be in support of applications are likely to be made by larger project developments only.
- Uncertainty of the auction process, and the fact that projects must be largely viable in their own right (assuming support cannot be depended upon) leads some to consider the CfD process as a 'bonus' rather than a mainstream support mechanism[219];
- A CfD is a commercial contract, and thereby creates a contingent liability for the contracted parties, i.e. the renewable energy project company with a government or utility as counterparts. Such a support mechanism, therefore, may be difficult to gain support where governments or the utility are not deemed very creditworthy.

Overall, it is difficult to envisage a CfD mechanism being deployed at EU level – more likely it will be explored by governments and economic regulators who are keen to introduce new SET capacity but within markets where additional costs to the consumers are hard to countenance. Member States with highly creditworthy governments are also likely to be where such a complex support measure can be countenanced and delivered successfully.

[218] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48129/2176-emr-white-paper.pdf

[219] Nabarro, 26 February 2015, Contracts for Difference - who were the winners? http://www.nabarro.com/insight/alerts/2015/february/contracts-for-difference-who-were-the-winners/

A9.7 Social acceptance can be a barrier to the roll out of certain technologies

Figure A9.4 gives an illustration of the definition of social acceptance introduced by Wüstenhagen et al (2007). The authors distinguish between three dimensions of social acceptance, namely socio-political acceptance, community acceptance and market acceptance. In this study, a particular focus is given to the socio-political acceptance dimension.

Figure A9.4 The triangle of social acceptance of renewable energy innovation

Source: Wüstenhagen et. al.(2007)

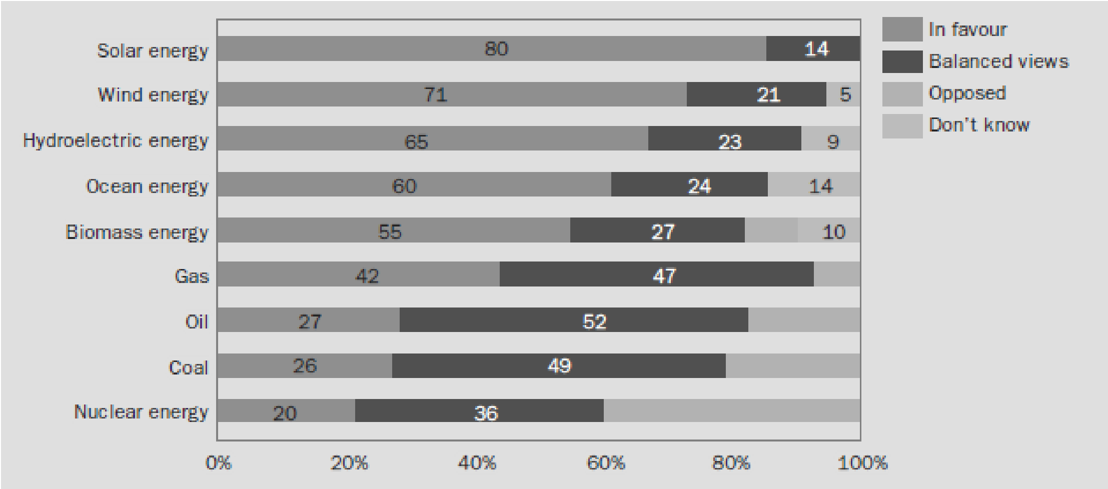
The literature review conducted by the study team pointed out to an overall lack of country specific information on social acceptance of renewable energy systems. From a sector perspective, it was possible to identify relevant surveys highlighting key social concerns. Likewise, on an EU level and in certain Member States (e.g. the UK) there are also more active research on these issues, leading to a greater information availability.

The next section presents the sector profiles of with regards to social acceptability, while the following section highlights the results of two surveys focusing on Europe and in the UK.

A9.8 Social acceptance of energy technologies in Europe

The results from EC's report "Attitudes towards energy" allow a closer look into the social acceptance of a set of energy technologies in Europe. Although this survey was undertaken in 2006, it enables some overall trends to be observed including the high overall acceptance of renewable energy generation compared with fossil-fuels or nuclear energy. According to the survey, solar energy is the most widely accepted energy technology across Europe, while biomass is the least accepted. The lower acceptance of biomass is most likely linked to the uncertainty relating to this source's net environmental impact as well as to issues regarding its competition with food crops (i.e. with regards to prices and land availability) Figure A9.5 provides an overview of the survey results.

Figure A9.5 General attitudes towards energy sources in the EU



Source: European Commission (2007) apud Lago et al. (2009)

In the UK, the Department of Energy and Climate Change (DECC) implements an annual survey to understand and monitor public attitudes to the Department's main business priorities. In its latest edition, the "DECC Public Attitudes Tracker – Wave 15" found that the level of support for specific renewable technologies were: 65% for biomass, 66% for on-shore wind, 73% for off-shore wind and wave and tidal, and 80% for solar. Interestingly, these results are consistent throughout the years. Moreover the results are also consistent with EC's research from 2006 presented above, in which solar is the most widely accepted renewable energy source and biomass is the least accepted[220]. Regarding smart metering, a study has found that 76% of British citizens would like a smarter home. Nevertheless, only 28% are willing to pay for this[221].

With regards to wind energy, the EC's report "Attitudes towards energy" provides a country by country overview of acceptance. On a scale from 1 (strongly opposed) to 7 (strongly in favour), the EU average was 6.3. The Member States with the highest acceptance were Denmark (6.7) and Greece. Poland, Hungary and Malta all averaged 6.4, while the UK, Germany and Finland showed the lowest level of support, with their average ratings falling between 5.7 and 5.8[222].

A9.9 Recent changes to European State Aid regulations for environmental protection and energy could have a positive influence on the growth in SET and FOAK funding

In 2014, the European Commission introduced the new *Guidelines on State Aid for Environmental Protection and Energy 2014–2020.*[223] These guidelines are applicable from 1 July 2014 until 2020. Member States have until 1 January 2016 to transpose these guidelines into national regulations.

[220] DECC, 2015. DECC Public Attitudes Tracker – Wave 15. UK Department of Energy and Climate Change [PDF]. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/474170/Wave_15_Summary_of_Key_Findings.pdf [Accessed 11 December 2015]

[221] GfK, 2014. 76 percent of Brits would like a smarter home – they just don't want to pay for it. Press release [PDF]. Available at: http://www.gfk.com/en-gb/insights/press-release/76-percent-of-brits-would-like-a-smarter-home-they-just-dont-want-to-pay-for-it-1/ [Accessed 11 December 2015

[222] Lago, C., Prades, A., Lechón, Y., Oltra C., Pullen A., Auer H., 2009. Wind Energy - The facts. Part V: environmental issues.

[223] Available here.

Of particular interest to this report are the following requirements[224]:

- Phasing out of FiTs (possibly in favour of feed-in premiums); and
- A gradual introduction of calls for tender for new generation capacity.

For other SET sectors, the new guidelines give the following allowances:

- Bioenergy - both operating and investment aid are permitted to support fossil fuels and biomass plants (including biomass co-fired power plants);
- Biofuels - the European Commission recognises the current overcapacity in the food-based biofuel market and therefore no longer sees investment aid from government institutions in new and existing capacity to be justified. Allowable state aids for biofuels are shown in Box A9.1 below. These show there is an opportunity for Member States to provide support to new innovative production plants or bio-refineries which can lead to novel biofuels.
- CCS - both operating and investment aid are permitted to support industrial installations equipped with CO_2 capture, transport and storage facilities or individual elements for the CCS chain. However, aid to support CCS projects does not include aid for the installation emitting the CO_2 – rather it refers to aid for the costs resulting from CCS projects.
- Smart grids – whilst acknowledging that tariffs are the most appropriate means to fund energy infrastructure, it recognises that such financing may not be sufficient. Thus, state aids may be granted to partially or wholly finance such projects in order to overcome market failures that often characterise energy infrastructure investments;

Box A9.1 State aid Guidelines on biofuel production[225]

Investment aid should only be allowed in cases of conversion of plants into advanced biofuel plants. In contrast, operational aid until 2020 should only be granted to plants in operation before 31 December 2013; and operational aid to food-based biofuels can no longer be granted after 2020.

Biofuels that fall under a blending obligation and receive state aid as well will not result in an increased level of environmental protection and therefore should not receive any state aid. Member States are only allowed to grant state aid in case they can demonstrate the aid is meant for sustainable biofuels that are too expensive to come on the market without financial support.

New and existing aid schemes for food-based biofuel should be limited to 2020.

Despite these limitations for financial support for biofuels, Member States will still be allowed to provide non-financial incentivises for food-based biofuel consumption after 2020. For examples, by the continuation of the current blending obligations.

As the CEER Status Review 2015 confirmed, a majority of the Member States surveyed had FiTs for RES generation in 2013. It is anticipated that for those countries that have not changed their FiTs between 2013 and 2015, changes will be announced up to January 2016. However, demonstration projects are exempt from the transition from FiTs to feed-in premiums and are also exempt from standard balancing responsibilities. These exemptions could be used by Member States to create demonstration-specific support schemes for SETs of particular interest.

The increasing use of competitive auctioning for RES projects (such as the UK's CfD regime) is likely to be of particular importance to the developers and investors of the first-of-a-kind demonstration projects covered in this study. This is because it is more likely to impact the larger scale of projects, particularly next-of-a-kind and commercialised versions of the first-of-a-kind demonstration technology. The new state aid guidelines include provisions for

[224] Adapted from European Environment Agency, *Energy support measures and their impact on innovation in the renewable energy sector in Europe*, EEA Technical report No 21/2014.

[225] European Commission, Guidelines on State aid for environmental protection and energy 2014–2020, 2014

technology-specific tenders on the basis of the potential of a new or innovative renewable energy technology.

A9.10 Other related Frameworks on State aid for Research and Development and Innovation

In June 2014, the European Commission adopted new rules to facilitate the granting of aid measures by Member States in support of Research and Development and Innovation (RDI) activities. More specifically, the new *Framework for State aid for R&D&I*[226] sets outs the conditions under which Member States can provide aid to companies in this field, including identifying the rationale for intervention. For example, it recognises that:

"State aid may be necessary to increase R&D&I in the Union in a situation where the market, on its own, fails to deliver an efficient outcome." [paragraph 48]

In this regard, the Framework sets out the market failures which might warrant allowable state aid including overcoming: positive externalities/knowledge spillovers; imperfect and asymmetric information; and coordination and network failures. A key condition for the acceptability of state aid is that it should have an incentivising effect on the behaviour of the undertaking. Some of the most important elements of any proposed case for Member State aid in the context of this current study of first-of-a-kind commercial-scale SET demonstration (as set out in paragraph 68) and include the:

1. Specification of intended change – i.e. the incentivising and catalytic effect of the aid in triggering a project or the speed or scale of investment;

2. Level of profitability – a project which is not, in itself, profitable might carry generate important benefits to society, such as CO_2 emissions reductions from a CCS project;

3. Investment amount and timeframe of cash flows – particular examples that would attract more support would include low levels of cash flows or a significant proportion of cash flows arising either sometime in the far future or in a very uncertain manner; and,

4. Levels of risk involved – there may be high probability of commercial failure or that the project will be less productive than expected which could undermine other activities of the aid beneficiary or the project costs might undermine its financial viability.

To "ensure predictability and a level playing field", maximum aid intensities are applied by the European Commission for R&D&I aid on the basis of three criteria (paragraph 74):

(i) Closeness of aid to the market;

(ii) Size of beneficiary – smaller undertakings are recognised as having more acute difficulties to finance a risky project; and,

(iii) Acuteness of the market failure.

In general, the intensity of aid is suggested to be lower when activities are linked to development and innovation than for research activities.

Alongside the Framework for State aid for R&D&I, the new *General Block Exemption Regulation* (GBER)[227] sets outs the conditions under which RD&I aid is exempt from the adoption of prior information notification to the Commission (i.e. it is "block-exempted"). The new rules offer more flexibility to grant aid and quicker deployment of aid.

226 Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0627(01)&from=EN

227 Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0651&from=EN

Based on the new GBER, the thresholds up to which aid can be exempted from prior notification to the Commission for approval have increased significantly, with allowable aid for experimental development (defined in Box A9.2 below) now at €15 million (formerly €7.5m)[228].

Box A9.2 Definition of Experimental Development in State aid Guidelines

> Experimental development: "means acquiring, combining, shaping and using existing scientific, technological, business and other relevant knowledge and skills with the aim of developing new or improved products, processes or services. This may also include, for example, activities aiming at the conceptual definition, planning and documentation of new products, processes or services; Experimental development may comprise prototyping, demonstrating, piloting, testing and validation of new or improved products, processes or services in environments representative of real life operating conditions where the primary objective is to make further technical improvements on products, processes or services that are not substantially set. This may include the development of a commercially usable prototype or pilot which is necessarily the final commercial product and which is too expensive to produce for it to be used only for demonstration and validation purposes. Experimental development does not include routine or periodic changes made to existing products, production lines, manufacturing processes, services and other operations in progress, even if those changes may represent improvements."
>
> *Source: Framework for State aid for R&D&I (2014); Definitions paragraph 1.3*

Importantly, the scope of aid measures for RD&I projects exempted from the obligation of prior notification to the Commission has been widened. Under the new rules, this covers not only innovation and aid for process and organisational innovation but also pilot projects and prototypes under the research infrastructure measure.

A9.11 Overall conclusions on the market conditions for first-of-a-kind commercial-scale SET demonstration projects

Market conditions for first-of-a-kind commercial-scale SET demonstration projects vary significantly from country-to-country and across SET sectors. This creates a complex landscape, making it challenging to analyse and draw meaningful conclusions about any one country's role in supporting FOAK projects, especially since the SET policy environment is constantly evolving. In general, across all SET sectors and countries, the outlook can be taken as generally neutral, although there is at least one Member State - and more typically two or three – for each SET sector which is deemed to have positive conditions for FOAK projects.

In order to account for the full scope of direct and indirect policy support, in addition to non-observable factors (such as attitudes towards specific technologies), proxy measures such as the location of test centres, existing installed capacity of renewables, and year-on-year changes in capacity have been used to identify key countries which offer some of the most favourable framework conditions.

Countries which have been identified as being of interest to FOAK projects either have consistent policy support (for SET sectors with relatively low levels of overall technology maturity) or a combination of consistent policy support with high levels of SET deployment (for innovations in SET sectors with a mixture of technology maturities, e.g., biomass conversion technologies).

When evaluating the impact of policy support on market conditions across the different SET sectors, it is not enough to consider direct RES support measures. For instance, some countries have significant levies or taxation on fossil fuels (e.g. Denmark, UK, and Germany) which indirectly support RES generation by improving the relative investment case for such technologies relative to their fossil-fuel counterparts. Countries such as the UK have also

---

[228] See European Commission Memo on new rules facilitating support for RD&I (http://europa.eu/rapid/press-release_MEMO-14-368_en.htm)

introduced innovative mechanisms like the CfD regime for providing more certainty to investors whilst also driving down the costs of renewables subsidies.

For well-developed SET sectors, such as solar PV and wind energy, there may be linkages between R&D efforts and commercial-scale direct policy support mechanisms, which in turn indicate clear cases of full-scale demonstration potential, since demonstration-stage projects are located between R&D activities and full commercialisation.

Conversely, for other SET sectors and for countries which favour either R&D efforts or commercial activities only, gaining a clear understanding for the potential of support for first-of-a-kind, commercial-scale SET demonstration projects is less straightforward. Very few countries are likely to have established track records, and development may be contingent on political interest, which is subject to abrupt change if government strategies change.

In terms of fundamental blockages, the absence of market support mechanisms – or withdrawal of support after it was previously in place (e.g. for solar PV) - has impacted on SET investment overall in some Member States, and by implication the likelihood of investors and financiers supporting innovations that previously would have found a place in such a subsidised market.

Annex 10 Overview of third country support schemes

A10.1 Introduction

The following seven schemes (also illustrated in Figure 2.3) were reviewed in detail including via consultations with several of the scheme managers:

- Advancing Renewables Programme (ARP), Australia
- NextGen Biofuels Fund, Canada
- Loan Programs Office, USA
- Carbon Capture Program, USA
- ARPA-E grants Program, USA
- New Energy and Industrial Technology Development Organisation (NEDO), Japan
- Callaghan Innovation, New Zealand

Table A10.1 provides an overview for these schemes while Table A10.2 illustrates their SET coverage. Key aspects of the schemes are discussed below.

A10.2 In general, there is a high degree of relevance of these schemes towards FOAK support, with five of the seven offering interventions around TRL 7-8.

Several schemes cover projects from TRL 4 or above through to TRL 8 or 9 (deployed and proven technology), while two schemes which offer the broadest support include NEDO in Japan (1 – 9) and the U.S. Carbon Capture Programme (2 – 8). Schemes that focus primarily on TRL 7 & 8 include the NextGen Biofuels Fund and the Loans Projects Office (which also covers TRL 9). The one scheme reviewed which does not cover FOAK projects is ARPA-E, while the New Zealand grants scheme does not offer sufficient grant funding to undertake a large-scale FOAK project of consideration in this study.

A10.3 Grant funding is the most common form of support in Australia, Japan, New Zealand and several U.S. support schemes

Besides these, interesting financing mechanisms reviewed include:

- Zero-interest loans through the NextGen Biofuels Demonstration programme in Canada. Here, the loan repayment terms are based on a negotiable percentage of free cash flow over a period of 10 years after project completion;
- Repayable loans and loan guarantees within the Loans Programs Office, USA. In this scheme, very long time horizons have been offered to pay back the loans. The average loan tenor is 22.3 years, far longer than for more commercial, mainstream projects; and.
- Combination of grant and loan support in Australia. For example, a €26.3million project involving a 10.6 MW first-of-a-kind, solar PV installation with storage at the DeGrussa Copper Mine aims to showcase the potential for RES at mine sites. Grant support of €14m million from ARENA complements up to €10m in debt finance from the Australian Clean Energy Finance Corporation, which specifically targets projects which the commercial sector is not yet willing to back.

A10.4 Annual scheme budgets vary widely

Some schemes have relatively modest budgets but can draw upon Federal funding (e.g. the Recovery Act in the USA has provided funds for both the LPO and CCPI (CCS) programme).

Table A10.1 Financial schemes supporting SET projects including first-of-a-kind in third countries

Scheme Name (delivery body)	Country	Year Started	Status	Type of Instrument	Budget	Project Funding Levels	Suitability for SET Projects
Advancing Renewables Programme (ARP)	Australia	2015	Open	Grants	~€217m for 2015/16 (total agency budget)	€70,000 to €33m (min 50% co-financing)	High – new programme focused on reducing costs and barriers to SET. Provides a robust funding 'ecosystem' where applicants are supported throughout the TRL spectrum through to TRL 9. VC fund and links to other public sector funders provides overall provision.
NextGen Biofuels Fund™	Canada	2007	Closed to new projects	Zero-interest Loans	€349m	40% of eligible costs or maximum of €140m	High – well established and well-published scheme which provides a continuum of funding for bioenergy innovations proven under the €412m STDC Tech Fund. Scale of ambition not matched by funded and operational projects (just 2 supported).
Loan Programs Office (LPO)	USA	2009	Newly opened in 2015	Loans (Full & Partial) and Guarantees	€31.4bn (€2.8bn of new funding announced)	€23m (LES) to over €1bn (CSP)	High – regarded as a key mechanism for 'bridging the finance gap' for commercial lenders with respect to FOAK projects. Wide project selection across SET, although there is some uncertainty regarding the TRL levels of the support since some technologies supported appear less technologically risky and already proven (e.g. Solar PV, CSP, Geothermal, Wind).
Carbon Capture Programme	USA	2009	Open	Grant	€92m per year (Agency) & €3.1bn previously earmarked from Recovery Act for the Office of Fossil Energy	Varying funding based on scale & type Intervention rates for power plants (30.8%) vs industrial CCS (62%)	High – well intentioned CCS programme, with opportunities for varying TRL support including for large-scale demonstration projects at coal-fired power stations (e.g. over €92m for FOAK projects capturing thousands of tonnes CO_2 per day). However, inability to finance such projects due to co-financing and permitting issues has led to just two of six original projects proceeding. More success with industrial CCS projects.

Scheme Name (delivery body)	Country	Year Started	Status	Type of Instrument	Budget	Project Funding Levels	Suitability for SET Projects
ARPA-E grants programme	USA	2009	Open	Grants	€257m (FY2015)	€2.8m on average (max €8.3m per project)	Not applicable – TRL focus makes it too early-stage as a support scheme for supporting FOAK projects. However, the approach taken gives valuable insights for effective interventions, including its strategic market focus to understand the nature and scale of market opportunities for technologies it supports; its close working with industrial companies and the venture investment community; and the discipline to close projects earlier which are not delivering against target.
New Energy and Industrial Technology Development Organisation (NEDO)	Japan	1980	Open	Grants	€1.1bn (FY2015)	Not specified (highly variable based on technology)	High – NEDO has a strategic intent to align FOAK project demonstration with clearly targeted international market opportunities which will support and enhance domestic innovation and supply chain capabilities. It has had success in supporting FOAK demonstration projects in the EU (e.g. France, Spain, UK) and elsewhere.
Project and Growth Grants (Callaghan Innovation)	New Zealand	2013	Open	Grants, repayable loans, equity	€97.5m for grants mechanism (and €48.8m operational funding)	up to €3m Intervention rates vary between 30-50%	Not applicable – New Zealand already has a mature renewables market and no immediate security of supply issue, so there is no pressure to push innovation or reduce emissions in the energy generation market. However, this scheme offers generic support to innovators who can then seek FOAK funding from the Ministry of Business, Innovation and Employment if necessary.

Source: ICF

Table A10.2 Sectoral breakdown of publicly financed instruments in support of RD&D for sustainable energy technologies

AEN = advanced electricity networks, BIO = biomass conversion, CCS = carbon capture & storage, CSP = concentrating solar power, GEO = geothermal, LES = large-scale energy storage, SPV = solar photovoltaics, WIN = wind energy; ● = TRL 7 or 8 projects eligible; O = TRL 7 or 8 projects not eligible in practice but other TRLs pursued

Instrument	Location of project	AEN	BIO	CCS	CSP	GEO	LES	OCN	SPV	WIN	Technology Readiness Levels (also for non-SET)
Advancing Renewables Programme (ARP)	Australia		●		●	●	●	●	●	●	4 – 9
NextGen Biofuels Fund™	Canada		●								7 – 8
Loan Programs Office (LPO)	USA	●	●		●	●	●		●	●	7 – 9
Carbon Capture Programme – power & industrial plants	USA			●							2 – 8
ARPA-E grants programme	USA	o	o	o	o	o	o	o	o	o	2 – 5
Grant support (NEDO)	Japan	●	●	●	●	●	●	●	●	●	1 – 9
Project and Growth Grants	New Zealand	o	o	o	o	o	o	o	o	o	4 – 8

Source: ICF

A10.5 Judging the overall market acceptance of schemes is difficult but on the whole the schemes are judged to be recognised and visible by the market

It is difficult to gauge the overall market demand for schemes as some schemes like ARP (Australia) were newly established in 2015 while others did not disclose this information or it was not available through literature review (LPO, NEDO).

In the ARPA-E scheme, the manager commented that application numbers varied depending on the technology sector and how broadly or narrowly the call had been written. In New Zealand, an 87% success rate from 165 grants can partly be explained by scheme experts closely supporting project sponsors, thereby improving the quality of applications.

A10.6 The levels of funding available are in the right 'ball park' for FOAK project support

Maximum funding levels range from €33m (Australia), €140m (biofuels, Canada), €92m or (large-scale CCS, USA) to over €1bn (for CSP within the LPO, USA). Even schemes which are of limited relevance for FOAK projects have maximum support levels of €2.8m (ARPA-E, USA) and €3m (New Zealand), often higher than EU Member State interventions.

Grant intervention rates may be as low as 30.8% (power plant CCS, USA) although typically maximum grant levels of 50% of project costs apply. Higher, technology specific interventions are possible (e.g. 62% for industrial CCS in the USA). Public institutions (e.g. universities, RTOs) may be eligible for higher support.

For loans, minimum levels of loan support ranged from 20% to 60% for the LPO scheme, contrasting with the Canadian NextGen Biofuels Fund where the maximum intervention was set at 40%, implying equity injections into FOAK projects of at least 60% by projects sponsors.

A10.7 Eligibility criteria for project funding varies widely among schemes.

Demonstration of the technology at pre-commercial pilot scale is often required, as are defined economic benefits that the support will generate. Examples include:

- ARP grants, Australia - financial viability and co-funding commitment; sited in Australia (or else funding typically restricted to 10% of funding); knowledge sharing obligation.
- NextGen Biofuels, Canada – project must be first-of-a-kind, large-scale demonstration sited in Canada, producing next-generation renewable fuel with Canadian feedstock.
- NEDO, Japan - aim to achieve full-scale demonstration; target commercialisation that achieves rapid economic growth; promote international cooperation.
- LPO, USA – projects which are at 'initial commercial deployment' and able to provide 'initial private equity' which can be complemented with debt finance.

In the case of the U.S. Clean Coal Power Initiative (CCPI), the emphasis is more on technical progress, including capture efficiency of 90% and a minimum capture and sequestration of 300,000 tpa of CO_2 emissions, although minimising additional costs from CCS implementation (i.e. <10% increase in cost of electricity for gasification systems; <35% for combustion and oxy-combustion systems) is also deemed an important eligibility criterion.

Case Study 3 Japan seeks to develop a strategic lead in floating offshore wind using public funding streams to achieve scale

METI's Strategic Energy Plan (April 2014)[229] notes that for offshore wind *"demonstration research projects that are under way in the seas off Fukushima and Nagasaki, which aim for the world's first full-fledged commercialization, will proceed further. With the goal of realizing commercialization as early as possible by around 2018".*

Japan's desire to become a world leader in offshore wind has led to the development of a technically successful 7MW turbine, the SeaAngel, developed and manufactured by Mitsubishi Heavy Industries (MHI), and supported by NEDO with a demonstration project in the UK.

Japan has also financed a Floating Offshore Wind Farm Demonstration Project (FY2011 to FY2015) in Fukushima, funded by the Ministry of Economy, Trade and Industry (METI) which originally planned to install and demonstrate one of the MHI SeaAngel turbines[230] but this has now increased to two. This project builds on the funding provided to the Floating Offshore Wind Turbine Demonstration Project (FY2010 to FY2015) by the Ministry of Environment (MOE). In this project, a 100kw turbine was first installed and then replaced by a 2MW turbine[231].

A recent report by the UK Carbon Trust[232], concluded that with more than 20 years of publically-funded research into floating technology, Japan is now a world leader; and that the full-scale projects at Fukushima and Kabashima confirm this status. Fukushima is also regarded as a 'flagship' project for floating wind, which could ultimately expand to 1GW of installed capacity at the site. To this end, METI has invested €170m (22bn yen[233]) in Phase 1 with a further €240m (31bn Yen) planned for Phase 2[234].

The Carbon Trust found that near-shore deployment (within 10km and under 20m) will represent the majority of offshore wind farms in Japan, at least until 2025. This could represent around 2GW. In the longer term, deeper water installations will be needed, requiring floating foundations – a technology in which Japan is a market leader in R&D. Carbon Trust therefore believe Japan may well achieve its 2050 target for total offshore wind deployment of 37GW (comprising of 19GW of fixed and 18GW of floating).

Japan recognises that grid access for new renewables capacity is currently limited, and is therefore driving market-related policies, such as incentives (FITs, subsidies) combined with support for standardisation and RD&D which plays to Japanese industrial strength. According to its Strategic Energy Plan, the vision is clear: *"Japan will promote the creation of the world's most advanced energy-related market by implementing demonstration projects for putting new technologies into practice at the same time as carrying out institutional reforms, including the electricity system reform."*

[229] http://www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/4th_strategic_energy_plan.pdf

[230] http://www.meti.go.jp/182uropa182/press/2013/1111_01.html

[231] http://goto-fowt.go.jp/182uropa182/home/

[232] Carbon Trust, October 2014, '*Appraisal of the Offshore Wind Industry in Japan*', for the British Embassy, Tokyo https://ore.catapult.org.uk/documents/10619/118716/pdf/41f8364a-04d3-4780-bb90-657b513cc9a0

[233] 1 EUR = 131.718 JPY at 10 November 2015

[234] *ibid*

Case Study 4 Building scheme branding and reputation are essential

The Loan Projects Office (USA) produces regular reports of its loan book and has reported in detail on the market stimulation effects of its support, at least for utility-scale solar PV. This scrutiny may well reflect the Federal government's desire to justify the enormous sums of funding it has used in this loans / guarantees mechanism (which was instigated in the wake of the 2008 financial crisis). In particular, demonstrating good value from the initiative to the general public after well-publicised failures like Solyndra which lost $500 million in support is critical when it went into administration is critical. This is especially since the Obama administration now wishes to use the same financing mechanism to support distributed generation with a further $3 billion of loans.

NEDO (Japan) undertakes detailed road-mapping of its key technology support, and evaluates the impact of projects, and especially the cost effectiveness of funding key technologies. Much of the material has been translated into English to broaden the readership. This helps to increase the global visibility of Japanese SET innovation and commercialisation prowess, and facilitate the deployment of NEDO-funded FOAK demonstration projects in foreign countries/regions such as the EU and North America.

Annex 11 Synthesis of findings from market participants

A11.1 Introduction

ICF interviewed 29 (36%) of the original list of 80 financial market participants with at least 29% in all four groups. Interviewees were senior representatives, often responsible for deciding on SET/FOAK strategy and decision making. Given overall investment and financial volumes disbursed by these organisations, views expressed by this sample are deemed to be representative of equity and debt providers overall within the European market. Findings are set out below.

A11.2 Key risks and showstoppers

The main concerns expressed by market participants are technology, completion, revenue and regulatory / revenue risks, summarised as follows:

- Technology Risk
  - Will the project work as expected?
  - Will scale up and integration into existing infrastructure work?
- Completion Risk
  - Will the project be completed to time, cost and specification?
- Revenue Risk
  - Are revenues assured (e.g. offtake agreements, tariffs)?
  - Are revenues enough to service finance, if project completed?
  - Is the business model viable?
- Regulatory & Legal Risks
  - Is there a stable legal / regulatory framework to support the business?

Of these risks, all four groups of market participants cite technology risks and risks due to regulatory instability as key to their business decisions although it was not possible to reasonably differentiate the importance of one more than the other. However, fundamentally, Revenue, Market & Regulatory risks are all interdependent since one will often need a Feed-in tariff (FiT) or Contract for Difference (CfD) in place to make a project financially viable; and that FiT/CfD need to be underpinned by a reliable counterparty.

Among other risks and obstacles, the high volume of costs for SET is cited as an obstacle by Producers and Specialised Investors; project completion risk is cited by Banks; and commercial risks are cited by Specialised Investors.

The underlying long term economics of individual SET projects are fundamental for all market participants. Essential considerations here relate to dependable levels of anticipated or forecast investment requirements (initial capex and working capital requirements), the weighted cost of capital, and revenues, as represented by the competitive position of SETs (in relation to conventional, fossil-fuel based technologies, as subsidised at present).

Of these risks and obstacles, only risks due to unproven technology, regulatory instability or inherently unviable project economics are ever cited as being showstoppers. Unproven technology is cited as a showstopper by Banks and General Investors. Potential regulatory instability (in particular, the risk of withdrawal of feed-in tariffs or other subsidies) is the reason why one Specialised Investor will not touch an opportunity (whether FOAK or not) involving subsidies during operations, e.g. CfD, FiT at elevated levels, tax credits, etc.

A11.3 SET sectors and technology readiness levels

Unsurprisingly, in view of their general attitude towards unproven technology in general (not necessarily SET-specific behaviours) all Banks and almost all General Investors[235] restrict themselves to opportunities involving SET projects at TRL 9, mostly involving wind energy, biomass conversion and solar photovoltaics.

Specialised Investors and Producers operate across a wider range of TRLs, namely TRL 5-9. They also operate across a wider range of sectors to a greater or lesser extent, such that only Ocean energy was the only SET sector in which no market participant interviewed was currently active (although some had been until a few years ago). Nonetheless, considering SET opportunities generally, wind energy, biomass conversion and solar photovoltaics are the most popular SET sectors among these groups as well. Considering FOAK opportunities, advanced electricity networks and large-scale energy storage take on more prominence.

Across the four groups of market participant, wind energy and biomass conversion are the most popular sectors, with 50% or more of individual market participants being active in each; advanced electricity networks, concentrated solar power, geothermal and large-scale energy storage are less popular, with around 25% of individual market participants being active in each; and ocean energy and carbon capture and storage are the least popular, with less than 10% of individual market participants being active in each.

A11.4 Financing decision criteria

Market participants were reluctant to divulge the criteria that they use, so much so that no market participant answered all the questions put to it on the subject. With that caveat, we nonetheless summarise the information received. The criteria reported through the interviews can be grouped into four categories (Technology, Developer, Developer's Partners, and Commercial) and clear parallels can be seen with the risks and obstacles reported.

As regards Technology, the criteria stated were:

- Is the technology proven? Are there any precedents anywhere? (BANKS) Is the technology proven and certified? (GENERAL INVESTORS)
- Is the concept proven? Is it unique, robust, scalable, and proprietary? Has it been piloted? (SPECIALISED INVESTORS)
- How complex is the project and what are the expected deliverables? (PRODUCERS)

As regards the Developer, the criteria stated were:

- Does the developer have a strong management team? (SPECIALISED INVESTORS, GENERAL INVESTORS)
- How efficient is the developer organisation? (PRODUCERS)
- Is the developer small but bigger than start-up and has it been around for at least 5 years? (SPECIALISED INVESTORS)
- Does the developer enjoy a near-monopolistic position through exclusive contracts or a concession? (GENERAL INVESTORS)
- What level of equity, cash (to service debt/equity), and government support does the developer bring? (BANKS)

As regards the Developer's Partners, the criteria stated were:

- Does the developer have a large industrial partner? (SPECIALISED INVESTORS, GENERAL INVESTORS and BANKS)
- Do the developer's partners bring performance guarantees? (GENERAL INVESTORS, BANKS)
- How reliable are the (developer and its) partners? (PRODUCERS)

As regards Commercial, the criteria stated, with no clear ranking identified, were:

[235] The exception is GI-3, which invests in opportunities involving SET projects at TRL6 and no higher; but this is an exception that proves the rule as GI-3 described its strategy as being more like that of a venture capital firm

- What are the market trends and prospects for the technology? (SPECIALISED INVESTORS)
- What are the pipeline of opportunities and prospects for new relationships with other market participants? (GENERAL INVESTORS)
- What are the market opportunities in the short and long-term and how will this project help develop our business? (PRODUCERS)
- What are the opportunities for deal syndication? (SPECIALISED INVESTORS, GENERAL INVESTORS and BANKS)

A11.5 Volumes and forms of finance, typical deal parameters

Banks and General Investors have the greatest volumes of finance to disburse, with each individual member of those groups disbursing over €100 million per year into SET opportunities. By contrast, Specialised Investors each disburse less than €50 million per year into SET opportunities, with some disbursing less than €10 million. Producers did not disclose the volume that they each disburse, but ICF research for Deliverable 10 indicates over €100 million annually for most.

Market participants were reluctant to divulge the deal parameters that they use, so much so that no market participant answered all the questions put to it on the subject. With that caveat, we nonetheless summarise the information received.

Debt is the main form of finance provided by Banks for SET, not just by the commercial Banks, but also the investment Banks. Of the Banks interviewed, most state that they provide senior debt only, secured against project assets, although one was also prepared to provide additional sub-debt, or mezzanine capital, which ranks lower in priority in the event of default. Generally, the banks rely first and foremost on the anticipated project cash-flows for their debt service, and in addition they take security over the project's assets. However, in the context of FOAK SET-type projects, lenders will seek additional security from developers, sponsors, etc., in terms of performance or financial guarantees

From the evidence received, no lender interviewed provides senior debt to FOAK projects without some form of guarantee to support debt service.

Equity is provided by Specialised Investors, General Investors and Producers. Specialised Investors provide between €0.5m and €4m per deal, including FOAK opportunities – essentially focused on venture investments which might entail small-scale FOAK projects. General Investors consulted provided between €100m and €150m per TRL 9 deal; the sole General Investor who provides equity for TRL 6 deals provides between €1m and €20m per deal. For Producers, the situation is less clear since only one Producer responded in relation to external investments; the answer given was between €10m and €200m.

Producers also finance SET opportunities on balance sheet, but the only information received about this was from two Producers who stated that the threshold investment level for in-house projects started at €5 million and €10 million respectively.

A11.6 Attitudes towards FOAK

The market participants who have a positive attitude towards FOAK are some (but not all) Specialised Investors and Producers. Owing to bad experiences with FOAK deals, and also SET deals, and the competing attraction of opportunities in other fields, fewer Specialised Investors are active and those that are though not to the same extent as in previous years.

The market participants who have a negative attitude towards FOAK consist of the Specialised Investors who have left SET entirely, all Banks and General Investors, and the Producers whose innovation strategy consists of continuous improvement of proven technology.

For Banks and General Investors, the levels of technical risk are too high. Most cited unproven technology as a showstopper. The others considered the circumstances under which they might reconsider their attitude as hypothetical.

A11.7 Market participants did propose an interesting list of potential mechanisms

In general, ideas for support from market participants mainly cover the ‘conventional’ mechanisms which have been identified through other parts of the study (for example, via EC, Member State and third country schemes, and corroborated in many cases by project sponsor survey responses). These mechanisms include:

- Grant funding – including for pre-feasibility / FEED studies and construction phase only[236], together with standard public-sector supported pilot/demonstration projects (as has been done for offshore wind through FP7 & Horizon 2020 – see Case Study 4 box below). However, two VCs were less supportive of Horizon 2020 grants, citing respectively onerous requirements for SMEs and a 60% co-financing requirement which was felt to be too high;
- Equity funding – suggested by market participants across all four groups. One VC observed that EU monies are currently *“spread too thinly to too little effect”* across various support schemes. One Producer said that *“there is a lack of equity and debt in the market for start-ups, due to long design cycles, capital intensive, and many investors seek out existing operational projects”*. Creation of a new expert-led equity support scheme, for example, with the EC partnering with the types of market participant (namely VC and private equity firms) who have the right “risk profile” for pursuing FOAK opportunities is the basic approach of such a fund. Another VC felt that the EC should establish a fund with an investment committee setting investment targets, making investment decisions, and having a right of first refusal in subsequent projects of investee companies. One PE firm felt that the EC could bring together 20 to 30 private-sector market participants such as VC/PE firms and pension funds as well as public officials and review investments on a volume discount basis with a hurdle rate of 6-8%. A VC echoed this approach but did so based on the fact that the only types of market participant who operate near “the Valley of Death” were VC firms, on the one side of the Valley, willing to finance early stage projects, and on the other PE firms willing to finance opportunities related to proven technology with a track record. However, two VCs felt existing VC funds and vehicles (such as the EIF) already existed;
- Repayable loans; and
- Guarantees including first-loss facilities used by EC/EIB to lower the risk of FOAK projects *“which is more important than raising the return”*.[237]

Other financial mechanisms suggested, which might or might not be feasible for the EC or Member States to consider, included:

- Bridge finance for the construction period;
- Provision of 70 – 80% of financing in several tranches of different types – for example, convertible grants, low-interest loans, mezzanine loans. *“If the investee company’s project fails, everyone loses money. If the project is semi-successful, the loan is repaid but not the grant. If it is successful, the loan is repaid, the grant is repaid, and a share of the returns is paid out.”*
- Guarantees to cover enforceability of contracts, performance defaults, integration issues, payment defaults, as well as “non-technical risks”[238]. These might come either from the EC[239] or, perhaps more realistically, from corporate sponsors – see Case Study 4 box below where this issue has arisen for the EU offshore wind supply chain, notably to cover supply chain risks for SMEs.

[236] This private equity firm felt “one-off” grants or subsidies to assist with construction would be helpful

[237] Note two banks were against such a mechanism

[238] In such a case, this Producer ‘might be prepared’ to bear technological risks in a FOAK project.

[239] One general investor was against such guarantees as it “raises suspicions that the technology is not ready”

- Utilise monies from existing R&D budgets – redirect a proportion of R&D budgets for commercialisation of R&D through soft funding, *"There is a huge amount of R&D funding available but only a pittance available for funding the commercialisation of R&D."*
- Contracts for Difference type support mechanisms – e.g. for CCS in the UK, underpinned by either a (repayable) grant[240] or loan guarantee;
- Technology-specific feed-in tariffs – only for biomass since, this would be *"impossible"* for LES or AEN projects and *"politically unrealistic"* for other SET;
- Reinsurance schemes to cover technical risks – for example, having an EU-wide insurance policy to reinsure against the technology risks of the first project of an investee company. This was specifically mentioned by several market participants to cover geothermal drilling risks with insurance policies already existing in France and the Netherlands. The basis of this recommendation is that the risk is due to "the geology failing 5% of the time", which is too often for investors when drilling costs may be €7 million. Hot-rock geothermal should not be eligible, according to one VC fund, as risks are higher in such projects.
- Incentivise large industrial companies to invest in FOAK - the large balance sheets of industrial companies make them more readily able than other market participants to invest in riskier FOAK ventures.

Case Study 4 Financing innovations within the EU offshore wind sector are helping to overcome funding needs and challenges

Joint ventures are now occurring, creating more financially robust ventures - a key strategy amongst offshore turbine manufacturers has been increased collaboration and partnerships, both to ensure strong balance sheets but also to pool technology development costs, skilled labour and capitalise on historic supply chain relations. Two significant examples included Danish Vestas Wind Systems A/S and Japanese Mitsubishi Heavy Industries who formed a JV in offshore wind energy, MHI Vestas Offshore Wind in April 2014[241]; and French Areva and Spanish Gamesa who formed a JV in offshore wind in July 2014[242]. The latter consortium is seeking to achieve close to a 20% market share in the European offshore wind market by 2020.

Developers are deploying more sophisticated financing approaches, being more innovative in how they finance ever larger and more complex projects. To mitigate the risk of holding all the costs for offshore wind parks on their balance sheets, European utilities are bringing in other forms of capital from a broader set of investment classes (e.g. pension funds, investment funds, insurance companies). Some developers are also offering investors the option to share portfolio risk, rather than taking the risk of a specific project. This strategy also opens investment opportunities for less experienced investors who may not have the market knowledge and insights invest in a specific project. Spreading risk across investors has helped to achieve financial close. Bond financing is now being used with lower spreads than bank debt, helping to reduce costs; the European Investment Bank's Project Bond Initiative is also helping to provide credit enhancement to project financing lowering risk to investors[243].

There is a need for more sophisticated insurance products to mitigate risks within the offshore wind supply chain, especially for more vulnerable SMEs. The financial services sector with the support of industry associations and operators should consider which areas to target and the most viable mechanisms to overcome these risk/liability issues.

[240] Grants considered equity equivalent and repaid when investors had achieved defined threshold rates of return

[241] See press release: http://www.vestas.com/en/media/~/media/4f40f781dd5c42f9aac58c718558d1ed.ashx

[242] See press release: http://www.gamesacorp.com/en/communication/news/areva-and-gamesa-signed-binding-agreements-for-the-creation-of-a-global-leader-in-the-offshore-wind-segment.html?idCategoria=0&fechaDesde=&especifica=0&texto=&idSeccion=0&fechaHasta=

[243] See http://ec.europa.eu/economy_finance/financial_operations/investment/188uropa_2020/index_en.htm

The EC should continue to stimulate investment in RDI infrastructure - RD&D grant support through Horizon 2020 was welcomed by offshore wind suppliers and the EC / Member States should also help to finance demonstration sites which can allow for long-term testing of innovative turbines whilst generating operational revenues.

Source: ICF, for DG GROW, Competitiveness of the EU Renewable Energy Industry – Final Report (a study which consulted with the EU offshore wind supply chain), 2014;

Capital 'recycling' for offshore wind projects improves developer liquidity – debt finance by the UK GIB of a novel offshore wind farm developed by DONG Energy allowed its project to be a "'*first of a kind deal' given that it was the first offshore wind project to commercially deploy the new 6MW turbine and it involved inherent construction risks that had never been debt financed previously'*. The GIB's refinancing of the project enabled DONG to free up money and 'recycle' its capital to invest in further projects *"in order to fund the scale of the generation requirement in the UK."*

Source: Aldersgate Group, 'Three years of the Green Investment Bank: what next?' – conclusions of a seminar held on 20th October 2015

Recommendations from market participants that do not involve financial instruments included:

- EC / Member State owned FOAK projects – i.e. *"a public authority or agency would own and operate"* a project and market participants would arrange to provide the technology and know-how; and
- Publish case studies of successful FOAK projects - to show clean technologies are investible and so attract investment.

Recommendations from market participants that focused on EC support for policy and regulatory frameworks, included for example:

- Achieve consistent energy policy across all Member States;
- Support regulation of the European energy market to enable a framework for secure revenue streams from energy storage; and,
- Getting governments to put a real cost on carbon emissions.

A11.8 Recommendations from Market Participants

Market participants from all four groups made recommendations for the EC and EIB regarding publicly funded support schemes, regardless of whether they themselves were interested, or could be persuaded to be interested, in FOAK opportunities. The most popular of these recommendations to the EC and EIB may be summarised as follows:

- Financial support should be provided, mainly as equity and guarantees, but with some involvement for subsidies (e.g. to help with construction) and debt;
- Collaborate with market participants with the most appropriate risk profile and who operate near the 'Valley of Death', i.e., venture capital firms and private equity firms;
- Incentivise large industrial firms (i.e. Producers) to invest in FOAK;
- Support technology developers from the early stages of project development (i.e., not only when their projects reach TRL 7 and the commercialisation 'Valley of Death');
- Harmonise policy and policy frameworks for energy across Europe, which would help to provide some price stability and revenue certainty.

A11.9 Summary tables

Table A11.1 gives an overview of the four market participant groups' financing strategies and (informing those strategies) perceptions of risks and obstacles with respect to SET.

Table A11.2 gives an overview of the four market participant groups' attitudes towards FOAK, the circumstances that they state might change their attitude from negative to positive (if applicable), and their FOAK financing strategies (if applicable).

Table A11.3 gives an overview of the EU and Member State support schemes explored by market participants and of their recommendations to the EC and EIB with respect to support schemes as well as to SET-related policies and policy frameworks.

Table A11.1 Overview of market participants' perceptions of risks and obstacles with respect to SET and of their SET financing strategies

AEN: advanced electricity networks; BIO: biomass conversion; CCS: carbon capture & storage; CSP: concentrating solar power; GEO: geothermal; LES: large-scale energy storage; SPV: solar photovoltaics; WIN: wind energy

	Specialised Investors	General Investors	Banks	Producers
Main risks and obstacles to SET financing perceived by market participants	■ Technology risks, including scale-up and risk associated with fitting new technology into existing infrastructure ■ Regulatory risks, especially as regards changes in feed-in tariffs and (other) subsidies ■ High volume of costs ■ Commercial risks, e.g. – High cost per MWh of generation – Need for supply agreements (for biomass) and offtake agreements – Unfair competition from outside Europe – Lack of commercial structure for revenue generation for energy storage	■ Unproven Technology ■ Regulatory Instability	■ Unproven Technology ■ Project Completion ■ Regulatory Instability	■ Unproven Technology (particularly in relation to external investments) ■ Regulatory instability, especially as regards changes in feed-in tariffs ■ Length of design cycles ■ High volume of costs
SET sectors of interest	Major: BIO, SPV; Medium: AEN, LES, WIN; Minor: CCS, GEO; Historic only: CSP, OCN	Major: WIN, SPV; Minor: BIO, CSP; Historic only: AEN, GEO, LES	Major: WIN, BIO, SPV; Minor: CSP, GEO	Major: WIN; Medium: BIO, LES; Minor: AEN, CSP, GEO, OCN, SPV
Technology readiness level range	TRLs 5 – 9	TRL 9 (all bar one), TRL 6 (one)	TRL 9	TRLs 5 – 9
Geographical remit	Each operates in a few countries on two or three continents: Europe, Americas, Africa, Asia	Varies from Europe to Worldwide	Worldwide, mainly Europe	Varies from Europe to Worldwide
Volume disbursed annually into SET	Up to €50 million by some Specialised Investors; up to €10 million by others	Over €100 million by each General Investor	Over €100 million by each Bank	Over €100 million by most Producers; €50m – €100m by one Producer
Main form of SET financing	Equity	Equity (all), Debt (most)	Debt	On balance sheet, Equity
Financing decision criteria ***(NB. Market participants were most reluctant to give specific details. Each of the criteria listed was specified by at least one market participant but by no means all in the group)***	■ Technology: – Is the concept proven? – Is it unique, robust, scalable, and proprietary? – Has it been piloted? ■ Trends in the market for the technology ■ Is the company small but bigger than start-up and at least 5 years old? ■ Strength of developer's management team ■ Large industrial partner? ■ Opportunities for deal syndication	■ Proven, certified technology? ■ Large industrial partner? ■ Guarantees from suppliers? ■ Strength of developer's management team ■ Potential for growth, profitability of developer ■ Does developer have exclusive contracts or concession? ■ Pipeline of opportunities? ■ Prospect of new relationships with other market participants? ■ Opportunities for deal syndication	■ Proven technology? ■ Large industrial partner? ■ Guarantees from suppliers? ■ Level of equity from developer ■ Level of cash from developer to service debt ■ Type and level of government support ■ Opportunities for deal syndication	■ How will the project help develop our business? ■ What are the expected deliverables from the project? ■ How complex is the project and how efficient the organisation? ■ What are the market opportunities in short and long term? ■ Reliability of prospective partners (NB these are criteria relating to external investments, not in-house projects)
Financing parameters ***(NB. Market participants were most reluctant to give specific details. Each of the criteria listed was specified by at least one market participant but by no means all in the group)***	■ Deal size range: €0.5m - €4m ■ Time horizon for return: 3 - 10 years ■ Target rates of return: – 2.5 – 5 times investment before exit – Indicative internal rates of return: solar, onshore wind 7%; offshore wind 8%; biomass conversion 15%.	■ Typical deal size: – Equity for TRL9: €100m - €150m – Debt for TRL9: €30m – Equity for TRL6: €1m - €20m ■ Debt/equity ratio: 70/30 ■ Debt-service coverage: "depends on project" ■ Time horizon for return: 5 - 20 years ■ Target rates of return: – 6 - 12% depending on strength of industrial partner – 5 times investment before exit	■ Min. deal size: €10m - €30m ■ Debt/equity ratio: range of 60/80-40/20, depending on technology risk, sponsor quality and undertakings etc. ■ Debt-service coverage: 1.3-1.4 ■ Time horizon for return: less than 15 years (typically much shorter[244]) ■ Dividend policy must be specified in loan agreement ■ Interest rates: 1 - 3% for corporate loans 5 - 15% for mezzanine	■ Deal size range: €10m - €200m ■ Time horizon for returns: 15 – 25 years ■ Target return on investment: "at least double digit" (NB these are criteria relating to external investments, not in-house projects.)

[244] Frequently linked to opportunities for refinancing whether in capital markets or otherwise

Table A11.2 Overview of market participants' attitudes towards FOAK, the circumstances that they state might change their attitude from negative to positive (if applicable), and their FOAK financing strategies (if applicable)

	Specialised Investors	General Investors	Banks	Producers
Attitude towards FOAK projects	Positive, mainly, but not to the same extent as historically because of problems encountered.	Negative, for one or more of the following reasons: ■ TRL 9 investors: – Unproven technology – Preference for low-risk/low-return investments – Lack of confidence in technology developers or their partners ■ TRL 6 investor: – Large volumes of finance required – Low return on investment and lengthy time horizons for those returns.	Negative. For most Banks, unproven technology is a showstopper. For the rest, the overall high level of risk rules FOAK out.	Positive, mainly.
If negative towards FOAK, what might change their mind?	■ For those who are against, nothing: they no longer invest in SET opportunities, let alone FOAK.	■ For some General Investors: sufficient de-risking by guarantees from industrial partners and publicly funded support schemes, but this was mentioned as a hypothetical possibility. ■ For one General Investor, hybrid projects in which FOAK storage were combined with non-FOAK other sectors might be a possibility. ■ For other General Investors: nothing in practice.	■ For most Banks, nothing. ■ One Bank might re-consider if risks were shouldered by other partners, who would have to include large industrials, developers with equity, and other key partners with whom it already has a relationship.	Of the two Producers who are negative towards FOAK, one was speaking in relation to external investments, and the other's involvement with innovation consists only of continuous improvement of proven technology.
If positive towards FOAK, financing strategy decision criteria and parameters	As those listed in Table A11.1 above for SET opportunities.	Not applicable	Not applicable	As those listed in Table A11.1 for SET opportunities, noting that they relate to external investments rather than in-house projects.
If positive towards FOAK, stage of initial involvement	■ Generally not specified. ■ One Specialised Investor does not become involved earlier than the time to build the demonstration plant (i.e., in construction phase, which may last 6 to 18 months). ■ Another Specialised Investor may become involved 8 to 9 years before expected profitability.	Not applicable	Not applicable	Not specified
If positive towards FOAK, any successful exits?	A minority (two) of Specialised Investors reported making successful exits.	Not applicable	Not applicable	Not specified

Table A11.3 EU and Member State publicly funded support schemes explored by market participants, and market participants' recommendations to the EC and EIB on support schemes as well as on SET-related policies and policy frameworks

	Specialised Investors	General Investors	Banks	Producers
EU and Member State Schemes explored	■ Horizon 2020 ■ European Investment Fund	■ Horizon 2020 ■ Danish Export Credit Agency (in conjunction with EIB)	None	None
Market Participants' recommendations about the TYPES of FINANCING that the EC/EIB should provide				
Recommendation for EC/EIB to provide DEBT?	YES – As low-interest loans, mezzanine loans	no recommendation made	YES – bridging finance for construction	YES
Recommendation for EC/EIB to provide EQUITY?	YES	YES	YES	YES
Recommendation for EC/EIB to provide GRANTS?	YES – For the construction phase; or – As convertible grants	NO	YES – For feasibility studies; or – As equity-equivalent grants	YES
Recommendation for EC/EIB to provide GUARANTEES/ INSURANCE/ UNDERWRITING?	YES	Some say YES; others say NO	YES (mixed opinions about First Loss facilities)	no recommendation made
Recommendation for EC/EIB to provide SUBSIDIES?	Some say YES (for construction phase); others say NO	YES – on a First-Loss basis	no recommendation made	no recommendation made
Other actions for EC/EIB to take, as recommended by Market Participants				
Actions relative to SUPPORT SCHEMES	■ Collaborate with Venture Capital & Private Equity Firms ■ Support technology developers from the early stages of their projects ■ Incentivise large industrial companies to invest in FOAK ■ Utilise monies from existing R&D budgets for commercialisation ■ Ensure that European taxpayers' money is used to support European businesses and not disguised non-European businesses	■ Collaborate with Venture Capital & Private Equity Firms ■ Support technology developers from the early stages of their projects ■ Accept major share of risk and minor share of returns	■ Harmonise EU and Member State innovation support schemes ■ Do not provide support as this would distort the market (NB this is a solitary opinion)	■ Ensure that the support scheme is user friendly and its financing "additional" (i.e., not displacing other financing) ■ Lower the level of non-technical risks ■ Prioritise SET sectors according to – Market size (Europe, worldwide) – Technological challenges – Technology Readiness Level – Expected time to market – Current price per MWh and expected price per MWh at maturity
Actions relative to POLICIES and POLICY FRAMEWORKS	■ Play a role in developing a consistent energy policy across all Member States ■ Regulate the European energy market to enable a framework for secure revenue streams from energy storage ■ Protect European businesses from unfair competition ■ Play a role in getting governments to put a real cost on carbon emissions	■ Play a role in developing pricing frameworks in order to provide revenue certainty through a stable off-take price or tariff ■ Encourage use of technology-specific feed-in tariffs ■ Encourage use of Contracts for Difference	■ Establish a framework for power purchase agreements and stable tariffs ■ Provide support for a framework that would allow Contracts for Difference -type contracts ■ Provide a clear EU CCS policy	■ Develop a policy to promote Power-to-Gas projects, for their own sake and as part of an initiative to maintain gas networks in Europe ■ Permitting and authorisations take more time and effort to obtain for FOAK than for non-FOAK projects; a policy to facilitate permitting and authorisations for FOAK projects would be helpful.
MISCELLANEOUS Actions	■ Publish reports on successful FOAK demonstration case studies as they would show that clean technologies are investible and so attract investment	■ Own and operate a demonstration project (General Investor would arrange to provide technology and know-how)	no other recommendations made	no other recommendations made

Annex 12 Risks for FOAK projects and mitigating actions

A12.1 Introduction

This paper summarises the risks which impact on SET FOAK projects and the types of mitigating measure which could feasibly be introduced, either by project sponsors or the public sector, through various Options which have been defined. It helps to illustrate which risks are most significant for SET FOAK projects, not only from a project sponsor perspective but, crucially, in the eyes of financial market participants in particular. This in turns leads to an analysis in which risks are classified either specifically for SET FOAK projects or as part of a more generic set of project and investment risks.

A12.2 Approach

A number of risks have already been established in this study from the detailed surveys and consultations with both project sponsors and financial market participants. The Interim report for this study presented these risks, and they are summarised in Section A12.4 , after approaches to assessing risk have been set out in Section A12.3.

This analysis is then built upon in Section A12.5 through a detailed and structured elaboration of the different risks which may impact on typical SET FOAK projects throughout their life cycle.

An assessment is then made in Section A12.6 as to the relevance of these risks for the financial market participants (as well as project sponsors), together with the types of mitigation measure which would be most appropriate to help either alleviate or eradicate such risks.

A value judgement has been made for each risk as to which one or more of the four Options proposed in this study (see Box A12.1 below) would be most appropriate for mitigating it.

Box A12.1 Proposed Options to help support the financing and construction of FOAK projects

Option 1: Grant scheme to support FOAK projects including the potential to provide upfront funding for key milestones (currently provided by NER 300 and potential future Innovation Fund)

Option 2: Debt facility providing specialist loan support to FOAK projects (currently provided by the €100m Energy Demonstration Projects pilot facility, which is to be scaled up to €150m in 2016/17)

Option 3: Equity fund - a new concept offering investment into FOAK projects

Option 4: Technical assistance provided to FOAK project sponsors, funded by the EC - and linked into Options 2 and 3 – as a SET FOAK Advisory Service

A12.3 Approaches to assessing risk

While risk will always be open to individual judgment and vary according to one's perspective of a particular project opportunity and type, most economic actors will identify a more-or-less similar set of risks – what differs are the relative importance and weighting which these actors attach to these risks. Recognising this is important when considering the various types of financial actor which the study has consulted with. For example, what represents an important risk to investors may not represent an important risk to lenders, and vice versa. Furthermore, guarantors[245] and grant providers will hold their own different perspectives too.

A due diligence undertaken when assessing a project will seek to:

a. Identify the risks associated with any specific scenario or project;

[245] When there is an agreement or contract between two parties, and one party fails to honour their obligations under the agreement or contract, then the aggrieved party may then call upon a guarantee for redress, with such a guarantee provided by a third party (the Guarantor) under pre-agreed conditions, i.e. the guarantee may not be callable under all scenarios.

b. Assess the potential impacts of such risks on project outcomes, in particular to identify risks that have the greatest potential impacts;

c. Estimate the probabilities of such risks arising, based on precedents, i.e., similar projects and similar scenarios from the past; but

d. Allocate risks to those project parties (investors, lenders, suppliers, contractors, etc.) best able to manage and carry them. The misallocation of risks can cause projects to fail.

As regards the assessment of risks (steps a, b & c above), in the context of SET FOAK projects, one is faced with a range of project types and scenarios for which – by definition – there are no direct precedents. This means that due-diligence risk assessment of a SET FOAK project opportunity must rely on sector experience, technical knowledge and individual judgment to arrive at a specific risk profile.

It is vital to remember that:

- Risk always exists. It cannot be avoided. Its presence is inevitable in every project;
- Risk changes over time. What may be a risk today, may not be a risk tomorrow. In the context of projects, it is often assumed that risks during construction are greater than during operations. Hence, the costs of finance may be lower for the latter period than the former; and,
- Risks can be managed, mitigated and shared between the parties to a project. Steps can be taken to mitigate or control perceived potential risks, should they arise.

A12.4 Technology, business and financial risks of SET FOAK projects

A12.4.1 Project sponsor perspectives on risks

The critical issue for project developers is that as technology development and demonstration progress, the risk profile changes, with technology risks weighing less heavily and market and operational risks weighing more heavily. At the point of market entry (and concomitant volume production and/or mass deployment), operational considerations (i.e. business economics, "revenue to costs") and risks dominate the business strategy.

The study has captured insights regarding the technology, market and financial issues pertaining to FOAK project sponsors who responded to ICF's e-survey. These are elaborated by SET category in Table A12.1. They provide compelling evidence of the challenges which beset sponsors and limit their ability to raise equity (as well as grant funding in some cases) or debt.

FOAK project sponsors provided insights into different types of risk and their severity. These are illustrated in three main risk themes: technology, market and financial, as follows:

Technology risks – the SET categories with the highest technical risks include BIO, Geothermal, LES, Ocean and Wind (offshore). While all new technologies carry some unknown risks because the technology is still being proved, there are some interesting remarks made about technology risks within, for example, geothermal, ocean and wind energy. One ocean energy developer noted the main obstacles:

> *"are technological. The OEM's in the market, even those with a major multi-national as a parent are not in a position, or not willing, to provide commercial warranties for their devices."*

Market risks – appear most important for CCS and CSP projects although the strength of comments from projects sponsor regarding LES shows that market risk is a major issue which affects investment, with *"a lack of long-term Member State strategies over electrical network requirements"* noted by one sponsor, *"uncertainty in markets for storage services"* by another, and criticism of the planning system by another (UK):

> *"Lack of intuitive planning system in many Member States creating major issues for developers (e.g. 50MW limit before DCO required in UK)."*

Financial risks and investor requirements – much of the financial risk being articulated by sponsors stems from the technology risk which is inherent in their projects and which then impacts on uncertainty around revenue streams. Nowhere is this felt more acutely than in ocean energy where one UK developer identified the barrier to achieving long-term operational performance to achieve more 'traditional' project finance:

> *"Lack of operational hours to prove reliability and forecast energy generation assumptions in financial model - therefore no access to 'traditional' sources of project finance."*

Another UK ocean energy developer clearly felt that the high risk profile of their sector made it challenging to find appropriate investors in the EU:

> *"Risk profile is inevitably high and can only attract investors with a high risk / high reward perspective - of whom there are few."*

An alternative suggestion for the uncertainty of ocean energy projects was made by another Norwegian developer who would like to see

> *"government involvement in supporting the first demonstration and commercial projects with [performance] guarantees."*

A geothermal energy developer also expressed their frustration concerning the lack of bankability of their type of project:

> *"No commercial financial institution, bank etc. is ready to get involved in financing."*

Large capital requirements and limited or no track record for project sponsors are also regarded as major constraints on gaining investment.

Box A12.2 overleaf illustrates key risk issues and challenges for ocean energy projects and offers potential funding and support solutions.

Box A12.2 Key lessons from the ocean energy field

The Draft Ocean Energy Strategic Roadmap[246] (October 2015) raises key issues which are worth considering around discussions of risk and potential funding structures.

Need to align the size and risk profile of the envelope with investment needs

Ocean energy projects in the demonstration and pre-commercial phase have budgets ranging each from €40m to €100m. The size / risk profile of support schemes need to be aligned with the size / risk profile of the projects in the sectors they cover. In that sense, EFSI type of budget seem better tailored than InnovFin scheme's budget (€100m for all renewables)

Need for flexible schemes taking into account changes / delays inherent to innovation

Examples where a scheme's inability to adapt to changes was detrimental include some projects funded under the EC's NER 300 programme and the UK government's Marine Energy Array Demonstration (MEAD) Fund which involved the developer Siemens/MCT's Skerries project which was unable to meet DECC's funding timetable).

Need to maintain investment support for emerging technologies until the industrial roll-out phase

The high upfront capital requirements of emerging technologies' projects cannot be met entirely through revenue-support mechanisms (pure demand-pull dominated mechanisms). Investment and project-specific support is needed until the industrial roll-out phase.

Need to address state aid challenges

It remains challenging for national government to provide investment and project-specific support under EU State aid guidelines. There would be a case to raise the state aid notification thresholds to €30m or to increase the maximum intervention rate.

246 http://www.oceanenergy-europe.eu/index.php/policies/ocean-energy-forum/draft-strategic-roadmap [the final roadmap is forecast to be published in October 2016 following further research]

Need for adequate financing models

Potential good practice financing solutions for the ocean energy sector include:

- The Meygen/Raz Blanchard approach, combining investment and revenue support mechanisms, in order to cover the upfront capital requirement and provide visibility on the market potential to investors.
- Publicly funded pilot zones, which are useful to spread the substantive costs of cabling and grid connection (which represent 20–40% of total project costs) across several projects (for example, as deployed at the Wave Hub test site off the north coast of Cornwall, UK).
- An EU insurance offering or fund (in the order of €50m to €70m of underwriting risk capital), which would underwrite various project risks and be available to multiple projects to mitigate the risk and drive down the cost of providing guarantees.
- Designing a public loan guarantee scheme, which would become available in the post demonstration phase, to leverage more debt funding.

Table A12.1 Overview of technology, market and financial risks sectors based on FOAK project findings from project developers[247]

Criteria	AEN	BIO	CCS	CSP	Geo	LES	Ocean	SPV	Wind
Key technology issues for FOAK projects from perspective of project developer [1]	"Applicability of technology"			"High probability" that project may fail its goals	"Implementing new reservoir technology in EGS project" "Uncertainty over resource prior to drilling"		"Unfavourable comparison with other technologies" "Difficulty in getting investors to believe the technology is viable" "Reliability and warranties still need to be improved"	"The problem is the demonstration of the feasibility and potential of the project."	"No reference projects available - No vendor warranty given" "Obtaining market competitive performance guarantees from suppliers, specifically the turbine manufacturer"
Key market issues [1]	"Impact of AEN infrastructure on tariffs"	"Lack of long-term goals & conditions at EU / MS level for biofuels"	"Main obstacles are not technological, but financial / political" "We needed…a better climate for CCS" "Price of CO_2"	"Market Uncertainty" "Country risks in Greece"	"Social acceptance is a secondary issue, not an investment / finance difficulty"	"No business case…revenue from power arbitrage is constantly shrinking" (DE) "Lack of clarity over financial support mechanisms for energy storage" (UK)			"Lack of certainty for legal regulations, especially for support schemes"

247 Includes grant funding ranges from NER 300 calls for comparison purposes.

Criteria	AEN	BIO	CCS	CSP	Geo	LES	Ocean	SPV	Wind
Key financial risks / investors requirements [1]	"Provision of convincing positive cost-benefit analysis"	"Investors require technical guarantees and very detailed data that is not available" "Since 2008 no debt from banks available for this type of project."[248]	"Lack of a commercial business case for CCS" "Investors are scarce"	"Not proven commercial track record hence not easy to finance… viability / profitability are in question."	"All investments front-end loaded" "Difficulty overcoming drilling risks" "Non-scalable project" "Investor misconceptions of business model"	"Uncertainty in committed revenue streams" "Grant programmes often take too long and out of sync with project (UK)" "Finding suitable financing instruments. Some projects do not fit into existing schemes" (AT)	"Much higher CAPEX required to demonstrate multiple machines." [i.e. an array] (UK) "Our equity comes from supplier partners that see a future business" "Capital markets are not willing to take the risk."	"In the present financial market risk aversion prevails."	"Market and credit conditions" "High investment amounts required (not all investors have capacity to finance this kind of projects)" [floating wind] "One of two main project obstacles was the risk appetite of purely financial investors with respect to debt financing."

Sources [1] Based on responses from more than 50 project sponsors who responded to an ICF survey. Note, more than 10 responses for ocean energy.

[248] This particular biofuels sponsor noted *"Before 2008 we had term sheets of EUR 10 million from two major banks; after 2008 nothing anymore due to crisis."*

A12.4.2 Financial market participant perspectives on risks

Financial market participants with the most positive attitudes towards FOAK projects consist of some, but not all, Specialised Investors (i.e., venture capital and private equity funds) and Producers (i.e. energy utility and engineering companies).

Specialised investors

Specialised Investors focus on the following aspects with respect to SET equity investments overall and these insights appear to dovetail with the feedback from FOAK project developers:

- Technology risks, including scale-up and risk associated with fitting new technology into existing infrastructure;

- Regulatory risks, especially as regards changes in feed-in tariffs and (other) subsidies and other Government induced policy risks (e.g. level of subsidies to fossil fuel based generation technologies). Differences across markets and a lack of harmonisation are also important. As one VC noted: *"technologies that are commercially viable in Czech Republic may not be 'investable' in Germany because of a different regulatory regime"*;

- Commercial risks, for example:
  - High capital costs (vis-à-vis more capital light investment propositions);
  - High cost per MWh of generation (i.e. challenging the economics of the business)
  - Unfair competition from outside Europe
  - Inefficient supply chains and less than competitive procurement channels (as for example in offshore wind)

In terms of business risks, Specialised Investors expressed issues and particular needs which would help them to engage more seriously with FOAK projects. Factors which are considered important, including for specific SET sectors, include:

Viable business models – for example, the lack of commercial structures for revenue generation for large energy storage, since it is providing a service not producing energy per se and there are such small margins to be made from day-night arbitrage. One venture capital fund (VC) commented: *"There is no way to make large-scale energy-storage projects commercial because revenue streams are not secure."* Another VC with interest in this area said that one would be to secure a contract with a utility under which the investee company provides capacity for a couple of hours when the utility requires it.

Need for feedstock supply agreements (e.g. biomass) and energy offtake agreements to be in place – this helps to commercially "de-risk" business models.

Assets installed prior to investment – again, a mechanism to help "de-risk" business models, but only mentioned by one investor and clearly pointing to slightly later engagement than those getting involved for example at the FEED[249] stage in a FOAK project.

Developer confidence in operational performance – FOAK projects cannot attract performance guarantees (unless backed by a large corporate willing to provide such a guarantee), so the ability to demonstrate reliable performance is fundamental to ensuring confidence. In comparison to technologies that may have clocked up *"a million hours of operational track record"*, and benefit from the backing of a large industrial company who can guarantee performance, business risks are elevated for FOAK projects. As one investor noted, a technology that might work for three months but then breaks down and requires three months to fix does not give confidence: *"Selling something new into the market is incredibly difficult: durability and reliability are key, not just an efficiency gain"*.

Associated investments into supply chains – one VC fund noted in solar PV that to make profits requires investments into more advanced technologies which is capital intensive if it requires investing in upgrading the manufacturing processes and building supply chains.

[249] Front-end Engineering Design

Size of developer – if a technology supplier company is small there is a risk that it will not be able to repay in the event of its technology not working (i.e. insufficient creditworthiness and economic strength).

Sovereign risks – create challenges for emerging markets in particular due to the possible currency / foreign exchange risk which potentially limits the geographical business opportunities for mass deployment for proven technologies.

IPR risks – for example: Does the developer own the rights to the technology? If not, how tightly controlled is any licensing arrangement including territorial access?

Management capabilities for developers – track record of undertaking similar projects is important. Some minimum thresholds such as companies having been in existence for at least five years and successfully piloted their technology.

Fundamentally, the very modest levels of funding which Specialised Investors have mentioned as being able to offer (e.g. with deal size ranges of €0.5m - €4m) are a limiting factor for the supply of equity investment. This is due to the scale of project investment requirements and need to collaborate with other investors. As one VC investor stated:

> *"[since] low-carbon projects are capital intensive, developing opportunities requires building a consortium to share the costs, unlike software or IT based technologies, which have lower capital requirements and have a faster route to the market. Renewable technologies have a much longer route to the market to allow investors to get their returns."*

Given the shortage of SET FOAK investors, finding investors to join together on deals could prove problematic, unless they can be incentivised.

Producers

For Producers, attitudes to SET equity investments outside their business reflect their interest in the likely outcomes from any project, which includes a longer time horizon of 15-25 years than for Specialised Investors, although there was some commonality of business issues/risks:

- How will the project help develop our business?
- What are the expected deliverables from the project?
- How complex is the project and how efficient the organisation?
- Reliability of prospective partners - can partners be expected to deliver on their tasks?
- Are there potential IPR issues?
- What are the market opportunities in short and long term?
- What are the requirements for reporting and publication during the project?

Unlike Specialist Investors, Producers have a deal size range of €10m - €200m for external investments, making them, at face value, as one of the most likely providers of equity for FOAK deals. This is particularly where such projects would align with their business strategy. A mixture of Specialised Investors and a Producer has worked effectively in the past and could in the future.

A12.5 Summary of risks facing SET FOAK projects

Table A12.2 seeks to capture the plethora of risks acting on SET FOAK projects using the project life cycle stages as a guide to understanding how risks impact on the project as it progresses. These stages are:

- Feasibility
- Front-end engineering design (FEED)
- Planning and permitting
- Financial close
- Construction / completion
- Commissioning
- Operations

Each risk is analysed using the following criteria:

- Project stage / component of project cycle
- Risk (as defined)
- Potential impact of risk
- Risk mitigators which could be used
- Understanding of whether the risk has a financial component to it
- SET sector relevance
- Implication of risk mitigation for Task 3 – here the risks are coded mainly in relation to the four key options set out in the Interim report and described above.

A review of the risk table shows that many of the risks identified for SET FOAK projects are generic. That is to say that they apply to FOAK and non-FOAK projects alike, across all SET sectors, and indeed many, if not most, industrial project and investment situations.

Risks highlighted in orange are regarded as the most important and pertinent to SET FOAK by experienced private sector project financiers on the study team.

There is very little differentiation in risks across SET sectors, other than those related to, for example:

- feedstock supply (for biomass);
- the need to obtain sea-bed licence and other permits (for ocean energy and offshore wind);
- types of offtake agreement for power or contracts to buy fuel (for biofuels); and,
- drilling risks (for geothermal and potentially CCS).

Table A12.2 Review of risks by FOAK project life cycle stage

#	Project stage / component	Risks	Potential impact of risk	Risk mitigator	Implication of risk mitigation for Task 3?
1	**Project feasibility**	Unclear project definition	Suboptimal end product and likelihood of post project issues arising	Upfront investment (including through technical assistance) in defining technical components and project's commercial objectives	**EC-funded technical assistance (Option 4)**
2	**Project feasibility**	Unsupportive policy / regulatory framework (for example, renewables not given priority access to grid and/or subsidies are not sustainable / predictable)	Loss of a target market (and hence replication opportunities in that chosen market) potentially impacts on project viability	Either the regulatory framework will need to be changed or the FOAK project will need to relocate to a new region/Member State (although business plan would require significant revision). Use International Arbitration for disputes.	**EC-funded technical assistance (Option 4)**
3	**Project feasibility**	Legal risks: complexity of FOAK project funding (possibly over 40 commercial and financial documents to be negotiated and signed at Financial Close) coupled with potential lack of a clear legal framework, regulation or law for private sector entities undertaking energy or power projects as public service investments	Could significantly lengthen negotations or worse lead to project stall	Presence of a [PPP-type] Concession Law for privately delivered public services.	**EC-funded technical assistance (Option 4)**
4	**Project feasibility**	Need for significant subventions (i.e. subsidies) to establish business case for the FOAK project	Reliance on subsidies creates a high risk that any future change could jeopardise projected revenues and cause the financial model to fail	**Potential 'showstopper'** if long-term certainty on tariffs cannot be achieved.	**EC-funded technical assistance (Option 4)**
5	**Project feasibility**	Changes to the prevailing legal framework covering any feed-in tariffs or subsidies which help to make projects financially viable and "bankable"	Inability to generate expected revenues and capitalise on available subsidies: if occurs at this stage it may stall / stop project; if during operations it could lead to an inability to pay back debt and lead to project debts being called in by lenders	Political risk mitigation measures against the risk of future change are limited. Apart from insurance, the participation of development banks, who enjoy "preferred creditor status" can mitigate some political risks, e.g. via the use of the A/B Loan Structure. Alternatively, the incorporation of international arbitration mechanisms (e.g. ICSID, UNCITRAL, LCIA, CIC, etc.) into the key projects contracts, supported by waivers of sovereign immunity, can on many occasions provide project financiers with the comfort they seek.	**EC-funded technical assistance (Option 4)**
6	**Project feasibility**	Market replication potential uncertain and hard to predict	Replication of original FOAK project cannot be accurately forecast leading to an inaccurate business plan that will potentially jeopardise investment or financing	Robust market research to assess the proposed FOAK technology against its peers, its renewable competitors and the wider energy market in the countries of interest. **Potential 'showstopper'** given that investment would be predicated on having good replication potential.	**EC-funded technical assistance (Option 4)**
7	**Project feasibility**	Uncertainty around grid connection if rights are not provided by the natioanl grid operator / Distribution Network Operator (DNO)	Inability to sell power from project or benefit from feed-in tariffs	Contract in place with national grid operator/DNO	**EC-funded technical assistance (Option 4)**
8	**Project feasibility**	Responsibility for building access infrastructure, e.g. connection to grid	Not able to deliver power to customers	Clarify responsibilities under project structure, plus indeminities for failure.	**EC-funded technical assistance (Option 4)**
9	**Project feasibility**	Offtake agreement - uncertainty over Power Purchase Agreement (PPA)	Inability to sell power from project and loss of revenues; will also impact ability to raise debt	Contract in place with DNO	**EC-funded technical assistance (Option 4)**

#	Project stage / component	Risks	Potential impact of risk	Risk mitigator	Implication of risk mitigation for Task 3?
10	**Project feasibility**	Offtake agreement - uncertainty over fuel sales	Inability to sell production capacity and loss of revenues; will also impact ability to raise debt	Contract in refinery / fuel distributor	**EC-funded technical assistance (Option 4)**
11	**Project feasibility**	Uncertainty over biomass feedstock supply	Inability to guarantee full scale production capacity and uncertainty over price	Long-term contract (10+ years) in place with suppliers to delivered required volume under a predictable price regime	**EC-funded technical assistance (Option 4)**
12	**Project feasibility**	Site acquisition (for land based FOAK projects)	Difficulties in obtaining site, especially if isolated or extensive land is required; potentially high cost (particularly if project is announced in advance which may increase land prices)	Since private investors will not wish to assume the risks of land acquisition, land availability and cost, such risk will usually have to be carried by the host government. Locate SET FOAK projects at isolated sites wherever possible. However, an isolated site may also become a **potential 'showstopper'**.	**EC-funded technical assistance (Option 4)**
13	**Project feasibility**	Site access (for construction and Operation & Maintenance)	"Access infrastructure", e.g. roads, pipelines, vessels, etc., for essential supplies plus availability of utilities during construction period (and later O&M phase), are key issues to be addressed and provision made, otherwise they are unmitigated risks	Ensure adequate contractual provision in place with key utilities and infrastructure providers, plus other providers of key services. Ensure adequate stocks and availability of key supplies and equipment. Site access may become a **potential 'showstopper'**.	**EC-funded technical assistance (Option 4)**
14	**Project feasibility**	All risks across project structure are not "ring-fenced" - for example, where different components are required in a CCS project or grid connection for an offshore wind farm or tidal array/farm	Split responsibilities for project completion, leading to cost over-runs, etc.	Ensure project developer has control over risks and can integrate: **potential 'showstopper'** if project developer cannot achieve this	**EC-funded technical assistance (Option 4)**
15	**Project feasibility**	Seafloor rights (for offshore FOAK projects)	Lack of a licence to operate	Thorough set of surveys commissioned by the project sponsor from specialist consultants in order to satisfy the regulatory agency and ensure grant consent.	**EC-funded technical assistance (Option 4)**
16	**FEED studies**	Ascertain potential areas of technical uncertainty. May lead to a lack of confidence in the technology, based on issues around the scale-up of the prototype or small-scale pilot plant to a large-scale FOAK project	Risks that technology will fail, or work sub-optimally, jeopardising project revenues and/or delaying timetable and/or increasing costs	Obtain an "EPC" (Engineering, Procurement, Construction) wrap from major engineering firms; failure to develop linkages to a major engineering firm will require some form of guarantee which could be insurance based or else achieved via a portfolio approach from a diversified FOAK equity fund/debt facility	**Potential for project / portfolio guarantee; Diversified portfolio to spread risk for FOAK projects (Options 2 and 3)**
17	**Planning and permitting**	Environmental permits take longer to be granted or are refused	Lack of a licence to operate	Guidance from regulatory bodies and/or consultants who can advise on the most appropriate way to navigate any regulatory hurdle and facilitate a regulatory approval. Prepare EIA at early date in project preparation process.	**EC-funded technical assistance (Option 4)**
18	**Planning and permitting**	Environmental agency is unfamiliar with the technology, especially if it is revolutionary ["frontier"] and it requires a FOAK project to create the precedent - 'Catch-22' situation	Environmental permits delayed or refused to FOAK project	Technical assistance / support to the agency using other exemplar projects / guidance to help draft appropriate environmental permits. Without such assistance this is a **potential 'showstopper'**.	**EC-funded technical assistance (Option 4)**
19	**Planning and permitting**	Complexity of permitting across different agencies	Inability to achieve all necessary consents and potential for significant additional time required	Technical assistance / support to the project sponsor to help navigate the prevailing systems; use of 'one-stop-shop' permitting to facilitate the process	**EC-funded technical assistance (Option 4)**
20	**Planning and permitting**	Planning permission refused	Lack of a licence to operate	Planning approvals; or need to relocate project to a more supportive region/Member State	**EC-funded technical assistance (Option 4)**

#	Project stage / component	Risks	Potential impact of risk	Risk mitigator	Implication of risk mitigation for Task 3?
21	**Planning and permitting**	Social acceptance	Inability to permit and/or build plant	Adherence to (voluntary) The Equator Principles [www.equator-principles.com] for projects over US$10mn (compliance requires an acceptable and approved Environmental Impact Assessment which will form one of the Conditions Precedent to any loan) and UN Principles for Responsible Investment [www.unpri.org] (which covers primarily governance ("ESG") issues and imply good practice for environmental and social compliance - for any FOAK financier/investor compliance with either should be an essential ingredient of any funding package; Community engagement and investment in schemes to mitigate potential impacts including redesign of project; Information campaigns which help to provide balance of issues. Lack of social acceptance is a **potential 'showstopper'**	**EC-funded technical assistance (Option 4)**
22	**Financial close**	Financial position of FOAK project sponsor/initiator and their capacity and willingness to provide support to achieve completion	Potential misrepresentation of the value of work achieved and progress made, leading to far higher costs incurred than anticipated	Assessment of the total expenditure to date on the technology or project by the sponsor (which itself is an area of considerable uncertainty and an opportunity for misrepresentation)— third party costs incurred, staff time committed, procurement of plant and machinery etc. Limited contributions (or mispresentation) or an inability to generate sufficient investment from the sponsor is a **potential 'showstopper'**	**EC-funded technical assistance (Option 4)**
23	**Financial close**	Risk of technology itself - has the technology been used before? what was the experience?	Project is stalled and is unable to reach Final Investment Decision	The Project Company may seek the advice of consultants, but a conservative approach is advisable, notwithstanding that the promise and prospects for using the latest and most up-to-date technology may prima facie seem most attractive. The underlying principle should be to use proven technologies	**EC takes senior position (i.e. first loss) for debt (Option 2) or a major equity position in projects (Option 3) to offset risk of an unproven FOAK technology by reducing exposure to other lenders/investors**
24	**Financial close**	Overall costs of project feasibility, FEED studies, planning & permitting are too high for the project sponsor to bear	Project is stalled and is unable to reach Final Investment Decision	Equity investment from investors; Corporate loan (if project sponsor within large company); Upfront grant funding from EC / MS support schemes	**EC-funded grant support for various components in early stages of project development (Option 1)**
25	**Financial close**	Insufficient distribution of investment risk across investors, elevating financial risks	Too high risk level per investor, preventing agreement across parties and stalling or killing the project	Greater levels of deal syndication, facilitated by an expert asset manager/fund manager/agency; role of EC in taking larger equity stake in project	**EC makes major equity investment into project; broad set of investors into a project (Option 3)**
26	**Financial close**	Insufficient distribution of debt risk across parties, elevating financial risks	Too high risk level per project financier, preventing agreement across parties and stalling or killing the project	Greater levels of deal syndication, facilitated by an expert asset manager/bank/agency; role of EC in making larger debt provision into project	**EC takes senior position (i.e. first loss) for debt; broad set of debt providers as second loss (Option 2)**
27	**Financial close**	Credit rating of some lenders in consortium is too low to build confidence across consortium	Inability to reach agreement on debt finance	Risk sharing agreement required in which one lender takes first loss	**EC takes senior position (i.e. first loss) for debt (Option 2)**
28	**Financial close**	Debt and equity ratio: a key risk for lenders will be the borrower's ability to service debt. Hence, their focus will be on the threat to the Debt Service Cover Ratio (i.e. free cash-flow / debt service) in any particular period. Likewise, for investors the risk is whether the anticipated profits and rewards will be achieved	If there is too much debt, then there is the possibility that, after operating costs have been accounted for, net revenues may be insufficient to service debt, i.e. interest, fees and repayments. Similarly, if there is too much equity, then the returns for investors may not be attractive. The result, therefore, will be a balance, albeit based upon subjective assessments, of the inherent project uncertainty and risk.	Generically, FOAK SET projects are unlikely to create any financial risks, which are not met also in conventional project financings. However, given the very low propensity (and zero in many cases) for banks to lend to FOAK projects, the emphasis will be on equity and grants to make up the vast proportion of funding.	**EC takes senior position (i.e. first loss) for debt (Option 2) or a major equity position in projects (Option 3) to offset risk of an unproven FOAK technology by reducing exposure to other lenders/investors. Also potential for grant funding (public risk capital) through Option 1**

#	Project stage / component	Risks	Potential impact of risk	Risk mitigator	Implication of risk mitigation for Task 3?
29	**Financial close**	Interest rate risks - variable or fixed rates for a loan	May have a large impact on the ability of the project to repay debt	Project Company would usually prefer to receive loans with fixed interest rates, so that future cost flows could be more accurately forecast. Lenders will often offer their borrowers project loans at a fixed interest rate, i.e. the lender is internalizing the risk between variable and fixed interest rates. Banks will often act as intermediaries providing fixed rates for borrowers who have variable interest rate loans and vice versa. Interest rate swaps can mitigate risks, but need to be employed with great care if not to create additional risks and unwanted complexities.	-
30	**Financial close**	Currency risks	A potential major uncertainty for private, infrastructure and energy projects, when there is a mis-match between the currency of operations and the currency of funding. As many FOAK SET projects may be outside the Eurozone, but the currency of funding is in Euros, this may represent a project risk to be addressed	Just as for interest rate risks can be mitigated by the use of the capital markets, so too can swaps be negotiated to mitigate currency risks. However, the inherent potential mismatch between the swap agreement and the loan debt service profile needs to be carefully managed. A prudent financial manager may use such mechanisms to mitigate a significant portion of the financial risks, e.g. up to 70%, but it may be quite risky to attempt to cover 100% of the perceived risks with such tools. Projects have a habit of never following the predicted path. Lack of foreign exchange risk cover could be a **potential 'showstopper'**	**Potential for EIB to offer a local currency loan? (compare the EBRD which now offers local currency loans for SMEs, helping to develop local capital markets)**
31	**Financial close**	Low profitability due to energy sector	Investments do not meet minimum requirements	Spread of investments to achieve portfolio (across technology sectors and geographies within EU) and hence produce an average portfolio return that will satisfy investors	**Diversified portfolio of investments achieved by an EC-funded equity fund (Option 3)**
32	**Financial close**	Inability to pay significant dividends for 5-8 years	Better and earlier returns from investments in other commercial or industrial sectors	Investors will need to be prepared to accept a long time horizon for their reward, especially for SET FOAK projects, although this will depend greatly on the sector in question	**Attraction of long-term, "patient capital" investors (e.g. pension funds, philanthropic funds, etc.) into an EC-backed equity fund with potential for attraction of Member State government funding (Option 3)**
33	**Financial close**	Inappropriate project vehicle structure	Potential liabilities arising	Technical assistance / support to the project sponsor using other exemplar projects to help develop a suitable SPV structure and improve financial governance	**EC-funded technical assistance (Option 4)**
34	**Financial close**	Thorough due diligence by lenders/investors reveals problems in any of the following (a) title to property (b) enforceability of contracts (c) whether all licensing & permits have been issued (d) outstanding litigation of sponsors (e) environmental issues & liabilities (f) local laws on insolvency, expropriation and compensation (g) relevant statutory instruments required for the project (h) proposed warranties & indemnities by participants (i) corporate & executive liability issues (j) mechanisms for repatriation of profits	Failure to satisfy these due diligence assessments will lead to the project being stalled and potentially failing	An experienced project sponsor will have the right expertise to fully understand the various requirements of lenders/investors. An inability to fulfil this due diligence is a **potential 'showstopper'**	**EC-funded technical assistance (Option 4)**

#	Project stage / component	Risks	Potential impact of risk	Risk mitigator	Implication of risk mitigation for Task 3?
35	Financial close	State aid refusal for Member State financing / grant interventions	Project is stalled and is unable to reach Final Investment Decision	Member State exemptions are applied for; EC mechanism provides additional funding which is exempt, potentially for grant support	EC-funded grant support for various components in early stages of project development (Option 1)
36	Construction/ Completion	Cost over-runs and delays (NB there is inter-dependence between the two)	Project may miss key deadlines (e.g. to qualify for subsidies) or losses will trigger losses in the Special Purpose Vehicle (e.g. debt converted to equity)	Negotiate fixed price, "turnkey" contracts for as much of the works as possible (80-90%), i.e. the contractor has responsibility to build the project to time and specification, and to hand it over on completion to the buyer/Project Company as a 'ready-to-use' asset; and/or Negotiate penalty and incentive clauses in the construction contracts (e.g. 15-20% of contract value); and/or performance bonds required from contractors. Note: early completion and sign-off should also trigger contractor incentive awards such as sharing cost savings or initial revenues	EC-funded technical assistance (Option 4); Potential to use EC-supported model contracts to assist innovators to negotiate most effective contracts
37	Construction/ Completion	Drilling risks	Geothermal resource / geological structures are not suitable for production of heat, reducing viability of plant. Similar geological constraints may apply to CCS projects as well	Drilling insurance (examples in France, Germany, Netherlands)	Existing insurance schemes available for geothermal drilling but not to cover CCS
38	Construction/ Completion	Potential immaturity of project design (since it is FOAK) creates construction risks	Project cost over-runs and delays to completion	Use experienced contractors who have done similar projects and has experience of the underlying technology and has financial strength to assume all risks (given the novel nature of FOAK SET projects, precedents will not exist, so experience of similar projects will bring comfort to financiers)	EC-funded technical assistance (Option 4); professional bodies and/or trade association member companies to help in selection of contractors
39	Construction/ Completion	Technological challenges in scaling up smaller plants	Technology may not work as planned and/or the technology concept may need to be refined to ensure it operates *(compare Risk 43)*	EPC 'wrap' to cover potential technological failures/inefficient operational performance (aka Performance guarantee). Significant is the requirement for investors and funders for undertakings and guarantees from plant, machinery and equipment suppliers — their willingness to provide completion and performance (specific output and guarantees, and life-cycle maintenance undertakings). One important aspect of this is the need to integrate/wrap undertakings from different corporate entities for the various elements - for example CCS or a complex biorefinery); and the need for these type of undertakings to include loss of revenue and profit over and above the make-good provisions performance guarantees and warranties.	EC-financed performance guarantee could potentially be introduced for cases where a large corporate cannot provide such guarantees to project sponsor
40	Construction/ Completion	Changes to original design specification	Any change can result in significant extra costs to the buyer	Keep the project specification fixed (although recognising that for FOAK-type projects, fixing and keeping to original specifications may be inherently difficult to achieve)	EC-funded technical assistance (Option 4)

#	Project stage / component	Risks	Potential impact of risk	Risk mitigator	Implication of risk mitigation for Task 3?
41	Construction/ Completion	Physical asset risk such as fire, theft, storm damage, flooding, etc.	Project cost over-runs and delays to completion; also impacts on operating costs. In the ocean energy sector, the view on insurance for ocean energy projects is that it is *"currently expensive, with high deductibles and limited cover. The insurance sector's experience with ocean energy is very limited, particularly with regard to marine operational issues."*	Private sector ventures will take project assets as security for any outstanding loans (especially if banks involved) and will require insurance for the physical assets against, fire, theft, etc. Condition Precedent to any project loans that an acceptable insurance policy is put in place. Furthermore, the ability of the Project Company to continue to pay premiums will be embedded in lenders' requirement for an Insurance Reserve Account to be maintained by a Trustee to cover the amount of the next insurance premium for so long as the loans are outstanding	While FOAK projects are inherently novel, project insurance markets are well versed in assessing and covering unusual risks, albeit premiums may be more elevated than the norm; Potential for EC to provide assistance to support premiums or provide scheme. *Ocean Energy Forum has called for an "EU insurance offering or fund to underwrite various project risks such as availability, performance, unforeseen events, failures, etc. A common reserve fund available to multiple projects in the initial farm roll out, to spread the risk and reduce the cost of providing guarantees."*
42	Construction/ Completion	Corruption in supply chain / site	Project cost over-runs and delays to completion	Corruption risk assessment and preventative / detective controls	EC-funded technical assistance (Option 4)
43	Commissioning / Operations	Technology fails to perform as specified (or project performance once operational)	Inability to generate expected revenues and capitalise on available subsidies	Performance warranties invoked (assuming these are in place); EPC 'wrap' used to deal with underperformance with potential for modifications to the technology to be paid for (normally construction and equipment supply contracts will be underpinned by warranties and liquidated damages for under-performance. Typically, warranties, under which the original supplier will repair at his cost any defect, will be available for 3-5 years after completion date. A technical failure after the warranty period should be covered by a Technical Services contract which the buyer / Project Company will have negotiated at the outset (i.e. the supplier will agree to repair equipment failure with payments based on pre-agreed unit prices for labour and materials).	EC-financed performance guarantee could potentially be introduced for cases where a large corporate cannot provide such guarantees to project sponsor
44	Operations	Uncertain revenues (i.e. what will be unit price or tariff for power generated, coupled with potential unpredictability & volume of production)	Inability to generate expected revenues and capitalise on available subsidies as well as raise potential debt into the project	Three approaches: (1) establish a Power Purchase Agreement (PPA) with a utility etc. which will clearly define the output of the generating asset - if this is possible, such as for solar PV, geothermal - and hence a project's revenue terms and credit quality; (2) allow power to be sold into a 'pool' enabling more uncertain volumes (and hence higher risk) but imposing penalties for less-than-contracted performance to counter elevated risks; (3) introduce a Contract for Difference whereby the producer or seller is, in effect, guaranteed a minimum price for output, with any upside profit above the agreed price allocated to the contractual counterpart. Likewise, if the minimum price is not achieved in the market, the counterpart makes up the difference.	EC-funded technical assistance (Option 4)

#	Project stage / component	Risks	Potential impact of risk	Risk mitigator	Implication of risk mitigation for Task 3?
45	Operations	Operating and maintenance costs unpredictable	Proper maintenance of assets during life of loan may not be possible if the maintenance programme is not being adhered to	Maintenance programme should be reviewed as part of financier's due diligence and, if necessary, provision for service contracts in the operating cost estimates made. For equipment such as wind turbines, original suppliers will often offer comprehensive service and maintenance contracts for the equipment they supply and will monitor the performance of the equipment remotely, reducing risks	EC-funded technical assistance (Option 4)
46	Operations	Technology performance deteriorates over time (e.g. wind farms can become much less efficient due to worn gearing after 10-12 years; solar PV due to material deterioration; CSP due to dust, etc.)	Inability to generate expected revenues and capitalise on available subsidies	Notwithstanding that the project has received regular maintenance, this issue is common for many type of power project and financiers need to be aware of it. Mitigation measures may be elusive to cover this risk, the only option being to limit long-term exposure, if such a possibility exists, for example by exiting investments through refinancing.	-
47	Operations	Management failure	Inability to generate expected revenues; potential market reputational damage	Prudent lenders and investors will insist through the terms and conditions of the finance they provide that, if the project starts to fail to perform, they reserve the right to change the management, if the project Company fails to do so.	-
48	Operations	Poor operational governance and controls	Potential impacts on plant construction and operation and impacts on costs; deviation from corporate objectives	Specification of level of design and performance detail that is required before project commences; stage gate approach; governance readiness review	EC-funded technical assistance (Option 4)
49	Operations	Lack of internal accountability due to poor organisational structure	Project overruns and cost increases	Risk- and issue-management systems implemented	EC-funded technical assistance (Option 4)
50	Operations	Inappropriate skillset in team	Poor quality execution which could lead to commissioning challenges	Advice on skills gaps and recruitment of experienced FOAK project implementers into the main EPC contractor	EC-funded technical assistance (Option 4)
51	Operations	Poor communication and reporting	No visibility of potential project overruns and cost increases; reputational damage; potential consortium problems	Master schedule of work; framework for reporting project metrics (Key Performance Indicators) and continuously updated risk register	EC-funded technical assistance (Option 4)
52	Operations	Poor financial governance	Project overruns and cost increases; reputational damage; potential consortium problems	Accredited systems and staff using model financial governance structures	EC-funded technical assistance (Option 4)
53	Operations	Taxation risks: for investors, in particular, such risks can represent the uncertainties of investing and operating in any particular market or country	Project overruns and cost increases; reputational damage; potential consortium problems	Transparency and good corporate governance in companies, including the avoidance of aggressive tax structures, can be made clear from the outset	EC-funded technical assistance (Option 4)

Risks assessed as being the most significant to SET FOAK projects

Colour code to potential EC options to mitigate risks

EC-funded grant assistance - to help developers initial costs of project development and construction (Option 1)

EC-supported loan scheme (Option 2) and/or equity fund (Option 3) interventions

EC- funded technical assistance - to assist in developing bankable projects (Option 4)

EC-financed performance guarantees - to cover technological/project underperformance

Insurance schemes - private or EC backed? (NB financiers to private energy - including FOAK SET - projects will expect to see an acceptable, comprehensive insurance package put in place as a Condition Precedent to funding.)

Limited scope (as specified) or no scope for EC intervention

Key references used for this analysis

1 ICF- various sources including proposal, market conditions mapping, Task 2 consultation, Interim report, Task 3 consultation and reporting

2 Blaiklock, TM (2015), The Infrastructure Finance Handbook: Principles, Practice and Experience; And pers comm with ICF (as member of ICF team)

3 PWC (July 2013), Successful Capital Projects: The integrated risk framework

4 The Crown Estate, Guide to an offshore wind farm (http://www.thecrownestate.co.uk/media/5408/ei-a-guide-to-an-offshore-wind-farm.pdf)

5 Draft Ocean Energy Strategic Roadmap (2015) - http://www.oceanenergy-europe.eu/index.php/policies/ocean-energy-forum/draft-strategic-roadmap

Options scoped out in Revised Interim Report

Option 1: Grant scheme to support FOAK projects including potential to provide upfront funding for key milestones (currently provided by NER 300 and potential future Innovation Fund)

Option 2: Debt facility providing specialist loan support to FOAK projects (currently provided by the €100m Energy Demonstration Projects pilot facility, which is to be scaled up to €150m in 2016/17)

Option 3: Equity fund - a new concept offering investment into FOAK projects

Option 4: Technical assistance provided to FOAK project sponsors, funded by the EC - and potentially linked into Options 2 and 3

Source: ICF

A12.6 Summary of the key risks facing SET FOAK projects

The most significant risks which need to be considered and addressed in any one SET FOAK project are shown in Table A12.3 overleaf, which is an extract of Table A12.2 above. These 13 key risks appear predominantly at either the project feasibility stage, financial close or construction/completion/commissioning stages

- Feasibility stage – 4 key risks
- Front-end engineering design (FEED) - 1
- Planning and permitting - 1
- Financial close - 3
- Construction / completion - 2
- Commissioning - 1
- Operations - 1

With regards to the types of intervention which the European Commission might consider to help overcome these key risks, the following suggestions have been made:

- Feasibility stage risks – EU funded technical assistance to help project sponsors to better understand risks associated with key target markets, market replication potential, risks across the project structure which need to be 'ring-fenced' and which may be very complex, as well as support with offshore projects and undersea licensing regimes.
- Front-end engineering design (FEED) – support either for a project guarantee to cover technology risk, or a sufficiently diversified portfolio within an EC-funded equity fund or debt facility to help overcome such risks.
- Planning and permitting - EU funded technical assistance to help environmental agencies to overcome their lack of technology familiarity and are stuck in a regulatory 'Catch 22' where a precedent is needed before a regulatory regime can be created!
- Financial close - EU funded technical assistance to help sponsors to adequately capture all expenditure and develop a robust financial plan for the project linked to the overall business plan; EC-funded equity fund or debt facility to help overcome prevailing risk perceptions surrounding the technology, especially if it really is novel and has no precedents; such funding mechanisms, with the EC taking a first loss or incentivising the private to co-invest, could also attract Member State money that can take a long-term view to achieve more strategic policy objectives as well as attracting private 'patient capital' and even philanthropic money.
- Construction / completion - EU funded technical assistance to help sponsors to better negotiate contracts with contractors (perhaps using model contracts) to minimise the financial losses associated with cost-overruns; a potential EU performance guarantee might be introduced to help sponsors which are unable to get corporate EPC 'wraps' on key technologies, thereby insuring against technology failures.
- Commissioning / operations - a potential EU performance guarantee could also come into play here.
- Operations - EU funded technical assistance to help sponsors to understand maintenance contracts and how to get the best deals[250].

Many of these issues were discussed with market participants in both the first and second phases of consultation with some feedback on potential solutions, and it is worth noting that of the 13 risks, nine could probably be resolved through the assistance of an SET FOAK Advisory Service, as noted in Table A12.3, which specifies broad mitigation measures.

[250] This risk arguably falls into financial close, but is placed here due to its life cycle importance

Table A12.3 Most significant risks acting on SET FOAK projects

#	Project stage / component	Risks	Potential impact of risk	Risk mitigator	Implication of risk mitigation for Task 3?
4	**Project feasibility**	Need for significant subventions (i.e. subsidies) to establish business case for the FOAK project	Reliance on subsidies creates a high risk that any future change could jeopardise projected revenues and cause the financial model to fail	**Potential 'showstopper'** if long-term certainty on tariffs cannot be achieved.	**EC-funded technical assistance (Option 4)**
6	**Project feasibility**	Market replication potential uncertain and hard to predict	Replication of original FOAK project cannot be accurately forecast leading to an inaccurate business plan that will potentially jeopardise investment or financing	Robust market research to assess the proposed FOAK technology against its peers, its renewable competitors and the wider energy market in the countries of interest. **Potential 'showstopper'** given that investment would be predicated on having good replication potential.	**EC-funded technical assistance (Option 4)**
14	**Project feasibility**	All risks across project structure are not "ring-fenced" - for example, where different components are required in a CCS project or grid connection for an offshore wind farm or tidal array/farm	Split responsibilities for project completion, leading to cost over-runs, etc.	Ensure project developer has control over risks and can integrate: **potential 'showstopper'** if project developer cannot achieve this	**EC-funded technical assistance (Option 4)**
15	**Project feasibility**	Seafloor rights (for offshore FOAK projects)	Lack of a licence to operate	Thorough set of surveys commissioned by the project sponsor from specialist consultants in order to satisfy the regulatory agency and ensure grant consent.	**EC-funded technical assistance (Option 4)**
16	**FEED studies**	Ascertain potential areas of technical uncertainty. May lead to a lack of confidence in the technology, based on issues around the scale-up of the prototype or small-scale pilot plant to a large-scale FOAK project	Risks that technology will fail, or work sub-optimally, jeopardising project revenues and/or delaying timetable and/or increasing costs	Obtain an "EPC" (Engineering, Procurement, Construction) wrap from major engineering firms; failure to develop linkages to a major engineering firm will require some form of guarantee which could be insurance based or else achieved via a portfolio approach from a diversified FOAK equity fund/debt facility	**Potential for project / portfolio guarantee; Diversified portfolio to spread risk for FOAK projects (Options 2 and 3)**
18	**Planning and permitting**	Environmental agency is unfamiliar with the technology, especially if it is revolutionary ["frontier"] and it requires a FOAK project to create the precedent - 'Catch-22' situation	Environmental permits delayed or refused to FOAK project	Technical assistance / support to the agency using other exemplar projects / guidance to help draft appropriate environmental permits. Without such assistance this is a **potential 'showstopper'**.	**EC-funded technical assistance (Option 4)**
22	**Financial close**	Financial position of FOAK project sponsor/initiator and their capacity and willingness to provide support to achieve completion	Potential misrepresentation of the value of work achieved and progress made, leading to far higher costs incurred than anticipated	Assessment of the total expenditure to date on the technology or project by the sponsor (which itself is an area of considerable uncertainty and an opportunity for misrepresentation)— third party costs incurred, staff time committed, procurement of plant and machinery etc. Limited contributions (or mispresentation) or an inability to generate sufficient investment from the sponsor is a **potential 'showstopper'**	**EC-funded technical assistance (Option 4)**

#	Project stage / component	Risks	Potential impact of risk	Risk mitigator	Implication of risk mitigation for Task 3?
23	**Financial close**	Risk of technology itself - has the technology been used before? what was the experience?	Project is stalled and is unable to reach Final Investment Decision	The Project Company may seek the advice of consultants, but a conservative approach is advisable, notwithstanding that the promise and prospects for using the latest and most up-to-date technology may prima facie seem most attractive. The underlying principle should be to use proven technologies	**EC takes senior position (i.e. first loss) for debt (Option 2) or a major equity position in projects (Option 3) to offset risk of an unproven FOAK technology by reducing exposure to other lenders/investors**
32	**Financial close**	Inability to pay significant dividends for 5-8 years	Better and earlier returns from investments in other commercial or industrial sectors	Investors will need to be prepared to accept a long time horizon for their reward, especially for SET FOAK projects, although this will depend greatly on the sector in question	**Attraction of long-term, "patient capital" investors (e.g. pension funds, philanthropic funds, etc.) into an EC-backed equity fund with potential for attraction of Member State government funding (Option 3)**
36	**Construction/ Completion**	Cost over-runs and delays (NB there is inter-dependence between the two)	Project may miss key deadlines (e.g. to qualify for subsidies) or losses will trigger losses in the Special Purpose Vehicle (e.g. debt converted to equity)	Negotiate fixed price, "turnkey" contracts for as much of the works as possible (80-90%), i.e. the contractor has responsibility to build the project to time and specification, and to hand it over on completion to the buyer/Project Company as a 'ready-to-use' asset; and/or Negotiate penalty and incentive clauses in the construction contracts (e.g. 15-20% of contract value); and/or performance bonds required from contractors. Note: early completion and sign-off should also trigger contractor incentive awards such as sharing cost savings or initial revenues	**EC-funded technical assistance (Option 4); Potential to use EC-supported model contracts to assist innovators to negotiate most effective contracts**
39	**Construction/ Completion**	Technological challenges in scaling up smaller plants	Technology may not work as planned and/or the technology concept may need to be refined to ensure it operates *(compare Risk 43)*	EPC 'wrap' to cover potential technological failures/inefficient operational performance (aka Performance guarantee). Significant is the requirement for investors and funders for undertakings and guarantees from plant, machinery and equipment suppliers — their willingness to provide completion and performance (specific output and guarantees, and life-cycle maintenance undertakings). One important aspect of this is the need to integrate/wrap undertakings from different corporate entities for the various elements - for example CCS or a complex biorefinery); and the need for these type of undertakings to include loss of revenue and profit over and above the make-good provisions performance guarantees and warranties.	**EC-financed performance guarantee could potentially be introduced for cases where a large corporate cannot provide such guarantees to project sponsor**

#	Project stage / component	Risks	Potential impact of risk	Risk mitigator	Implication of risk mitigation for Task 3?
43	**Commissioning / Operations**	Technology fails to perform as specified (or project performance once operational)	Inability to generate expected revenues and capitalise on available subsidies	Performance warranties invoked (assuming these are in place); EPC 'wrap' used to deal with underperformance with potential for modifications to the technology to be paid for (normally construction and equipment supply contracts will be underpinned by warranties and liquidated damages for under-performance. Typically, warranties, under which the original supplier will repair at his cost any defect, will be available for 3-5 years after completion date. A technical failure after the warranty period should be covered by a Technical Services contract which the buyer / Project Company will have negotiated at the outset (i.e. the supplier will agree to repair equipment failure with payments based on pre-agreed unit prices for labour and materials).	**EC-financed performance guarantee could potentially be introduced for cases where a large corporate cannot provide such guarantees to project sponsor**
45	**Operations**	Operating and maintenance costs unpredictable	Proper maintenance of assets during life of loan may not be possible if the maintenance programme is not being adhered to	Maintenance programme should be reviewed as part of financier's due diligence and, if necessary, provision for service contracts in the operating cost estimates made. For equipment such as wind turbines, original suppliers will often offer comprehensive service and maintenance contracts for the equipment they supply and will monitor the performance of the equipment remotely, reducing risks	**EC-funded technical assistance (Option 4)**

Source: ICF

A12.7 Sectoral perspectives on key risks

Reviewing specific risks for different SET FOAK project types, and taking account of project sponsor perspectives and other findings from the study, one can conclude that areas of particular risk across each SET sector are as shown in Table A12.4. These illustrate the importance of risks associated with:

- The technology itself
- The market context, including regulatory frameworks and market support mechanisms
- Political risks
- The role of the project sponsor
- Planning and permitting
- Construction phase
- Operational phase
- Commercial risk

Table A12.4 Key risks by SET sector

	AEN	BIOMASS	CCS	CSP	GEO	LES	OCEAN	SPV	WIND
Capacity:	50-70MW	Wide range	250-300MW	40-110MW	12-90MW	5-250MW	5-340MW	Diverse	2-400MW
Typical value:	€30-40mn	€10-300mn	€500-1400mn	€185-330mn	€75-120mn	€15-350mn	€20-1000mn	€40-50mn	€50-2000mn
Markets:	Highly developed power networks	EU wide	W. Europe only to date	Southern EU MS	Limited to few EU MS	W. Europe MS	W. Europe MS & especially NW Europe for tidal energy	EU wide	EU wide
Key risks identified:									
Technology	Choice and impact of technology & applicability	Technology: performance guarantees available?	Full chain CCS is multi-component, increasing completion & operational risks	Technology: availability of long-term performance guarantees	Technology: availability of geothermal resource long-term	Technology: experience & performance guarantees?	Technology: many project types but few successful demonstrators (lower risk profile for tidal than wave devices)		Technology: availability of long-term performance guarantees
Market support	Market support mechanisms, e.g. tariffs & regulation	Market support mechanisms, e.g. tariffs & regulation	Requires significant long-term government & sponsor commitment.	Market support mechanisms, e.g. tariffs & regulation	Few regional precedents & experience of technology & operations	Market demand (a regulatory controlled market)	Wide range of project values (escalating significantly once project arrays are being considered)		

	AEN	BIOMASS	CCS	CSP	GEO	LES	OCEAN	SPV	WIND
Regulatory		Market risks for biofuels	Political risk on regulatory framework	Political risk on regulatory framework & tariffs long-term		Political risk on regulatory framework & tariffs long-term	Political risk on regulatory framework & long-term tariffs (although some highly favourable subsidy regimes such as five Renewable Obligation Certificates in Scotland)	Political risk on regulatory framework & tariffs long-term	Political risk on regulatory framework & tariffs long-term
Project sponsors	Strength & commitment of sponsors			Strength & commitment of sponsors	Strength & commitment of sponsors		Strength & commitment of sponsors	Strength & commitment of sponsors	Strength & commitment of sponsors (although improving especially for offshore wind)
Planning & permitting		Potentially lengthy / complex planning & permitting	Potentially lengthy / complex planning & permitting	Potentially lengthy / complex planning & permitting	Potentially lengthy / complex planning & permitting		Potentially lengthy / complex planning & permitting		Potentially lengthy / complex planning & permitting
Completion & operational risks				Completion: hi-tech & complex projects	Completion: drilling risks		Long-term operational risks persist		Completion and operational risks prevail
Commercial			Commercial & financial viability given very large investment values: carbon price too low			Limited market in arbitrage to justify investments	Commercial viability quite uncertain		

	AEN	BIOMASS	CCS	CSP	GEO	LES	OCEAN	SPV	WIND
Suitable funding structures for SET FOAK projects:									
	Equity & grant: not lending risk	Equity & grant: availability of debt depending on technology types	Equity & grant, but to date no full-scale precedents. Debt will be needed, but availability highly uncertain	Equity, grant & debt: lender caution, as some precedents have failed	Equity, grant: lender caution, as few sectoral & regional precedents. Insurance used to cover drilling risks	Equity & grant: lenders uncertain of some technologies (not pumped storage) plus demand & business case	Equity, grant and debt: very limited as some precedents have failed, but tidal farms will need debt support	Equity, grant & debt: lender caution, as some precedents have failed	Equity, grant & debt: lender caution and some projects are very high value, requiring significant funds
Equity	✓	✓✓		✓	✓	✓	✓	✓✓	✓✓
Debt (loans)		✓		✓	✓	✓	✓	✓	✓
Grants	✓✓	✓✓	✓	✓	✓	✓	✓	✓✓	✓✓

Availability of options:

✓✓	*High availability across Member States*	✓	*Medium availability (e.g. some Member States)*		*Limited or Unavailable*

Source: ICF

A12.8 Concluding remarks on how financial market participants deal with risk

From our consultations and understanding of financial market actors, we conclude the following about the various organisations which could be involved in SET FOAK projects:

- Financiers to SET FOAK projects will undertake the same due diligence with respect to identifying and mitigating project risks as for conventional project financings.
- Investors, however, may, however, show more flexibility in addressing risks compared to lenders, who will be much more risk averse and, therefore, protectionist of their capital.
- Guarantors, whether commercial or financial, may take a similar perspective to lenders, focussing on the probability that their guarantee may be called.
- Grant providers may judge an SET opportunity against other less onerous, qualitative or political measures.

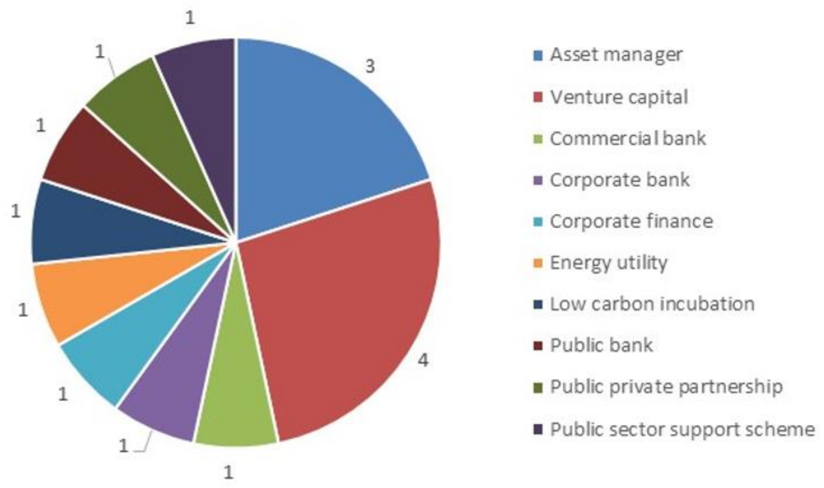
Annex 13 Market participant survey analysis paper

A13.1 Overview and approach

The views of market participants on a debt facility and an equity facility were sought by means of an e-survey in order to gain insights on market rationale, sectoral coverage, size and operational parameters. In total, 15 replies were received (from market participants who had participated in Task 2 and public-sector support schemes in task 1) and further analysed. Most responders agreed to be interviewed by telephone. Each revealed a very good understanding of SET markets and the FOAK project funding challenge.

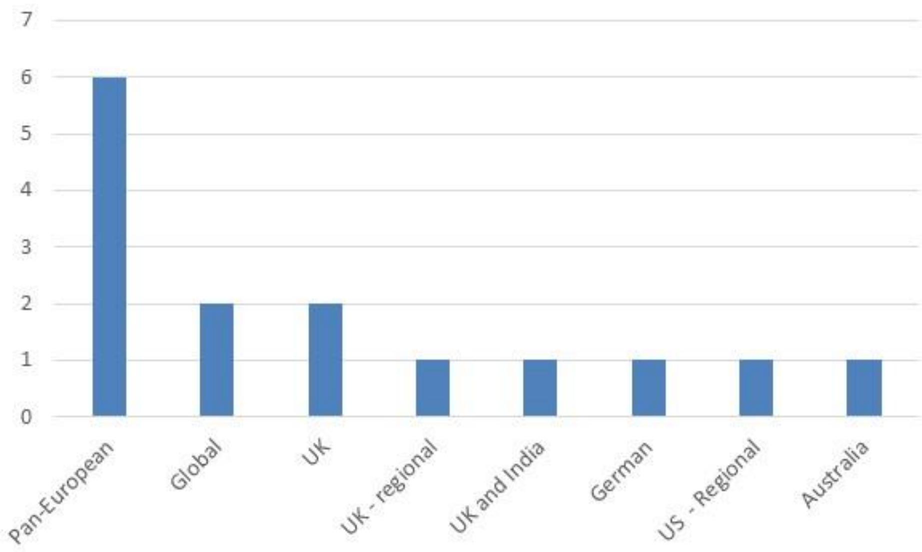
In terms of the organisational spread, the respondents spanned a wide variety of organisations: three responses each from asset managers and venture capitals along with responses from nine different organisational types varying from banks to project developers.

Figure A13.1 Types of organisations interviewed (n=15)



With respect to geographical coverage, six of respondents have pan-EU operations, four of the respondents are active mainly in the UK (either nationally or regionally, including one firm that also had a growing presence in India); two organisations have a global reach; the remaining three respondents have a more national presence, operating respectively in Australia, Germany and the USA.

Figure A13.2 Geographical coverage of interviewees



A13.2 Analysis of responses received

A13.2.1 Q1 - What is your view on the overall funding landscape for first-of-a-kind (FOAK) project funding since mid-2015? (*sample=15*)

The vast majority of the interviewees believe that the funding landscape for FOAK projects has either remained unchanged since the second half of 2015, i.e., bad, (n = 8) or has become worse (n=3).

These perceptions are based on a number of given reasons including an absence of significant new players as existing funding institutions are getting more and more constrained by regulatory and risk aversion agendas; scarcity of funding sources (both equity and debt) and tight financing. One respondent noted that it is “impossible to fund a FOAK project of €5m – €10m unless you get a big name EPC contractor who takes all the risk”). Examples of projects (such as CCS) being abandoned due to a lack of additional financing – despite having secured funds from the EC – were also cited by the interviewees.

Only a minority of interviewees (n=4) considered that the funding landscape has improved since mid-2015. Reasons given include: more deal flow is now available; funding programmes have become more accessible and relevant to the SET sectors than earlier interventions; and there is a wider pool for non-traditional lenders that could support new and smaller projects. Moreover, some interviewees consider that the volume of available capital and the hunger for yield have increased the appetite of investors for accepting greater risk.

A13.2.2 Q2 - What type of finance do you feel is most required for supporting European SET FOAK demonstration projects? (*sample=14*)

Equity is considered by all the interviewees as the most appropriate type of funding for FOAK projects, either on its own as the only really viable funding option (n=8) or in combination with debt (n=6).

Some of those advocating equity as the only type of funding stated that for FOAK projects an “all-equity” solution will be required until the technology is proven and that debt is not worthwhile without a path to replication. One respondent said that debt is not worth having unless the technology risk can be offset by an EPC contractor (“debt has limited upside but unlimited downside”). However, others believe that flexibility in the funding mechanisms is important and thus that projects which can support debt should receive it alongside equity, which would be the main form of funding.

A13.2.3 Q3a - What kinds of institutional investor would be most interested / best placed to contribute to an EC-backed equity fund focused on FOAK projects? (*sample=13*)

Interviewees expressed diverse opinions as to the types of investor who might potentially contribute to an EC-backed equity fund focused on FOAK projects. Several interviewees (n=3) expressed a clear preference for pension funds, followed by asset managers or insurance companies, as being most likely to support such facilities. Others (n=3) indicated that “impact investors” or large corporates might seek to get on board such a fund. (One cited the example of Apple that recently announced investment in a green bond which had been a significant development in the market.) Infrastructure funds, institutional banks, governments, family offices and high net worth individuals (HNWI) were also mentioned as potentially interested investors.

A13.2.4 Q3b - Do you think that a company like yours would be interested in investing in such facilities? (*sample=12*)

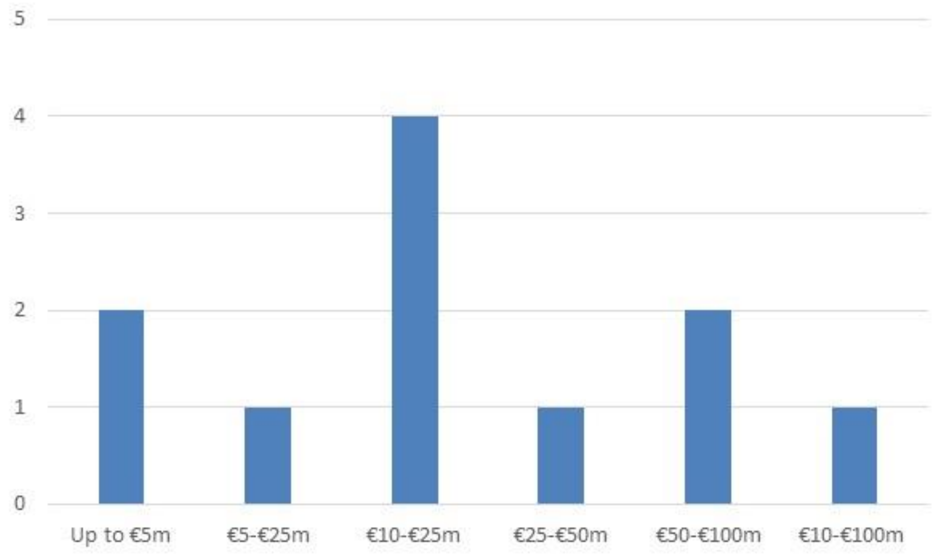
The vast majority of the interviewees (n=10) believe that companies like theirs would not be interested in investing in such facilities as this was out of the scope of their services or their mandate. Only one asset manager (out of 3 interviewed) and one commercial bank indicated that there could be a potential interest.

A13.2.5 Q4 - What is the minimum amount that each institutional investor would be interested in contributing to an EC-backed equity fund focused on FOAK projects? (*sample=11*)

Opinions vary in terms of the minimum amount that institutional investors would be interested in contributing to an equity fund. More specifically, one of the interviewees mentioned that “institutional investors typically look at larger deals however smaller investment houses and HNWI could play a role in the smaller end of the market”. Thus it could be concluded that contribution varies based on the type of investor.

Replies consisted of ranges varying from lower than €5 million to up to €100 million. Two respondents proposed a range of up to €5 million; one proposed €5m – €25m; four proposed €10m – €25m; one proposed €25m – €50m; two proposed €50m – €100m; and one proposed €10m – €100m. These answers are reflected in the graph below

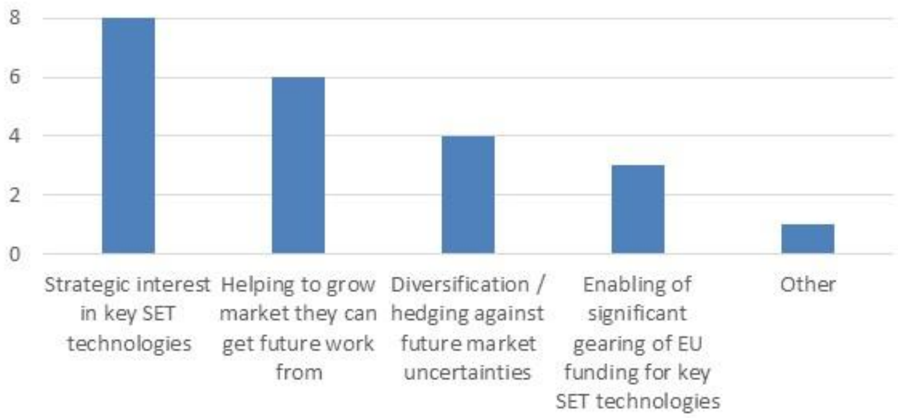
Figure A13.3 Minimum amount of Euro that each institutional investor would be interested in contributing to an EC-backed equity fund focused on FOAK projects? (sample=11)



A13.2.6 Q5 - What might encourage corporates (engineering firms, oil majors, energy utilities) to participate in an EC-backed equity fund focused on FOAK projects? (*sample=12*)

Strategic interest in key SET technologies along with fostering market growth to generate future work from it have been given by the interviewees as the most prominent parameters for encouraging large corporates. Less frequently encountered replies included diversification and enabling of significant gearing of EU funding for key SET technologies, as indicated in the chart below:

Figure A13.4 What might encourage corporates (engineering firms, oil majors, energy utilities) to participate in an EC-backed equity fund focused on FOAK projects? (sample=12)



Note 1: "other" includes limited exposure and risk so that more investors are attracted.

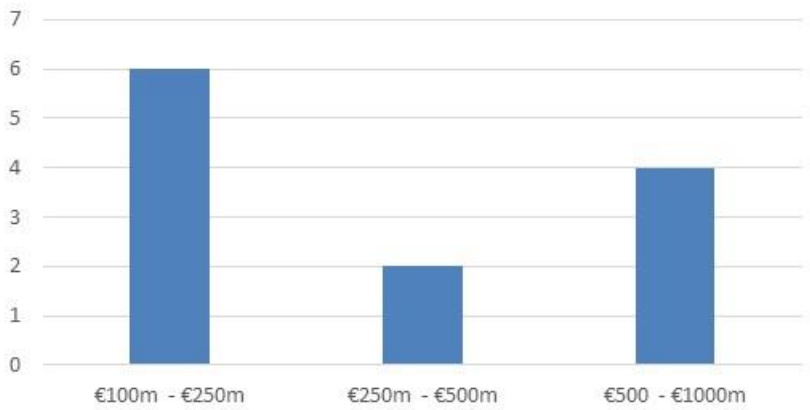
Note 2: Interviewees were able to select multiple factors (thus replies do not add up to 12).

A13.2.7 Q6 - What is the optimal value for the proposed equity and/or debt facility? (*sample=12 for equity and 8 for debt*)

<u>For equity:</u>

Half the interviewees gave €100m – €250m as the optimal value range. Nonetheless, one third gave €500m - €1bn, as they feel that that would be necessary for the fund to have market presence, credibility and investment power:

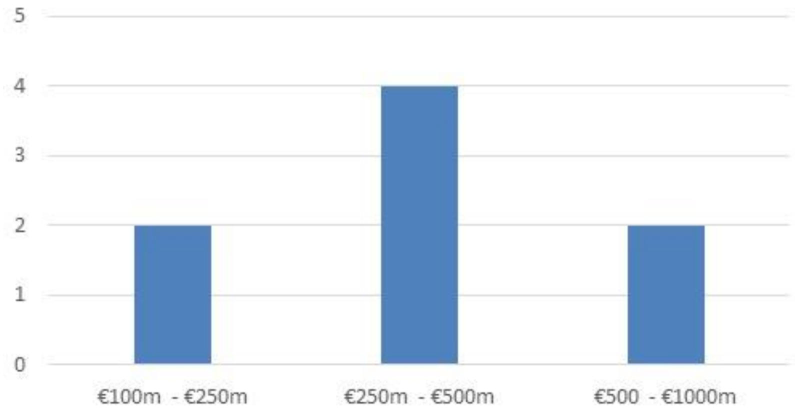
Figure A13.5 Optimal value for the proposed equity facility? (*sample=12)*



For debt:

Fewer interviewees answered with respect to debt than answered with respect to equity, indicating much less appetite for a debt instrument. Half the interviewees gave €250m – €500m. One quarter said €100m – €250m; one quarter said €500m – €1bn.

Figure A13.6 Optimal value for the proposed debt facility? (*sample=8)*

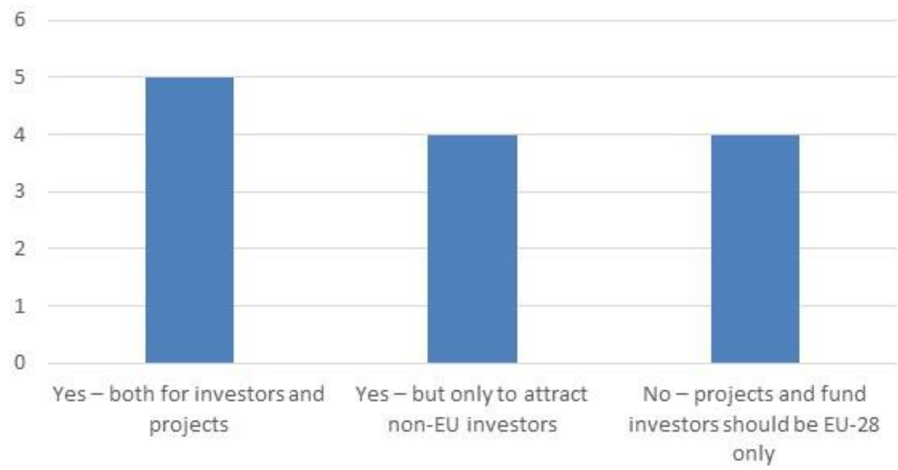


However, based on feedback received, the optimal value "depends on the perspective". Private equity firms for example would anticipate a bigger fund whereas developers would prefer a smaller one.

A13.2.8 Q7 Should the equity fund be able to have reach outside the EU? (*sample=13*)

Some interviewees show a clear preference for focusing on FOAK projects within the EU-28, irrespective of whether investors are European or internationally sourced. More specifically, four interviewees were sceptical about a broader reach outside the EU indicating that both projects and fund investors should be within EU-28 only. However, an equal number were in favour of the fund having reach outside the EU in order to attract non-EU investors for EU-28 focused projects. The main criticism of going outside the EU is related to the country risk, which should also be considered on top of the technology or investment risk and, it was said, means that this approach "will probably lose government support".

Figure A13.7 Should the equity fund be able to have reach outside the EU? (*sample=13*)



Five respondents were positive about an equity fund having a non-EU scope both in terms of investors and projects, with one advocating that such a collaboration "would enhance horizons in terms of technology, vision and business style".

A13.2.9 Q8 - Which SET sectors do you think should be included or excluded from an equity-based facility?

The table below provides an overview of the 15 replies received for each one of the SET sectors under scrutiny. Interviewees were asked (by means of a simple YES or NO) to indicate sectors that should either be included or excluded from an equity-based facility.

Based on the feedback received, a colour rating has been developed with green variations indicating preference (light green for low/ dark green for high) for inclusion and red variations (light red for low/ dark red for high) indicating preferences for exclusion of each sector.

The sectors Concentrating Solar Power, Geothermal, and Ocean Energy received fewer than 15 replies (n = 13, n = 13, n = 14 respectively), owing to responders claiming lack of familiarity with the technology sector, hence the grey cells at the end of those rows.

SET sector	Rationale for inclusion	Rationale for exclusion	Positive	Negative	Overall ratings for equity fund
1. Advanced electricity networks	■ The sector is not as speculative as others and thus it needs to change. This is sector is a "low hanging fruit…you can go and fix it now". ■ "Smart grids are hot". ■ "Sector is highly attractive". ■ "Could provide significant commercial outcomes if proven".	■ At present there are grants supporting the sector. ■ "Battle already lost - too difficult to fund". The sector could be interesting only if there is strong governmental support through regulators that can bear innovation costs.	13	2	
2. Biomass conversion technologies	■ This technology needs a real boost as it faces great challenges. The sector is "bigger hitter from a deployment viewpoint". ■ The scale parameter should be considered ("many small biomass plants vs a few larger plants"). ■ "Could provide significant commercial outcomes if proven".	■ Investors lacking confidence in this sector. ■ Considered to be "sufficiently mature".	11	4	

SET sector	Rationale for inclusion	Rationale for exclusion	Positive	Negative	Overall ratings for equity fund
3. Carbon Capture and Storage	■ "Storage is important". ■ Funding is a major problem for this sector. Guarantees against storage leakage of CO_2 means very high levels of contingency are needed and no one can predict risks until FOAK is completed. Thus, support on this sector is necessary to overcome failures and give the technology a real boost.	■ At present there are grants supporting the sector. ■ "Inclusion of this sector could use up the whole fund due to higher CCS investment required." ■ "Difficult economics." ■ "No market for CCS" - especially since it requires 25% of energy load for storage. ■ Limited potential for income: "not worth investing".	6	9	
4. Concentrating solar power*	■ "Considerable upside" ■ "Emerging technology"	■ "Not a good idea for investment." ■ Technology "hasn't proven very efficient", especially in Europe. ■ It is not competitive. ■ The technology is fundable in the markets. Thus, "any EU funding would be potentially displacing private money". ■ "Not a FOAK technology"	6	8	
5. Geothermal energy	■ "It seems attractive"	■ At present there are grants supporting the sector. ■ Technology to pick up late 2040's. ■ Not applicable in the EU. ■ "Sufficiently mature" ■ "Not a FOAK technology"	6	8	

SET sector	Rationale for inclusion	Rationale for exclusion	Positive	Negative	Overall ratings for equity fund
6. Large scale energy storage solutions	■ This technology needs a real boost as it faces great challenges. ■ This technology is a "bigger hitter from a deployment viewpoint". ■ "People are investing in generation but storage is coming". ■ "Highly attractive" ■ "Very interesting" ■ "Real need – very important technology".	■ This is a difficult sector because of a lack of business model. However, "nothing should be ruled out as there might be an interesting opportunity to support".	13	2	
7. Ocean energy (mainly tidal stream)	■ Tidal looks interesting (compared to wave which is less promising). ■ "High potential in EU"	■ Questionable economics ■ "It must be government support – too much for VCs and too challenging for corporates (you could invest a couple of billion euros into it and still lose it)". ■ Limited number of suitable sites ("it's all about sites"). ■ "Very difficult to get to a competitive cost of energy generation".	5	9	
8. Solar photovoltaics	■ "Inclusion of solar in building products" ■ "The market is growing"	■ "Difficult to compete with Chinese manufacturers – VC money has been lost in solar technology investments." ■ Already a mature market ("happening anyway") although 2nd and 3rd generation PV might be interesting. ■ They are fundable in the markets – "any EU funding would be potentially displacing private money." ■ "Overbanked"	2	13	

SET sector	Rationale for inclusion	Rationale for exclusion	Positive	Negative	Overall ratings for equity fund
9. Wind energy (mainly offshore)	▪ "High potential in EU" ▪ "The market is growing" ▪ Positive for new technology like floating turbines	▪ Questionable economics ▪ They are fundable in the markets – "any EU funding would be potentially displacing private money." ▪ Offshore wind is a mature market. ▪ "Already mainstream"	7	8	

Source: ICF survey of market participants, March – April 2016.

A final interesting insight given by one respondent is that although some sectors look less promising and relevant for inclusion under an equity fund, no sector should be ruled out yet since more technologies interesting enough to support might emerge.

A13.2.10 Q8 - Which SET sectors do you think should be included or excluded from a debt-based facility?

The feedback received for the debt-based facility covers 13 replies since two participants did not consider debt as an option. The reason cited was that SET FOAK projects cannot normally attract any commercial debt due to their high risk and the suggestion was that the provision of equity should be the main objective of support.

Using the same approach as that used in the table above, the overall responses for those sectors in which a debt-based facility might focus its efforts are indicated by the degree of positive and negative ratings and the overall colour coded rating in the last column. This shows almost the same results as those indicated for the equity fund. The sectors Concentrating Solar Power, Geothermal, and Ocean Energy received fewer than 13 replies, owing to responders claiming lack of familiarity with the technology sector, hence the grey cells at the end of those rows.

SET sector	Rationale for inclusion	Rationale for exclusion	Positive	Negative	Overall ratings for debt facility
1. Advanced electricity networks	▪ "Major enabler of flexibility – attention needed onto innovation character to avoid financing meaningless projects"	*Same comments as equity*	10	3	
2. Biomass conversion technologies	*Same comments as equity*	*Same comments as equity*	7-8	5	
3. Carbon Capture and Storage	*Same comments as equity*	▪ There is limited potential for income – "not worth investing". ▪ "Needs to be proven first"	4	9	
4. Concentrating solar power*	*Same comments as equity*	*Same comments as equity*	5	7	
5. Geothermal energy	*Same comments as equity*	*Same comments as equity*	6	6	
6. Large scale energy storage solutions	*Same comments as equity*	▪ "Needs to be proven first".	12	1	
7. Ocean energy (mainly tidal stream)	*Same comments as equity*	*Same comments as equity*	5	7	
8. Solar photovoltaics	*Same comments as equity*	*Same comments as equity*	3	10	
9. Wind energy (mainly offshore)	*Same comments as equity*	*Same comments as equity*	7	6	

Source: ICF survey of market participants, March – April 2016.

A13.2.11 Q9 - What is the minimum number of SET FOAK projects you think is needed for each facility to look credible in the market? (*sample=11 for equity and 9 for debt*)

For equity, the majority of the interviewees indicated that a minimum of 10 projects is required (n=6), with other replies varying from three to eight projects and in some instances to 15 or even 20 projects (one reply each). Ten is also considered the ideal number for a debt facility (n=4), followed by five projects (n=2) with others indicating at least either 3, 8 or 15 projects (one response each).

Other valuable insights pertain to risk distribution within the fund. More specifically, based on feedback from one of the interviewees, “no one project should ever account for more than 10% of a fund’s total investment portfolio”. Moreover, 15 is considered the optimal number of projects that should be covered by such a mechanism since portfolio diversification is necessary to ensure success of a handful of promising projects and overcome failure of others.

A13.2.12 Q10 - How long should the facilities be in place? (*sample=13*)

Some of the interviewees (n=5) mentioned that an Evergreen fund would be more suitable and advantageous since it would not be necessary to keep raising investment into the fund but “if you need to top up, then go out and raise more”. In addition, an Evergreen fund is deemed more appropriate if it is backed by private investors. Otherwise, a time horizon of 10 years would be more suitable and was favoured by several respondents. This would fit well with longer term institutional investors such as pension funds.

A duration of 5 – 6 years was recommended by two interviewees who also indicated that a preferable approach would be to treat the fund as a project in its own right – for example, by starting with an EC SET FOAK Fund I, and then rolling out Fund II, III, IV etc., as the funding concept took off – because an Evergreen fund would entail risks, including design errors that could lead to the fund not working efficiently, difficulties in allowing parties to exit the fund, and potential controversy concerning the annual fees which the fund manager would be entitled to.

A13.2.13 Q11 - Do you believe that an equity fund focused on FOAK projects should cover other TRLs? (*sample=14*)

A majority of interviewees (n=9) consider that TRL 6 should be covered under a fund facility, based on the working hypothesis (embedded in the question) that this would enhance the fund’s pipeline and allow it to pick up innovative projects ahead of time. Arguments in favour of earlier TRLs are based on the fact that there is little money for any pre-FOAK technology thus an equity fund should be able to cover other TRLs as well (and even later FOAK stages).

The overwhelming majority of respondents felt that the fund should also include TRL 9, based on the working hypothesis (embedded in the question) that this would “improve investor upside, giving opportunities to stay involved with projects as technology licensing and deployment gains are made”.

One respondent supported the broader coverage of TRLs in the fund as being necessary to yield results by spreading risk indicating that “risk/reward” is the key relationship as TRLs might not be very clear. Thus flexibility is required as indicated by another interviewee who said that “If you do FOAK, then you need NOAK to generate success and potentially compensate for any money loss that FOAK can lead to”. Other feedback received shows that investors recognize the need to support earlier stage projects when they are being delivered by credible people with “good private sector backing” and “a thorough business plan” that promises a believable and fundable route to commercialisation.

A13.2.14 Q12 - Up to what level of management fee (annual and possible capital gain) would be tolerated by institutional investors? (*sample=12*)

Most respondents (n=8) are in favour of a management fee in the order of 1-2% plus carried interest[251] (with only one interviewee preferring a 1-2% fee without carried interest). Based on feedback received, “anything more than that” is not deemed “palatable”.

By contrast, two respondents indicated that a management fee in the order of 2%-5% was acceptable, with just one of these suggesting carried interest on top. Just one respondent favoured a 2% management fee.

A13.2.15 Q13a - What sort of returns structure would be expected to incentivise private sector involvement? (*sample=10*)

An asymmetric returns structure was given as a preferable model by five respondents, one saying that it is “critical to ensure that EC absorbs first loses up to a defined maximum” and another giving a figure of 50% for such a loss. The EIB models in which EIB takes a first loss on the fund of funds investments was also cited as an example in support of this structure.

On the contrary, three interviewees opted for a *pari passu* approach. However, two respondents felt that a blend of both *pari passu* and asymmetric returns was needed because the balance depends both on the risk level of the technology and on how far away it is from being commercial.

Worth noting is that one respondent mentioned that although they would strive for *pari passu* they would ultimately need to show flexibility hence they are in favour of a combined return structure.

A13.2.16 Q13b - What level of returns would you expect to be provided from the equity facility? (*sample=13*)

A minimum of a 10% to 15% return rate is expected by most interviewees (n=9), with three respondents considering higher returns, in the order of 15%-20%. One of these latter respondents, who also think the fund could have global reach[252], stated that 15% returns should be more applicable in Europe whereas the latter should be applied in for example Africa. Only two respondents sought a 20%+ return. However, the feedback indicates that those rates would also depend greatly on the investors involved (i.e. their expectations) and how untested the FOAK projects are.

A13.2.17 Q13c- What sort of ownership structure do you think investors / the Equity fund would wish to take in projects? (*sample=12*)

There was a sliding scale of opinion as to the weight of ownership in each FOAK project. Nearly half of respondents (n=5) felt that the fund should be taking majority investments (50%+ stake) in projects. Their rationale is that such a structure would ensure control. Two respondents indicated that a significant stake in the order of 35%-50% would be appropriate (one gave two responses – either 35%-50% (significant stake) or 25%-35% (significant minority stake). A further four respondents thought that a significant minority (25%-35%) stake would be preferable. Overall, the ownership structure was highly dependent on the investor, the technology and the project sponsor and territory. This suggests that there should be flexibility in the investment approach of the fund.

[251] Carried interest or ‘carry’ is a share of profits that general partner of an equity fund would be eligible to receive once all limited partners had received the target profits, as set out in the fund mandate and contract between investors.

[252] An interesting comparator fund is the GEEREF (Global Energy Efficiency and Renewable Energy Fund) delivered by the European Investment Fund which supports funds investing in Africa, Asia and Latin America. However, GEEREF’s model is to support proven and deployable low carbon technologies at TRL 9 and 10.

A13.2.18 Q14 - What would be a minimum "lock-in" (i.e. investment commitment) period for investors to an Equity fund? (*sample=12*)

A period of 3-5 years was indicated by eight respondents as the preferred timespan for investors' commitment to the equity fund followed by 5-10 years preferred by three respondents. One respondent opted for both options (i.e. 3-5 years and 5-10 years); another commented that the exact lock-in period would depend on the investor.

A13.2.19 Q15 - What sort of institution would be best placed to manage and deliver each option, assuming inherent sector knowledge and experience? (*sample=13 for equity and 12 for debt*)

Equity fund

In terms of an equity fund, an asset manager was indicated by six respondents as the best sort of institution for managing and delivering such a facility for reasons including the necessity of putting together a very credible management team with sectoral/industrial knowledge and technical expertise. The European Investment Fund (EIF) was ranked as the second best option (n = 3) by responders who argued that such an institution would understand better the political objectives of the fund compared to private actors and be more capable of fulfilling the overall mandate of such a fund.

Finally, two respondents felt that either an asset manager or the EIF would work. Just one respondent thought that an investment bank was a preferable manager.

Debt facility

With regards to the debt facility, there was a wide spread of views on the best type of institution to manage and deliver such a facility. Four respondents felt that a development bank was best placed; an equal number had a preference for an asset manager. Other respondents indicated an Investment Bank and the EIF (one reply for each). The remaining replies covered combinations of institutions (development bank and asset manager was indicated by one and commercial banks, investment banks and asset manager by another). The prevailing view was that there was a need to ensure that the "best in the class" institution is appointed.

A13.2.20 Q16 - What incentive structure might be suitable for such a manager, to achieve maximum efficiency and success? (*sample=9*)

A general observation is that both strategic alignment between the manager and the EC's strategic policy objectives and, crucially, a lack of conflict of interest in the management of such financial mechanisms are fundamental to the ultimate success of the mechanism. As one respondent put it:

> *"Where the fund starts from is really critical - is it an investment play or strategic case? What is the driver for the fund? The vision needs to be clear."*

Some sort of incentive structure involving a basic annual management fee and carried interest "conforming to market norms" (see answers to Q12) which is linked to performance (for example "based on disbursement and success of investment"), is certainly the most frequently cited suggestion. One respondent noted that fund managers "should not be able to live comfortably" if the fund is unsuccessful which means that the threshold for carried interest might be set quite high. In contrast, another stated that *"anything other than a standard private equity formula would not work".*

Since funding FOAK projects is capital intensive and risky, one respondent noted that investment managers might be tempted to be too risk averse in order to avoid losses that would result in no money in the carried interest "pool". This then reiterates the importance of the strategic objectives of the fund and its TRL focus:

> *"Because it's so risky an area, it would be hard for an asset manager to get good returns. But you don't want this fund to invest in 'no-hopers' - technologies that*

> *investors won't touch – so you need technologies which are very nearly market ready."*

One respondent, who favoured a public institution for managing such ventures, said:

> *"Delivering the sector is good enough...I do not believe this will work if commercial entities are appointed to deliver it."*

Another respondent who echoed this sentiment at a more operational level, commented that there *"needs to be sufficient commercial and policy incentive to avoid funds merely being deployed for short term commercial returns."*

Interestingly, one respondent (a private sector fund manager) reported that they were successfully managing an ERDF early stage fund investing in clean technologies and low carbon innovations and delivering both financial and policy objectives. Several companies it had supported alongside other investors had been delivering FOAK projects of up to €5-10m in value. The respondent reported that they had managed to achieve the European Commission monitoring KPIs of the fund without any real issue and that overall the fund *"has worked pretty well"*.

How to obtain EU publications

Free publications:

- one copy:
  via EU Bookshop (http://bookshop.europa.eu);
- more than one copy or posters/maps:
  from the European Union's representations (http://ec.europa.eu/represent_en.htm);
  from the delegations in non-EU countries (http://eeas.europa.eu/delegations/index_en.htm);
  by contacting the Europe Direct service (http://europa.eu/europedirect/index_en.htm) or
  calling 00 800 6 7 8 9 10 11 (freephone number from anywhere in the EU) (*).

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).

Priced publications:

- via EU Bookshop (http://bookshop.europa.eu).

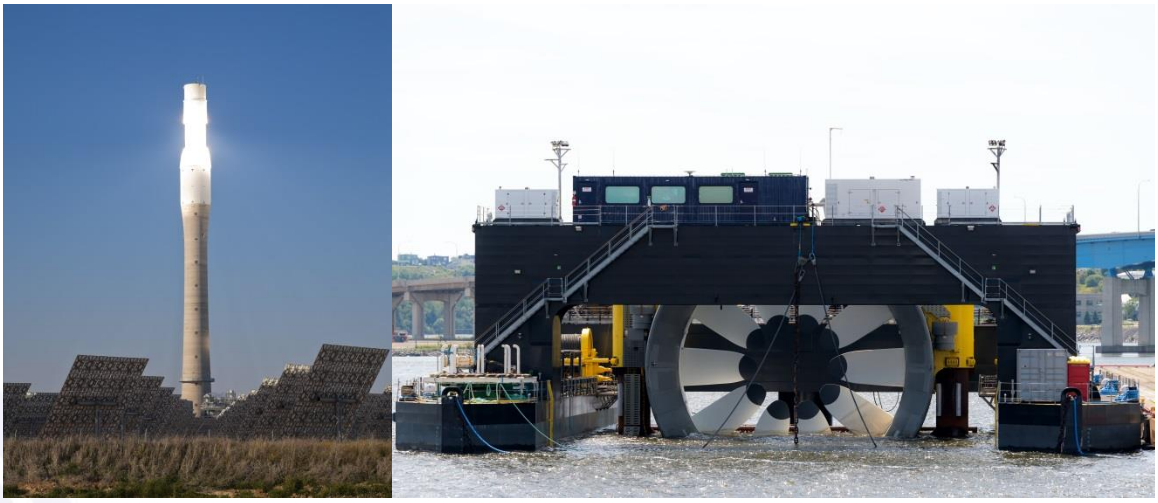
This study, commissioned by DG Research & Innovation, examined the role of financial instruments in the support of commercial-scale, first-of-a-kind (FOAK) energy demonstration projects focused on Sustainable Energy Technology (SET) sectors in Europe. FOAK projects are highly risky and the supply of equity and debt is at much lower levels than the financing of proven low carbon technologies. Market participants have very different appetites for risk, which in turn leads to complex financial structures being required to enable such projects to achieve financial close. Consequently, there is high demand for a suite of public sector funding mechanisms to be made available to fill the commercialisation, 'Valley of Death', funding gap. Two EU financial instruments have been identified as being needed: equity provision and specialist loans (as the latter already being offered by the Energy Demo Projects (EDP) facility), both at a scale of around at least €250 million and ideally €500 million.

Studies and reports

Publications Office

ISBN 978-92-79-62115-4

European Commission



Innovative Financial Instruments for First-of-a-Kind, commercial-scale demonstration projects in the field of Energy

Annex of Deliverables

Written by ICF *in association with London Economics*

September 2016

ICF

Research and Innovation

EUROPEAN COMMISSION
Directorate-General for Research & Innovation
Directorate G — Energy
Unit G.1 — Strategy
Contact: Nuno Quental
E-mail: RTD-ENERGY-COM@ec.europa.eu
European Commission
B-1049 Brussels

EUROPEAN COMMISSION

Innovative Financial Instruments for First-of-a-Kind, commercial-scale demonstration projects in the field of Energy

Annex of Deliverables

EUROPEAN COMMISSION

EUROPE DIRECT is a service to help you find answers to your questions about the European Union

Freephone number (*):
00 800 6 7 8 9 10 11

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you)

LEGAL NOTICE

This document has been prepared for the European Commission however it reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

More information on the European Union is available on the internet (http://europa.eu).

Luxembourg: Publications Office of the European Union, 2016.

PDF	ISBN 978-92-79-62115-4	doi: 10.2777/704393	KI-06-16-027-EN-N

Printed in the United Kingdom.

PRINTED ON RECYCLED PAPER

Contents

1 Introduction

This is the Annex of Deliverables pertaining to a study, commissioned by DG Research & Innovation, to examine the role of financial instruments in the support of commercial scale, first-of-a-kind (FOAK) projects focused on Sustainable Energy Technology (SET) sectors in Europe.

The study was carried out by ICF International, in association with London Economics, between March 2015 and June 2016.

The underpinning research has required extensive research and consultation with European technology sponsors, financial market participants (drawn from the global financial supply side) and technology and innovation support schemes at the EU and Member State level as well as in non-EU countries.

This Annex of Deliverables is structured as follows:

- Section 2 provides the "Instrument Description", a set of descriptions of 14 EU and EU Member State schemes used to support SET technology projects. The Instrument Description incorporates two precursor deliverables, namely the ""Instrument List" and the "Instrument Selection". Thus Section 2 augments Section 2.3.1, Section 3.2 and Annex 1 of the main report,
- Section 3 presents the "Market Participant Description Sheets", a set of factsheets describing the 80 shortlisted market participants, and the "Consolidated List of Market Participants". The Consolidated List incorporates two precursor deliverables, namely the "Market Participant List" and the "Market Participant Selection". Thus Section 3 augments Section 2.3.1, Section 3.3. and Annex 4 of the main report;
- Section 4 presents the "Market Conditions Description Sheets", a set of factsheets describing market conditions that affect may affect investment in SET projects in 32 European countries (EU-28 plus Iceland, Norway, Switzerland and Ukraine), organised by SET sector. Thus Section 4 augments Section 2.3.1, Section 3.4, and Annex 5 of the main report;
- Section 5 provides the "Regional Analysis", a set of descriptions of 7 third country schemes used to support SET technology projects. The Instrument Description incorporates two precursor deliverables, namely the ""Instrument List" and the "Instrument Selection". Thus Section 5 augments Section 2.3.1, Section 3.5 and Annex 6 of the main report;
- Section 6 provides the write-ups of interviews with the 29 market participants who agreed to be interviewed for the Market Participants Survey. Thus Section 6 augments Section 4.1 of the main report.

2 Instrument Description

Through the interviews and online research described, the ICF Team sought information on the following areas:

- Technological coverage and Technology Readiness Levels (TRLs) of projects supported by the scheme;
- Type(s) of instrument deployed by the scheme, e.g., loan, equity;
- Annual budget of the scheme;
- Maximum level of funding for any given project, both in absolute terms and as a percentage of the project's budget, supported by the scheme;
- Eligibility criteria that projects have to meet;
- Contractual conditions to which project developers have to agree;
- Market acceptance and relevance of the scheme (in terms, for example, of the number of applicants per year/call and the success rate of applicants);
- Effectiveness of the scheme (in terms of the known outcomes and impacts, including, for example, the number of successful demonstration projects introduced to the market)
- Efficiency of the scheme (for example, in terms of the extent to which private funds have been leveraged); and
- Connections, if any, to (other) EC support schemes, such as the NER 300 support for commercial scale projects.

Additionally, the ICF Team has made an assessment of the appropriateness of the scheme for supporting first-of-a-kind commercial-scale demonstration-stage projects in the nine clean-energy technological sectors of interest from the SET Plan.

Description sheets for each of the schemes are provided overleaf.

Name	**New Entrants Reserve (NER) 300 and proposed Innovation Fund** EC/DG Climate Action/EIB
Geographical area	EU
Year started	2010
Status	Open
Type of instrument	Grants
Annual budget	€2.1bn overall, based on competitions which opened in November 2010 and April 2013
Project funding amounts	Under NER 300, the financial award allocated to a winning project is a maximum amount that is dependent on the assumed avoided CO_2 emissions from that project. Final disbursement is based on operational performance of projects and awards are dependent on the verified avoidance of CO_2 emissions[1]. The threshold for NER 300 is 50% of relevant costs although smaller interventions have been committed. In its proposal for a revised ETS adopted on 15 July 2015, the Commission suggests to renew the existing NER 300 by an Innovation Fund, which should be endowed with 450 million allowances targeted not only at CCS and innovative RES, but also to innovative energy-intensive industry. It should be a means of directing further revenues from the ETS towards the demonstration of innovative low-carbon technologies in the industry and power generation sectors.
TRL focus	TRL 7-8 (projects must be at a commercial scale, but using technologies which are not yet commercially viable)
Technology coverage	Demonstration projects performing environmentally safe capture and geological storage of CO_2 (i.e. CCS) or using innovative renewable energy technologies across a broad sector of SET sectors.[2] The Innovation Fund will enable low carbon innovations in industry to be included.

http://ec.europa.eu/clima/funding/ner300-1/index_en.htm

http://ec.europa.eu/clima/funding/ner300/index_en.htm

Contact details:
Member State
National Contact Points
http://ec.europa.eu/clima/funding/ner300/docs/contacts_en.pdf

.

[1] Article 11(2) of the NER Decision stipulates that the actual funding rate shall be calculated by dividing the awarded funding by 75% of the total amount of CO_2 stored in the first 10 years (in case of a CCS project) or the total amount of energy produced in the first 5 years (in case of a RES project). This means that a project delivering at least 75% of the projected performance will receive the full funding and that projects delivering less receive the proportionate equivalent of the total funding awarded. This provision aims to take into account the greatly elevated risks of innovation projects at TRL 7-8, specifically that there is little market experience available for a solid assessment of the expected project performance.

[2] The NER 300 Decision lists eight main RES categories, 34 RES sub-categories and eight CCS project categories as eligible. Projects were sought in each of these categories.

Instrument objective

The revised EU ETS Directive prepared the ground for the third ETS trading phase (2013-2020). A new feature of the Directive included the establishment of the NER 300. The vision was for a mechanism which would 300 million allowances from the EU ETS to be monetised to support the development and deployment of low carbon/decarbonised technologies by financing demonstration projects for RES and CCS technologies. The creation of NER 300 contributes to the successful implementation of the following EU policies and strategies: “Investing in the Development of Low Carbon Technologies” (COM(2009)519 Final); the SET-Plan; 2030 Climate & Energy Package (COM(2014)15); the Energy Roadmap 2050 (COM(2011)885); and the Roadmap for moving to a competitive low carbon economy in 2050 (COM(2011)112).

NER 300 was also intended to encourage Member States to support key low carbon technologies which can take advantage of domestic competitive advantages in terms of both their renewable energy sources and innovation/supply chain capabilities and strengths.

Overall, the key objectives for NER 300 can be summarised as follows:

- Support a broad technological range of RES and CCS demonstration projects;
- Ensure knowledge sharing and dissemination arising from the support;
- Achieve the highest possible cost-effectiveness for use of NER 300 funds;
- Achieve a wide geographical spread among EU Member States; and,
- Achieve leverage of private (and potentially public) sector of funding.

The Innovation Fund, proposed for the 4th phase of the ETS, will broaden the scope of the NER 300 to include industrial low carbon innovations, mainly aimed at supporting the commercialisation of carbon reducing technologies within energy intensive industries. The aim is to provide support to improve company competitiveness and avoid carbon ‘leakage’. The new Fund will again cover projects in all Member States, including small-scale projects, and Member States will still be able to make a pre-selection of projects at their own discretion[3].

Target beneficiaries

For NER 300, technology sponsors, engineering companies, energy utilities. Industrials/manufacturers will be eligible for the Innovation Fund as well.

Eligibility criteria and specific contractual conditions

The “NER 300 Decision”[4] contains the criteria and principles of operation of the Programme, in particular the eligible types of projects it can support. It also defines the role of the EIB and details of the due diligence assessments which must be carried out before any funding can be granted. Guidance for applicants was set out on the DG CLIMA website[5].

Current rules for project screening and eligibility include the following non-negotiable requirements for renewable energy projects, which must:

1. Break new technological ground, i.e. by demonstrating a novel solution to a technological challenge at a relevant scale;
2. Be on the cusp of “commercial” deployment and free of any financial obstacles, i.e. once the NER 300 project has ended there should be no requirement for further public subsidy (beyond any market incentives/subsidies such as feed-in tariffs);
3. Either produce energy or facilitate its integration into the grid (such as “smart grid” applications);
4. Provide proof of “additionality” of funding needs (i.e. projects must provide evidence in their applications

[3] European Council decision of 23 October 2014

[4] Commission Decision 2010/670/EU of 3 November 2010 laying down criteria and measures for the financing of commercial demonstration projects that aim at the environmentally safe capture and geological storage of CO_2 as well as demonstration projects of innovative renewable energy technologies under the scheme for greenhouse gas emission allowance trading within the Community established by Directive 2003/87/EC of the European Parliament and of the Council.

[5] For the first funding round: http://ec.europa.eu/clima/funding/ner300-1/index_en.htm and for the second funding round: http://ec.europa.eu/clima/funding/ner300/index_en.htm

that they could not have been realised without the availability of public funding); and,

5. Provide a degree of knowledge sharing to help disseminate the findings of the project.

On the basis of the judgement of an independent assessor, the innovativeness of each project is categorised as follows:

- Little or no innovation;
- Some innovation demonstrated, but mainly incremental;
- Highly innovative project for some component or aspect of the technology/process;
- Highly innovative project that is likely to represent a ‘game changing’ step in technology/process.

An Amendment to the NER 300 Decision in February 2015[6] extended the timetable of awarded projects, which should now enter into operation by December 2018 (if selected for funding under the first call) or June 2020 (if awarded under the second call).

Market acceptance and relevance

A tendering procedure was organised by the Commission with two rounds of funding. Interest from project sponsors and Member States appears to illustrate the relevance of NER 300: In the first round 79 applications were received from 21 Member States (13 CCS and 66 RES projects)[7]. In the second round 32 applications were received from 12 Member states (1 CCS and 31 RES projects). Of these, the EIB received 12 re-submitted projects from the first round[8].

Effectiveness and efficiency

NER 300 has generated good interest from technology sponsors from across SET sectors and Member States. Given the maximum funding levels, leverage achieved should be at least 1x should all projects become operational. This would be in line with other types of support programmes targeting later stage, higher risk projects.

Although some up-front payments were provided in a small number of cases, the general lack of up-front payments has increased the levels of risk associated with projects achieving a Final Investment Decision. The extension of the NER 300 timetable is evidence that project sponsors have taken much longer in reaching final close on projects. To date, three of the 39 active projects are operational[9].

Member State screening of projects and their involvement in the decision making process suggests that strategic projects were put forward for funding that might not have otherwise not have been supported by the market.

ICF assessment of appropriateness for financing SET projects

NER 300 provides funding at the scale necessary to overcome the commercialisation “Valley of Death” for many FOAK projects.

The major benefit that a successfully implemented NER 300 programme can achieve in the support of SET (i.e. FOAK) projects in Europe is that it can help to reduce the risk profile associated with this investment ‘class’ as a result of its ‘demonstration effects’. This in turn can help secure new and increased volume of private sector investment into additional FOAK demonstrators as well as “Nth of a kind” projects. This will help

[6] Commission Decision (EU) 2015/191 of 5 February 2015 amending Decision 2010/670/EU as regards the extension of certain time limits laid down in Article 9 and Article 11(1) of that Decision (notified under document C(2015) 466)

[7] One more application for a renewable energy project was received from Ireland, but in a later stage this project was withdrawn from the first round of applications, and was re-submitted in the second round

[8] http://www.eubusiness.com/topics/environ/ner-300-2

[9] ICF research based on various information sources such as http://europa.eu/rapid/press-release_MEMO-12-999_en.htm; NER 300 1st call for proposals - awarded projects available at http://ec.europa.eu/clima/news/docs/c_2012_9432_en.pdf; NER 300 second call for proposals - awarded projects available at http://ec.europa.eu/clima/policies/lowcarbon/ner300/docs/c_2014_4493_annex_en.pdf; http://www.eubusiness.com/topics/environ/ner-300-2, http://www.ner300.com/ and project developers’ websites.

to lower the levelised costs of energy production.

The new Innovation Fund has the potential to eliminate some of the teething issues that have beset NER 300. For example, it could:

- Remove a fixed intervention rate, judging intervention rates on a project-by-project basis reflective of the risks and possible benefits;
- Focus on a technology neutral approach, enabling all potential technology solutions, large and small, to be considered;
- Remove the need for geographic balance across the EU, focusing instead on the best potential solutions to reducing overall EU emissions;
- Clarify and simplify the approach to state-aid considerations;
- Focus on the most cost-efficient projects – and by implication have a common approach to assessing cost-effectiveness across technologies, and include confirmation of market failure;
- Provide early funding on the basis of achieved project milestones to reduce risk, placing greater weight on project design and planning;
- Consider removing the link between funding and verification of CO_2 reduction, reducing the risk to developers and reliance on the independent assessments of the potential for emission savings.

It will be vital for a new Fund to speed up the application and disbursement process to ensure projects are built in the timescale foreseen. Otherwise there is a risk that technological progress in similar cutting-edge technologies will be made in third countries and the EU economy will become less competitive in RES and CCS innovations.

Name	InnovFin Large Projects (ILP)
Geographical area	European Union
Year started	2014
Status	Open (initially to 2020)
Type of instrument	Direct term loans and guarantees with tenor of up to 10 years
Annual budget	Part of InnovFin which has total resources of €25 billion between 2014 and 2020.
Project funding amount	€25m - €300m
TRL focus	TRLs 1 – 8
Technology coverage	Open to projects in all SET sectors

InnovFin Large Projects

http://www.eib.org/attachments/documents/innovfin_largecaps_flysheet_en.pdf

Contact details:
EIB
98-100, Boulevard Konrad Adenauer
L-2950 Luxembourg
(+352) 43 79 1

Instrument objective

To improve access to risk finance for research and innovation (R&I) projects with a relatively high credit risk. This is the same as the objective of its predecessor, the Risk Sharing Finance Facility (RSFF).

Target beneficiaries

Large companies, universities and public research organisations, R&I infrastructures (including innovation-enabling infrastructures), public-private partnerships and special-purpose vehicles.

Eligibility criteria and specific contractual conditions

Projects must contain a “technological leap” and their risks must nonetheless be judged “bankable” by EIB. Funding must be used to defray the costs of eligible R&I activities undertaken over a period of 3 to 5 years with direct term loan or guarantee periods of up to 10 years. Although funding consists typically of senior debt, EIB can provide funding in other forms – for example, “quasi-equity” (i.e., convertible loans) – depending on risk ratings. Typically, up to 50% of total costs are covered, though this depends on the risk structures of the promoter (i.e. their credit risk limit) and the proposed operational structure. Covenants and security are decided by EIB on a case-by-case basis.

Market acceptance and relevance

The number of applications so far indicates that the ILP will be as popular as the RSFF, which provided similar levels of funding to projects in SET technologies (including some first-of-a-kind projects at commercial scale and demonstration stage), mostly in wind and CSP, in the period 2007-2013[10]. The attrition rate for applications is fairly high so far, as it was with the RSFF: 60-70% rejection. (20-30% of applications rejected after initial due diligence; then 20% after EIB Board decision but before contract signature; then 20% after contract signature but before [final] decision to proceed.)

[10] Overall, RSFF provided financing worth €11.3bn to 114 R&I projects, together with loan guarantees worth a further €1.4bn (source: Report to the Parliament and Council on financial instruments supported by the general budget according to Art.140.8 of the Financial Regulation as at 31 December 2013 (COM(2014)686 Final), October 2014). In terms of energy projects, the contribution under RSFF overall was around 16% of the budget, and all energy projects supported were low carbon, particularly in the wind and CSP sectors.

Effectiveness and efficiency

Since the ILP has been in operation for only just over a year, no evaluation has yet been performed, though one is expected to begin in 2016. An evaluation of the RSFF showed that it generated a leverage effect of 11.6 from the EC's financial contribution[11], realising additional private investment of €34bn into R&I. Since the RSFF proved to be an attractive financial instrument for companies, organisations and projects focused on research, development and innovation[12], EIB's expectation is that the ILP will also be able to leverage (mostly) private-sector finance similarly successfully. EIB expects to lever the €25bn of its lending under the total InnovFin mechanism to at least, given the 50% max rule, €50bn and perhaps to €75-80bn[13].

ICF assessment of appropriateness for financing SET projects

The ILP should be able to generate a high leverage factor using an instrument that has been deployed before by the RSFF on different types of projects involving SET technologies, including some first-of-a-kind. According to EIB, the RSFF model "successfully 'crowds in' private sector financing."[14] That said, the RSFF was characterised by JRC as focused on 'limited to moderate risk levels'[15]. The higher risk profile of first-of-a-kind commercial-scale demonstration-stage projects in SET technologies (driven in part by the fact that developers of such projects often lack a stable commercial track record and also by the fact that projects need to successfully demonstrate a technology for at least a year[16]), means that, overall, the ability of ILP to target projects of interest to this Study could well be limited.

[11] Independent Expert Group (2013) Final Report - Second interim evaluation of the RSFF http://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/interim_evaluation_report_rsff.pdf

[12] Advantages of the scheme included: a stable funding source; a long maturities (of up to 10 years); large single loan sizes (of up to €300m); and the signalling effect of EIB funding as a quality stamp to help attract other lenders. While the geographical spread across Member States was not widespread (concentrated in Germany, Spain, and France), the sectoral allocation was fairly diverse (16% went to energy projects, a similar percentage as ICT, with the engineering sector receiving 37% of the capital allocation). However, research Infrastructures and SMEs were not well represented. Since the instrument is delivered by EIB but supervised by DG RTD and DG ECFIN, a lot of time is required for reporting and this is said to have increased the costs of the initiative and increased administration time. Source: Independent Expert Group (2013) Final Report - Second interim evaluation of the RSFF http://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/interim_evaluation_report_rsff.pdf

[13] ICF consultation with Marc D'hooge, EIB

[14] ICF consultation with Marc D'hooge, EIB

[15] JRC (2013) Report on Innovative Financial Instruments for the Implementation of the SET Plan, First-Of-A-Kind projects. Luxembourg: Publications Office of the European Union

[16] ICF consultation with Marc D'hooge, EIB

InnovFin: Energy Demo Projects Pilot (EDP)

Instrument overview

Launched by the EC and EIB on 15 June 2015, InnovFin's EDP facility is focused on first-of-a-kind projects using technologies not yet proven at scale (i.e. TRLs 7 & 8) which can be replicated in the EU and globally. The facility is a strong outcome of the EU's Strategic Energy Technology (SET) Plan. The objective is to support innovative companies and project promoters to overcome the "Valley of Death" between the demonstration and commercialisation phase. The ability of EDP to target the implementation and performance risk of a project in the design, construction and early operational phase is an important feature, although this phase should at appraisal not be deemed to last longer than 4 years.

Instrument objective

The EDP aims to improve access to risk finance for first-of-a-kind projects that have a very high credit risk and would not find alternatives sources of funding.

Type of instrument

The EDP is able to provide direct lending of between €7.5m and €75m. EIB can provide up to 50% with the expectation of around 25% equity and 25% of funding from other sources. Collateral requirements, which project sponsors must fulfil to receive funds, will be set by EIB on a case-by-case basis.

Effectiveness and efficiency

The elevated risk in projects targeted by the EDP facility is covered by the European Commission carrying 95% of potential losses on a portfolio basis. However, once successfully demonstrated and the following conditions are met, the EDP guarantee is released:

■ Financial performance of the project is in line with pre-agreed cover ratios which demonstrate that the expected cash flows are being generated; and

■ A competent external advisor can validate that the project has been completed; that it has achieved a minimum level of technical performance; and it is fully operational.

Following release of the guarantee, 100% risk for the operating phase is carried by the EIB.

Market acceptance and relevance

Solid market interest has been shown to date: as at 29 July 2015, EDP had already attracted 20 applications and a total of 41 full applications by mid-September 2015[17]. SET coverage is broad, with applications for projects involving technologies from six SET sectors: biowaste-to-energy, CSP, floating wind turbines, geothermal energy, solar PV, and tidal and wave energy. As might be expected, the attrition rate is high – only 26 applications are still under consideration. According to EIB, the concrete project proposals received to date have generated a robust evidence base and thus allowed EIB to feel justified that there is a market for the EDP facility. However, this will need to be corroborated by other research such as the current RTD study. EIB expects the EDP facility to "crowd private finance into a high-risk area", similarly to the ILP[18].

[17] Discussion with DG RTD, 28th September 2015

[18] ICF consultation with Marc D'hooge, EIB

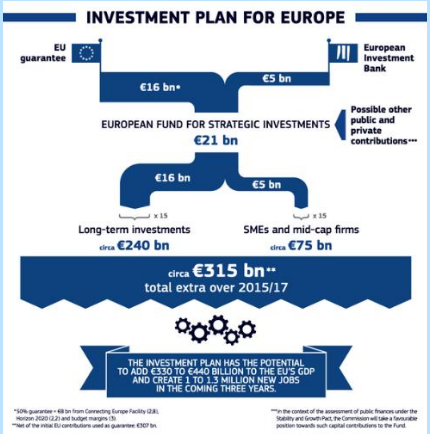
ICF assessment of appropriateness for financing SET projects

The EDP provides an important additional source of funding for first-of-a-kind SET projects as it is designed to fill a specific market gap in high risk debt finance, complementing equity and potentially grant funding. At €7.5m minimum funding, the facility is also able to target smaller project levels than its parent, the ILP facility (minimum €25m), opening some greater potential for project coverage.

The strong market interest shown in the scheme, across different SET technologies and TRLs, since it started operations is evidence that there is market demand for such a support mechanism.

The challenge will be whether the types of organisations and projects applying for support can meet the set eligibility criteria; and EIB also faces a challenge in assessing the market risk criteria four years into the future.

Name	**European Fund for Strategic Investments (EFSI)** EC/EIB
Geographical area	EU
Year started	2015[19]
Status	Open
Type of instrument	Loans, loan guarantees, equity
Annual budget	€21bn initially committed (comprising a €16bn guarantee from EC and €5bn from EIB's own resources) Further contributions now pledged from nine Member States including: France (Caisse des Depots & BPI, €8bn), Germany (KfW, €8bn), Italy (CDP, €8bn), Spain (Instituto de Credito Oficial, €1.5bn) and the UK (€8.5bn)[20]
Project funding amounts	There does not appear to be any set level of financing which is guaranteed by EFSI. However, in the renewables and resource efficiency space, projects to date suggest that a minimum of €50-75m is put forward for a guarantee under the Fund
TRL focus	TRL 5-9 (to be confirmed)
Technology coverage	Broad sectoral and geographical coverage with no specific quotas



http://www.eib.org/about/invest-eu/

Contact details:
EIB
98-100, Boulevard Konrad Adenauer
L-2950 Luxembourg
(+352) 43 79 1

Instrument objective

The Investment Plan for Europe, introduced by the EC and EIB in order to help overcome the current investment gap in the EU, seeks to mobilise private financing for strategic investments. By targeting strategic and economically viable projects, EFSI seeks to stimulate economic growth and create jobs and sustained benefits for the EU. The objective is to use EC money to leverage private and public money (e.g. through public banks in Member States) of at least €315bn over the three years to 2018.

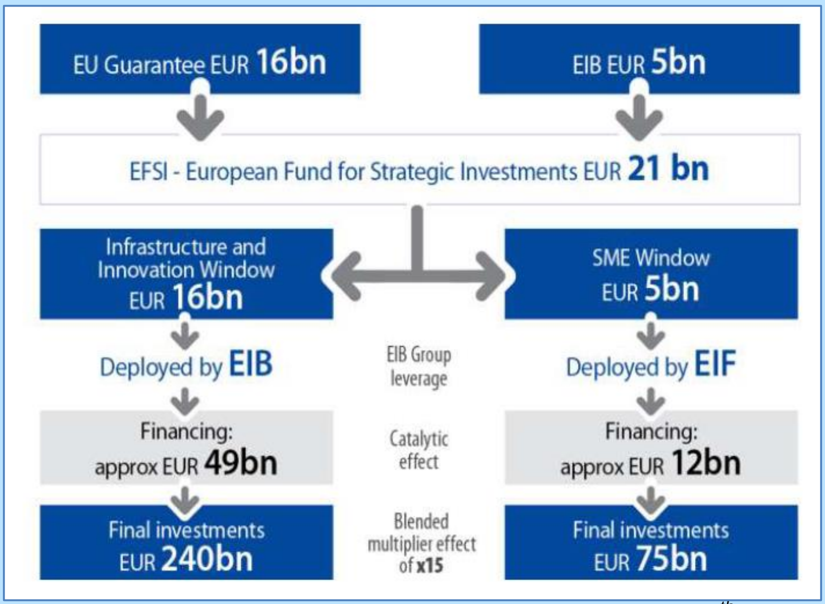
The Fund will focus on sectors of key importance to the EU economy and areas in which the EIB already has a track record and expertise, for example in RDI, strategic infrastructure (covering, for example, energy and transport), and the expansion of renewable energy and resource efficiency projects.

The EFSI works by pooling funding from EU's Budget with funding from the EIB and contributions from national investment banks. This fund will serve as creditor protection or a guarantee to support both long-term investments in Infrastructure and Innovation and investments by SMEs and mid-cap firms.[21]

[19] Completion of the formal establishment of EFSI occurred in July. http://www.eib.org/infocentre/press/releases/all/2015/2015-175-eib-approves-eur-10-billion-of-new-eib-loans-and-launches-european-fund-for-strategic-investments-with-european-commission.htm

[20] Investment & Pensions Europe, *EFSI names board, backs projects financed by Danish schemes*, 23 July 2015 http://www.ipe.com/news/alternatives/efsi-names-board-backs-projects-financed-by-danish-schemes/10009177.fullarticle

[21] http://www.e3g.org/docs/E3G_Juncker_Investment_selection_criteria.pdf



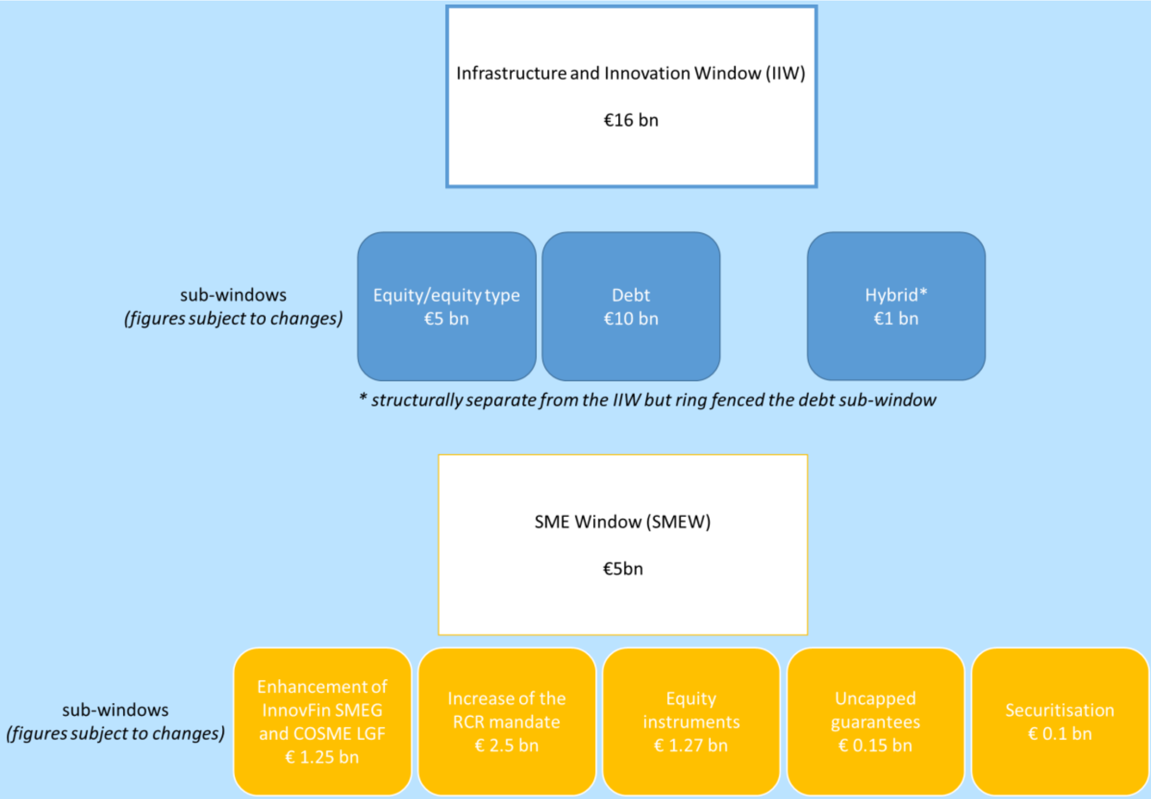
Source: European Investment Bank – The investment Plan for Europe (EFSI) – 5th October 2015. Available at http://www.eif.org/what_we_do/efsi/

Infrastructure and Innovation window
Projects within this window will be financed by the European Investment Bank (EIB) financing schemes. The Fund provides:
- Long-term senior debt for higher risk projects;
- Subordinated loans and;
- Equity and quasi-equity funds.

Typical projects eligible for EFSI funding within the Infrastructure and Innovation window are:
- Transport infrastructure;
- Broadband infrastructure;
- Energy infrastructure;
- Renewable energy;
- Long-term investment funds;
- Research and Innovation;
- Education.

SMEs and Mid-cap companies window
Projects within this window will be financed by the European Investment Fund (EIF) financing schemes. The Fund provides:
- Venture Capital;
- Guarantees;
- Securitisation;
- Growth finance.

Typical projects eligible for EFSI funding within the SME and Mid-cap companies windows are:
- SME (e.g. equity in a start-up; micro-loans to an SME)
- Mid-cap companies (e.g. Loans for R&D projects; Venture capital for developing a prototype)



Source: ICF based on EFSI Steering Board, EFSI Strategic Orientation, December 2015. Available at: http://www.eib.org/attachments/strategies/efsi_steering_board_efsi_strategic_orientation_en.pdf

Investment platforms

Final recipients can be supported through EFSI via so called Investment platforms. The rationale for establishing platforms is that they can serve to:

- raise the profile of particular sectors / territories among potential investors;
- create strong project pipelines in strategic sectors / territories;
- bring in the necessary geographical / thematic expertise necessary to make informed investment decisions in specific areas;
- alleviate the constraints linked to the lack of coordination on infrastructure development (which can in some cases, e.g. grid planning, lead to prohibitive individual project costs;
- mitigate the transaction costs associated with information sharing between financiers and project promoters;
- spread the risk of individual projects among financiers; and,
- adopt a long-term view on the returns of their investments, which could attract institutional investors such as insurance companies and pension funds.

As per the paragraph 4, Article 2, of the EFSI Regulation, Investment platforms can be organised on a geographical or on a thematic basis. They are entities (with or without legal form) which invest, directly or via financial intermediaries, in a group of investment projects. Concretely, an investment platform can take the form of, e.g.,:

- A co-financing agreement with the EIB, whereby platform stakeholders (i.e. investors) commit, with appropriate risk-sharing provisions, to co-invest with EIB for certain types of its operations under EFSI;
- A thematic investment fund;
- A geographic investment fund.

The Investment platform then provides equity and/or debt financing to companies/projects falling under its geographic or thematic scope. Creating an investment platform thus consists of bundling smaller projects together (projects from a particular territory – e.g. region or group of Member States - or from a particular sectors – mono-sector platforms or multi-sector focus).

Investment platforms need to attract other investors beyond EFSI. Each platform will need to have its sponsor, be it a National Promotional Bank, a Government agency, a Sovereign Wealth Fund, a private investor or an individual company. The sponsor will be responsible for establishing the platform and will notably be responsible for defining: the investment needs, the sectorial and geographical focus, the business case, the sources of funding, the risk-sharing agreements as well as the decision-making rules. It is also expected to bring in part of the funding. The European Investment Advisory Hub (EIAH) created, like EFSI, under the Investment Plan can provide advisory and technical assistance services during that process.

Target beneficiaries

Private companies, especially larger organisations, are likely to be key beneficiaries of EFSI, not least due to the strict lending criteria which EIB follows. Projects may be cross-border if required.

Eligibility criteria and specific contractual conditions

Projects supported through EFSI will be required to fulfil normal EIB project cycles and governance structures. The eligibility criteria with which projects must comply are as follows:

- Main criteria:
  - They should be consistent with European Union's targets and policies;
  - They should be economically and technically viable;
  - They should provide additionality in areas where underinvestment has occurred due to market failures,
  - They should maximise the mobilisation of private sector capital.[22]
- Further criteria:
  - Innovativeness;
  - Replicability;
  - Readiness for demonstration scale;
  - Readiness of commercial operation in maximum 4 years;
  - Prospect of bankability;
  - Commitment of promoters, sponsors and operators to co-fund the project.

Two new dedicated bodies have been set up to provide oversight and guidance:

- EFSI Steering Board: will provide guidance on the target risk profile of the portfolio and strategic orientations of EFSI; and,
- EFSI Investment Committee: will assess and approve the use of the EU budget guarantee of €16bn for specific operations.

Market acceptance and relevance

Momentum built in the roll out of EFSI during the second half of 2015, with several major 'projects' in the SET/resource efficiency sector supported by end October 2015, including:

- Abengoa's RDI II project in Spain, which is focused on advanced biotechnology/chemical processes for advanced biorefineries, advanced power systems and renewable energy. In July, EIB provided a loan for €125m or 37% of the total financing costs of €340m, of which €50m was put forward to EFSI for backing with the balance (up to €75m) supported by "InnovFin – EU Finance for Innovators". Support of €30m from Spain's Instituto de Credito Oficial has also been explored[23];
- Nobelwind NV offshore wind farm (aka Belwind 2), Belgium - EIB has provided a €250m loan (a "large portion" of which will be proposed for EFSI backing) into the SPV which is completely separate from

[22] http://www.e3g.org/docs/E3G_Juncker_Investment_selection_criteria.pdf

[23] http://www.eib.org/projects/pipeline/2014/20140587.htm & http://www.eib.org/infocentre/press/releases/all/2015/2015-153-el-bei-firma-el-primer-prestamo-bajo-el-fondo-europeo-de-inversiones-estrategicas-en-espana-en-apoyo-de-las-actividades-de-idi-de-abengoa.htm

Belwind NV and "created to isolate the development risk of Belwind 2". EIB funding represents around 38% of the total cost of €655m for constructing the 165MW project which reached financial close in October 2015 and is due for construction in April 2016[24,25,26];

- Metsä Fibre Corporation's Aanekoski's next generation 1.3m tpa bio-product mill in Finland to replace an old mill at the site (€1.2bn investment of which 40% equity and 60% debt financed (to include bank loans and trade credit)[27] with EIB providing loan support of €275m or 23% of total financing (of which €75m will be proposed for EFSI backing)[28]. Besides pulp production, the mill will produce tall oil and turpentine. Waste residues will be used on site to generate more power than is required, while production side streams will benefit other businesses on site (i.e. through industrial symbiosis).

Effectiveness and efficiency

Much of the EFSI financing is being "piggybacked" onto existing EIB support, either through the InnovFin mechanism or via EIB's day-to-day lending processes. As EIB states "EFSI is not a fund or other legal entity and it does not trade independently"[29]. Due to EIB's mandate and governance, EIB's capital injection into the EFSI will seek to increase the volume of higher risk projects and address market failures in risk-taking which hinder investment in Europe. Overall, therefore, it is highly likely that there are large efficiencies to be gained from this approach. However, there are also risks that deals will be repackaged to take advantage of EFSI's guarantee that might not need it. New oversight structures put in place by the EC and EIB to monitor and take decisions on the use of the EC guarantee should help to prevent such actions (or deadweight).

EFSI will operate on a portfolio basis covering hundreds of projects. This means that its full impact (i.e. the multiplier) of the EC guarantee can only be measured at the end of the investment period. However, EIB consider that, based on previous experience, a multiplier of 15 is realistic.

ICF assessment of appropriateness for financing SET projects

EFSI has the potential to help overcome some of the financing challenges for SET projects, especially helping some Member States to target strategic projects that might otherwise fail to be financed.

To date, its portfolio of "investments" is too small to draw any real conclusions, other than to observe that there is potential for crowding out of private finance. For example, in the case of offshore wind, where the significant (i.e. 38%) recent financing of Nobelwind in Belgium by EIB is covering a wind farm deploying standard 3MW turbines which are now completely proven and carry little risk. Equally, the provision of large-scale financing for a new pulp mill in Finland for one of the largest pulp companies in Europe also appears a low risk strategy, especially given the drive towards cleaner production methods in the pulp & paper industry as well as industrial symbiosis, i.e. it would simply be uneconomic these days not to design new pulping mill infrastructure without embracing such innovative production methods.

The real test of EFSI will be to see whether it has the ability, and appetite, to explore higher risk ventures, including SET (i.e. FOAK) projects, which *really* would not happen without such EC support.

---

[24] http://www.eib.org/infocentre/press/releases/all/2015/2015-236-eib-support-for-wind-farm-off-belgian-coast.htm

[25] http://www.4coffshore.com/windfarms/windfarms.aspx?windfarmId=BE08

[26] http://nobelwind.eu/

[27] http://bioproductmill.com/articles/metsa-group-to-build-next-generation-bioproduct-mill-in-aanekoski

[28] http://www.eib.org/projects/pipeline/2014/20140557.htm & http://www.eib.org/infocentre/press/releases/all/2015/2015-131-finland-first-loan-under-investment-plan-for-europe-eib-supports-construction-of-large-scale-bio-product-mill.htm

[29] http://www.eib.org/attachments/press/investment_plan_for_europe_qa_en.pdf

Name	**Energy Technology Development and Demonstration Programme (EUDP)** Danish Energy Agency
Geographical area	Denmark
Year started	2007[30]
Status	Open
Type of instrument	Grants
Annual budget	Around €50m (DKR 400m) is disbursed per year[31] supporting around 80 projects annually. €314m disbursed between 2008 and 2012.
Project funding amounts	While taking into consideration state aid rules on intervention rates, EUDP typically supports 50% of project costs[32], but that can vary from 38% to 78%. There is also no minimum or maximum level of funding. However, whilst average grant size per project is around €0.7m, it can increase up to €30m in cases where there is a linkage to, for example, NER 300[33]. Overall percentage of costs covered depends on company size, project type, commercial aspects, the technical and economic risks involved, as well as the incentive effects of the grant on other funders.
TRL focus	TRL 4-9[34,35]
Technology coverage	Technology neutral but with a bias towards on energy efficiency projects (construction, processes, appliances etc.) offering significant commercial potential[36].

eUDP Energiteknologisk udvikling og demonstration

http://www.energiteknologi.dk/

Contact details:
+45 33 92 67 00
ens@ens.dk

The scheme's secretariat is located in the Danish Energy Agency. The programme is headed by an independent board, appointed by the Minister for Climate and Energy.

[30] www.ens.dk

[31] http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/dk/supportmeasure/support_mig_0009

[32] Public funding of R&D activities carried out by not-for-profit universities and public research institutions may be supported with up to 90% since these are generally not covered by EU state aid rules for R&D & Innovation.

[33] http://www.energiteknologi.dk/da/stats

[34] In addition to development and demonstration programmes, the EUDP programme can supply funding to research which prepares or directly supports demonstration activities (TRL 2-4).

[35] EUDP (2015) Indkaldelse

[36] The following types of projects or activities are eligible for funding: development and/or demonstration projects; research projects; international collaboration; dissemination of research results and other relevant technological knowledge; partnership initiatives carried out as part of the development of private-public collaborations. Project examples include: BioGasol's demonstration facility for second generation biofuels and Risø DTU's programme on a new generation of solar cells.

Instrument objective

EUDP's main objective is to ensure the development and demonstration of new energy technologies, which can reduce dependency on fossil energy and contribute to minimising the CO_2 burden and other environmental impacts of energy consumption.

EUDP also aims to promote collaboration between public and private actors and boost Denmark's involvement in international activities within the environmental technology area. Therefore, an important activity for EUDP is to create synergies between its own priorities and the strategic priority areas of EU energy programmes. EUDP also manages Danish applications to the NER 300.

EUDP has two technology neutral calls per year plus technology-specific 'targeted actions' which are integrated on an ad hoc basis into calls[37], e.g., a recent targeted action on the use of solar cells into building technologies. Applications may also be submitted for funding research that improves or supports demonstration, as well as for funding certain other activities, including IEA research projects.

Target beneficiaries

Target beneficiaries are private and public commercial enterprises or knowledge institutions based in Denmark. Applications may also be submitted by consortia of relevant research institutes. 70% of available funds go to private organisations while 21% go to universities. Overall, 81% of the funding for private enterprises goes to SMEs (57% for small firms and 24% to medium-size firms) while 19% goes to large companies[38].

Eligibility criteria and specific contractual conditions

Projects must focus on the development of their application in relation to existing technologies and solutions. The application needs to be innovative, patentable, have a practical implementation, meet a market demand, and have a well-defined customer. It furthermore needs to be replicable, scalable and financially competitive. Project proposals must include a viable business plan and the commitment to make public the results achieved in order to ensure that these are utilised to promote further developments in the energy field.

Market acceptance and relevance

The first projects were finalised in 2010. Funding has been given mainly to RD&D on second generation biofuels, energy efficiency, hydrogen and fuel cells, and wind technology. The success rate for applications in 2013 was around 33%, but in 2014 it increased to around 50%.

In 2013, the main funding areas (according to the relative amount of funding received) were energy efficiency (25%) biomass and waste (24%) and wind (16%)[39].

A recent study[40] shows that scheme beneficiaries recognise the importance of the scheme within Denmark and that it complements the other innovation support provision (EUDP fills an important funding gap following other support for earlier stage research). This study also revealed that EUDP has links to 42% of all Danish corporate holdings and strong relations with the other Danish support programmes.

Effectiveness and efficiency

A mid-term report carried out in 2014 revealed that over 70% of all project participants expect that they will bring new energy technology on to the market, in most cases within five years of completing their project.

[37] Targeted actions include calls for wave energy, renewable energy for district heating purposes, and second generation bioethanol for the transport sector.

[38] ENS (2013) Report 2013 Available at: http://www.ens.dk/sites/ens.dk/files/ny-teknologi/energiteknologisk-udvikling-demonstration-eudp/1._aarsberetning_for_eudp_og_green_labs_dk_2013.pdf

[39] ENS (2013) Report 2013 Available at: http://www.ens.dk/sites/ens.dk/files/ny-teknologi/energiteknologisk-udvikling-demonstration-eudp/1._aarsberetning_for_eudp_og_green_labs_dk_2013.pdf

[40] DANSKE ENERGIORDNINGER (2014) Brugerkortlægning for statslige tilskudsprogrammer. Available at http://www.ens.dk/sites/ens.dk/files/ny-teknologi/energiteknologisk-udvikling-demonstration-eudp/brugerkortlaegning_02_10_14.pdf

EUDP projects have contributed to employment as well as increased export possibilities and helped Denmark meeting its climate and energy goals[41].

ICF assessment of appropriateness for financing SET projects

Although the funding levels offered are generally very modest, the EUDP provides an important national mechanism for supporting first-of-a-kind SET projects. It is seen as a vital component of the Danish innovation “ecosystem”, allowing technology developers to benefit from a continuum of R&D support.

The explicit connection to EU funding programmes, such as NER 300 and to a lesser extent the IEA, not only shows an effort to coordinate funding activities but also helps to explain why for some first-of-a-kind SET projects supported by EUDP, there is sufficient flexibility to increase typical funding levels to a point which can help fill the funding gap.

The programme is technology neutral but indicates specific technological focus areas to support national priorities such as energy efficiency in buildings, smart grids and energy storage. The flexibility in funding amounts allows demonstration projects in different areas since some technology areas such as small-scale fuel cells need larger amounts than small-scale biomass projects.

[41] http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/dk/supportmeasure/support_mig_0009

Name	**Market Development Fund (Markedsmodnings-fonden)**
Geographical area	Denmark
Year started	2013[42]
Status	Open
Type of instrument	Grants and guarantees, disbursed within two different sub-programmes and never mixed.[43] ▪ Grant funding of €0.4m – €1.3m. (Most projects receive €0.4m – €0.8m.) ▪ Guarantees are limited to €0.4 – €1.6m with 80% of performance risk covered.
Annual budget	€18m for 2013-2015 85% of the annual budget is for market maturation funding of which 90% is allocated to grants and 10% to guarantees. The remaining 15% is for pre-commercial public procurement in water and climate adaptation. Around 4-5% of the annual budget is for operations, including the board and marketing.
Project funding amounts	The Fund supports the project costs for small companies with 45-60% and large companies with 25-40% of project costs.[44,45]
TRL Focus	TRL 7-9
Technology coverage	Technology and sector neutral. Grants are focused on the testing and adaptation of products under real-life conditions. Guarantees are directed at end-users to mitigate buyer uncertainty about investing in novel technologies[46].

http://markedsmodningsfonden.dk/kvikguide

Contact details:

+45 72 20 00 30
erst@erst.dk

Instrument objective

The Market Development Fund's "faster to the market" sub-programme aims to help enterprises bring their new products to the market[47].

[42] The Fund started in 2013 but it is a continuation of a previous fund called Business Innovation Fund which ran from 2010 to 2012. The previous instrument had more money but also targeted earlier technology maturation projects and regional development projects. With the new innovation strategy the Danish government wanted to make it easier for companies to know where to apply and therefore split up the more "general fund" into a number of smaller focused funds.

[43] Co-financing for testing and adaption of the product under real-life conditions & co-financing of guarantees for the end-user to mitigate the buyer's uncertainty about investing in novel technology – see http://www.technology-development.eu/energy-environment-and-climate

[44] The grant is not given upfront but on presentation of incurred costs.

[45] It is not possible to combine the grant or guarantee with other public funds.

[46] In this case, the risk is split between the manufacturer (20%), the Market Development Fund (60%) and the buyer (20%), i.e. if the product deviates substantially from the initial promise, the customer will get back up to 80% of the price.

[47] Another objective of the Fund is to make it easier for public-sector institutions to obtain innovative solutions by funding pre-commercial procurement.

Target beneficiaries

The programme is mainly aimed at SMEs, but larger companies can also apply.

Eligibility criteria and specific contractual conditions

To qualify for a grant, the project needs to be mainly implemented in Denmark and completed within 3 years. To qualify for a guarantee, the innovative product must be fully developed and ready for market introduction.

The Fund prefers not to invest in small projects and companies as there is a perception that projects below a certain “critical mass” struggle to make a significant impact on the market. Successful projects should lead to job creation and exports. The innovation should be new to the global market. The project must have a business plan and a realistic growth forecast. Part of this assessment must be based on documented market interest. Competencies within the company must match what is necessary for a successful project including both business and technical experience. The sponsor’s experience in bringing new technologies to market, as well as their market knowledge and industry collaborations are also evaluated by the Fund. The additionality of the project funding is also essential.

For the application process, applicants must submit 12 pages on how they fulfil the eligibility criteria and submit a business plan. Applications are graded 1-4 for each eligibility criterion. The Fund’s board members make the final selection of successful candidates. (The most important challenges for technology developers, especially SMEs, as highlighted by the scheme manager, are the lack of track-record and capital which puts them in a position where no one will lend them money to grow. Companies targeting conservative markets, such as the building sector, have additional difficulties to make users change to a new product / process.) The Fund is now testing a new dialogue-based application process where companies can choose to pitch their project orally. This new application process is being scrutinised to see whether it enables different kinds of information exchange which could be useful when screening applications.

Market acceptance and relevance

The Fund is the only scheme in Denmark supporting technology in a pre-commercial development stage, aside from the EUDP (see next sheet). Given that the Fund has operated for just 2 years, it is now relatively well known: a survey amongst business revealed that almost 20% of Danish SMEs knew about the Fund.

The Fund has three calls per year with, on average, 83 applications and a success rate of 20%. It is successful at targeting smaller companies. 50% of supported companies have less than 10 employees and 80% have less than 50 employees. However, it does not usually support large demonstration plants and has only supported a few biogas projects at commercial scale. The majority of energy demonstration projects apply to the EUDP scheme.

Effectiveness and efficiency

An assessment has been done of the Fund that showed good results regarding job creation. It has been estimated that every €0.13m disbursed by the Fund creates two new jobs at the end of the project and eight new jobs two years after the end of the project. The leverage of private funding is 1:1.

ICF assessment of appropriateness for financing SET projects

While the Fund is helping to fill a domestic market need for accelerating new innovations into the market, it is not very suitable for first-of-a-kind SET demonstration projects due to the low amount of funding per project. Furthermore, it operates in isolation with no links to other Danish support schemes or to European funding schemes. However, the scheme manager highlighted two lessons learned that any financial instrument targeting the development and demonstration of technology might benefit from:

- First, the technology developer should be required to include potential customers/users in funded projects;

- Second, the market demand for a specific technology or product needs to be validated. For example, this might be achieved through a memorandum of understanding (MOU) with a potential client who promises to purchase a certain number of parts if certain conditions are met (such as price and technical specifications).

Name	**Programme Investissements d'Avenir (PIA) (tr: "Investments for the Future")**
Geographical area	France
Year started	2010[48]
Status	Live (financing is expected to be continued until 2016 / 2017[49]).
Type of instrument	State aid (i.e. grants and reimbursable loans/repayable advances[50]) dedicated primarily to projects at TRLs 6 & 7; and equity-based financing dedicated to projects at TRLs 8 & 9.
Annual budget	No annual budget officially set for the scheme. Overall budget amounts to €3.3 billion (or €471m/year over current expected lifetime) and overseen by ADEME which was awarded responsibility for implementing the scheme in the area of energy and sustainable development / ecological transition[51].
Project funding amount	Financial support is targeted at projects worth €3 million or more. CGI and ADEME are committed to financing projects up to 2017. On average, CGI and ADEME seek to contribute between 30 and 33 per cent of the overall budget required for a project, although funding levels vary by type of financing offered. Where grants are the preferred mode of financing, maximum grant levels of 50% apply so as no to exceed the threshold for state aid under current State Aid Guidelines. By contrast, the maximum applicable threshold for projects supported via equity financing is about 33%. This is not mandatory but is considered good practice in order to avoid instances of malpractices in the management of a particular project.

http://www.gouvernement.fr/sites/default/files/contenu/piece-jointe/2015/03/ra-cgi-2014.pdf

Contact details:
+33 1 57 87 40 00
contact.cgi.fr@cgi.com

[48] N.B. The PIA is a continuation of the "*Fonds Démonstrateur de Recherche*" (New Energy Technologies Demonstration Fund), administered by ADEME and effective from 2008 to 2012. The Fund had a total investment capacity of EUR 400 million for projects aimed at the development of energy technologies for which there was no viable market. The fund was mainly targeted at manufacturers or public-private partnerships in need of financing for high-cost demonstration projects with experimental goals but long-term market prospects. Eligible technologies were: production by thermochemical means, essentially based on pyrolysis gasification, and production by biological means, based on enzyme hydrolysis and/or fermentation. The main sector targeted was: transport (sources: IEA (2012); actu-environnement.com (2008) http://www.actu-environnement.com/ae/news/Fonds_demonstrateur_recherche_innovation_technologie_energie_5534.php4

[49] Sources : ICF Consultation with CGI ; Commissariat Général à l'Investissement (CGI), 2014. *Investissements d'avenir - Calendrier PIA 1 et 2* http://www.languedoc-roussillon.direccte.gouv.fr/IMG/pdf/Calendrier-AAP-01-11-2014-PIA1-_PIA2.pdf

[50] ADEME offers financial support to project owners via State aid (subject to European competition regulations). State aid is offered in either of the following two forms: (1) state aid with systematic profit-sharing (known as "repayable advances"); or (2) grants (primarily reserved for research bodies). Source: ADEME 2015. *Investments for the Future* http://www.ademe.fr/en/investments-for-the-future

[51] Sources: ICF consultation with CGI; ADEME, 2015. *Investments for the Future* http://www.ademe.fr/en/investments-for-the-future

TRL focus	Priority is given to projects between TRL 6 and TRL 9. (The total amount of funding offered to projects at TRLs 8 and 9 is greater than the total amount of funding offered to projects at TRLs 6 and 7. By contrast, the number of funded projects at TRL 6 or 7 is greater than the number of funded projects at TRL 8 or 9.) Funding is not targeted at projects at TRL 5 and below as these projects are generally established for research purposes only.	
Technology coverage	Funding is targeted at projects in energy generation and smart grids as well as transport, recycling and 'circular' economy.	

Instrument objective

As a a tool for industrial policy and green growth, the PIA exists to finance innovative projects aimed at creating and developing key industrial sectors and, ultimately, strengthening France's strategic competitive advantages.

Target beneficiaries

SMEs (through the '*Ecotechnologies'* Fund); intermediate-sized enterprises and large enterprises (in the form of direct investments by ADEME).

Eligibility criteria and specific contractual conditions

A minimum funding threshold of €3 million is used to 'pre-screen' prospective projects. Other criteria considered for selection include: (1) project size; (2) the likelihood of a commercialisation success; (3) market outlook/potential (e.g. target market(s)/market segment(s), potential market share, potential turnover/volume of sales, degree of competition, etc.); (4) added value of the project or resulting products/services developed; (5) technological obstacles identified and proposed technological leaps; (6) financial strength of the selected beneficiaries/partners – this criterion is regarded as key; (7) financial returns potential to the State; (8) environmental impacts, especially envisaged positive impacts; (9) other anticipated impacts, notably the level of economic activity and the level of direct and indirect employment in the next five to ten years and geographical concentration of such impacts[52]; and (10) comparative advantages and potential barriers to entry.

An additional criterion also has to be met for projects falling into the action on energy and ecological transition. Project owners must provide quantitative evidence of the extent to which the prospective project will contribute towards sustainable development. Quantitative evidence pertaining to one or more of the following indicators is required: (i) production and use of renewable energy; (ii) contribution towards energy efficiency; (iii) contribution towards GHG reductions; (iv) air pollution; (v) water quality; (vi) use of resources; (vii) contribution towards waste reduction; (viii) impact on biodiversity; (ix) societal impact(s).

Contractually, it is expected that project sponsors or partners contribute substantially to financing the project. For every individual project, it is expected that net equity be in excess of the amount of funding offered by ADEME. One rule of thumb is that every €1 financed by the PIA scheme must be matched by an equal or higher amount of equity from project sponsors or private partners.

Market acceptance and relevance

Since its inception, the scheme has received around 300 applications per year. The typical success rate is between 20% and 30%, i.e. between 60 and 90 projects are selected and funded every year. To date, €1.5 billion has been committed to projects.

[52] General conditions for selection are set out in the Convention established between the French State and ADEME

Effectiveness and efficiency

The scheme has not yet been fully evaluated, owing to the small number of projects that have reached completion to date. A mid-term evaluation is due to take place in 2016, followed by an ex-post evaluation due to be carried out between 2020 and 2022. However, some early results are available[53]. These paint a mixed picture regarding the scheme's impact to date. For example, in the last two years, most projects that closed did so without having reached their expected technology development and commercialisation stages. Only an estimated ten projects reached "completion", i.e. the relevant technology was successfully developed and deployed, and their commercialisation appears to be sluggish, as evidenced by the slow pace so far reimbursements made to the French State by project sponsors[54].

ICF assessment of appropriateness for financing SET projects

The available evidence suggests that the PIA lays solid foundations for supporting the development of innovative energy technologies in France: the scheme budget is very large; the SET focus is broad; the TRLs are appropriately targeted; the number of projects supported annually (between 60-90) is large; the allowable funding rates per project are set at levels which lever private finance; and the different types of funding support (i.e. grants or equity) creates options for applicants and funders.

However, since a considerable number of funded projects have not achieved their forecast objectives regarding technological development and commercialisation, and the level of reimbursements from those that have is lower than anticipated, it is too early to determine whether the PIA will be effective in the long run at catalysing the commercialisation and deployment of large-scale first-of-a-kind technologies. It will be interesting to read a full evaluation of the PIA's impact, when that is published, as the PIA is probably the largest Member State scheme of its kind and therefore worthy of future study.

[53] ICF consultation with CGI

[54] ICF consultation with CGI

Name	**BMUB Environment Innovation Programme (EIP)(operated by KfW)**	
Geographical area	Germany	
Year started	In operation since 1979[55,56,57]	
Status	Open, operated by KfW	
Type of instrument	Loans and investment grants. The programme subsidises interest loans covering up to 70% of eligible expenses or an investment grant of up to 30% of eligible expenses. However, in practice the maximum intervention rates are only given in exceptional cases. In general, most loans and grants cover about 20% of eligible costs. Grants are provided directly by KfW to the applicant, while loans are given by intermediary commercial banks. However, KfW decides what contractual terms (interest rate and duration) the commercial bank will use for a specific loan. Interest rates range between 2.7% and 7.5% depending on the viability, securities and innovative character of each project.	
Annual budget	€25m / year, with additional funds (€5-10 million) in some years made available. Budget used for grants and to subsidise lower interest rates for bank loans which the programme supports.	
Project funding amounts	No maximum amount is specified although generally limited to around €1m.	KFW Bank aus Verantwortung
TRL Focus	TRL 7-9 (nominally, but in practice earlier stage for energy projects)	
Technology coverage	Under the EIP, there is no restriction on industries or technological sectors. The programme is demand-driven (i.e. it focuses on those projects/sectors that applicants submit). Further, the programme, over certain periods, issues calls for specific industries/technologies, such as green IT, material efficiency, recycling of plastics, inner-city energy efficiency, etc. The programme has encouraged a lot of energy efficiency projects and renewable technologies, including conversion of biomass, but the scheme manager indicates this is not a primary focus any more due to technological innovation limits in these areas. The current emphasis is on resource efficiency as an overall goal. Pure energy projects do not have a high chance of gaining support. Key focus areas in	www.umweltinnovationsprogramm.de **Contact details:** Tel:+49 34021032550 pmi@uba.de

[55] Interview with scheme manager, Dr. Heidrun Moser, Umweltbundesamt, on 6 August 2015

[56] https://www.kfw.de/inlandsfoerderung/Unternehmen/Energie-Umwelt/Finanzierungsangebote/BMU-Umweltinnovationsprogramm-%28230%29/

[57] Source of some information: Development of an instrument for fostering investment in clean technologies with allowances from the EU ETS - Task 1 report – Unpublished study by authors for European Commission, DG Clima, 2012

	the near future will be: industrial and municipal use of heating processes (Abwaermenutzung); heat storage; and heating & cooling.	

Instrument objective

The rationale of the programme is to support the demonstration and scale-up of innovative environmental technologies, with the aim that they raise environmental standards and, where appropriate, become Best Available Technology (BAT) in key industry sectors. The programme also has a policy support function whereby information is collected about BAT and its cost effectiveness and efficiency in order to tighten environmental regulations. Support focuses on the highest levels of technological innovation (i.e. very new technologies and/or technological combinations). The programme helps companies to reduce the financial risk for technical decisions and to provide a more robust basis for the introduction of the technology into the market.

Target beneficiaries

Domestic and foreign private entities, local authorities, and Special Purpose Vehicles (SPVs). SMEs are also promoted. The programme focuses on established companies.

Eligibility criteria and specific contractual conditions

Technical evaluation criteria include: (i) Level of innovation (needs to be high) (ii) Environmental benefits need to go beyond current Best Available Techniques; (iii) Replication potential; and, (iv) Potential cost-efficiency of the innovation.

EIP-supported projects have to remain operational for at least 5 years (even in the case of a buy-out) under normal market conditions. Additionality is another key criterion: if it is believed that the project would have been financed without the funding from EIP, the project will not funded.

Any legal entity is eligible for the grant/loan, including natural persons and municipalities. However, the focus remains on SMEs and larger companies. The programme only covers projects carried out within Germany as well as technologies or processes that have not previously been implemented in Germany.

Loan applications are made through financial intermediaries: loans are given for up to 30 years and funding can be combined with other KfW support products and public funding.

Grants are requested more than loans (due to current unfavourable financing conditions for projects). As a criterion for grant support, the innovation needs to be standardised in order to be easily replicated in other organisations. This replication can be carried out by the same company or other companies (including through licensing).

Start-up companies are usually not funded since the technology maturity is not deemed ready for large-scale demonstration or deployment support. Additionally, the longer term administrative procedures and technical support favour established companies (often from the manufacturing sector) with long time scales to bring products to market.

Market acceptance and relevance

The EIP has funded well over 700 projects during the last 30 years and is a highly regarded industry support programme in Germany. Project documentation on energy related initiatives can be found on the programme's website (although information is only accessible in the German language): http://www.umweltinnovationsprogramm.de/projekte?field_checkbox_project_status_value=All&kate=8&field_pk_kategorie_tid%5B%5D=8&sorter=created&sort_by=created&sort_order=DESC. Successful projects are also published on a web-site which seeks to promote German technology[58], thereby increasing the visibility and impact of the public support. Roughly one-third of all applications have an energy focus.

[58] www.cleaner-production.de

The initial project proposal verification stage is very successful at filtering out weaker projects. During the first stage of the application procedure (submitting of outlines) the programme receives about 100 applications per year. 50% of these will move to the second stage (full proposals) and 25 – 33% will be supported in the end.

Effectiveness and efficiency

16 projects in the energy sector have been supported to date with individual support of around €1m (although some projects have received up to €5m due to extra funding available).

The programme combines innovation criteria with environmental performance and economic considerations which makes it very suitable to foster environmental technologies. The two-stage application process reduces resources during the application process (both for programme managers and project applicants). However, overall there is a high overhead cost for the programme management due to the amount of resources put into technical and financial evaluation and support.

The EIP scheme manager indicates a 95% success rate for projects. Technical monitoring and inspections by UBA, coupled with financial advice and verification (through KfW), are regarded as decisive in achieving this very high success rate. However, the effort required to provide this level of scrutiny and project support is very significant. Around 86 colleagues across the two institutions are available as technical and financial advisers to project owners.

ICF assessment of appropriateness for financing SET projects

The energy sector (energy efficiency, renewable energy sources, energy distribution) has traditionally been one the key sectors supported by the EIP. However, over recent years the programme has taken a broader approach to resource efficiency with the result that projects with a pure energy focus are no longer treated favourably. This is unfortunate as EIP is a good example of a support mechanism which can help to deploy and replicate innovations into the market, but nonetheless the following lessons learned from its operation are of interest:

Assessment of applications

- Assessment of project ideas needs to be thorough and robust (both on a technical and financial level): Many ideas / technologies would fail under market circumstances and this can often be foreseen at the application stage. An investment in supporting project applicants during the application and development stage is often financially worthwhile it as this increases the success rate significantly.
- A two-stage application process can create efficiencies for both applicants and fund managers and help to filter out weaker projects at an early stage;

Financing approaches

- A combination of a grant through the EIP and a guarantee from a local bank to provide distribution of risks can be a useful model. However, the administrative costs to the companies should not become too high.
- Close technical, financial and political support creates incentives, even for larger companies (e.g. multinational), to pursue risky investments into first-of-a-kind projects.

Scheme management and delivery

- Division of duties between different responsible authorities can be very effective, drawing on;
  - The integration of innovation, environmental and economic criteria; and
  - The follow-up and assistance of a technical expert with industry knowledge who can contribute to the successful development of projects.

Name	ERP Innovation Programme	
Geographical area	Germany	
Year started	2007	
Status	Open, but due to close in December 2015[59,60]	
Type of instrument	Loan application through bank	
Annual budget	No information could be obtained from the funder	
Project funding amounts	Up to €25m per project or up to €50m in loans[61] per enterprise for the development of new technologies to save, store, transmit or produce energy. For other types of projects, the funding amount is limited to €5m. Funding covers 100% of eligible costs	https://www.kfw.de/inlandsfoerderung/Unternehmen/Innovation/Finanzierungsangebote/ERP-Innovationsprogramm-%28180-185-190-195%29/
TRL focus	TRL 4-8	
Technology coverage	Development of new technologies to save, store, transmit or produce energy	**Contact details:** kfw.brussels@kfw.de

Instrument objective

The ERP Innovation Programme serves the long-term low-interest financing of market-oriented R&D of new products, production processes or services, as well as their further development. Under the German Energy Transition (*Energiewende*) the programme has supported larger projects aimed at (the further) development of technologies for saving energy, improving the efficiency of energy production, energy storage and more efficient energy transmission.

Target beneficiaries

Established SMEs and self-employed professionals.

Eligibility criteria and specific contractual conditions

A prerequisite is that the applicant is conducting R&D mainly with its own staff. Enterprises also need to have been in existence for longer than two years.

10-year fixed interest rates are provided with an additionally reduced interest rate for small enterprises and repayment-free start-up period.

Depending on the sales volume of the beneficiary company, up to 60% risk assumption by the KfW, subordinated debt can be provided with no collateral necessary for the subordinated funding tranche. The funding can be combined with other KfW support products and public funding.

Market acceptance and relevance

No demand could be established under this Window since 2014 and no further information could be obtained from the funder with respect to this lack of market uptake.

[59] No interview was secured for this scheme and the information for this fiche was obtained from limited information found via on-line sources. In email conversations with the author, KfW highlighted that from 01.12.2015 the separate funding window for energy related project of max. EUR 25 million will be closed. No demand could be established under this window since 2014.

[60] https://www.kfw.de/inlandsfoerderung/Unternehmen/Innovation/index-2.html, https://www.kfw.de/Download-Center/F%C3%B6rderprogramme-(Inlandsf%C3%B6rderung)/PDF-Dokumente/6000001631-M-Innovationsprogramm-180-185-und-190-195.pdf

[61] Consisting of a subordinated tranche (not collateralised) and a debt tranche

Effectiveness and efficiency

No information could be obtained from the funder.

ICF assessment of appropriateness for financing SET projects

Although relatively high funding amounts are available for investments in the development of innovative energy generation, the main focus of this programme seemed to be on general R&D activities in companies (the usual maximum loan size is €5m). The granting of funding up to €25m for energy projects was only an exception to the programme.

Given that no demand could be established under this Window since 2014, from December 2015 the separate funding Window for energy-related projects (allowing up to a maximum of EUR 25 million) will be closed.

No further information could be obtained from the funder as to the reasons for this lack of market demand. Possibly, parallel programmes such as the Energy Transition Finance Initiative (see below) offer better conditions for projects in this area.

Name	**Energy transition financing initiative**	
Geographical area	Germany	
Year started	2012	
Status	Open[62,63]	
Type of instrument	Loans provide 50-100% of debt financing required	
Annual budget	Financing volume 2013: €178m; 2014: €140m	
Project funding amounts	€25m – €100m covering max 50% of project costs.	https://www.kfw.de/inlandsfoerderung/Unternehmen/Energie-Umwelt/Finanzierungsangebote/Finanzierungsinitiative-Energiewende-%28291%29/
TRL focus	TRL 8-9	
Technology coverage	Focus is on support of measures in the fields of industrial energy efficiency investments for energy savings, production, storage and transmission.	**Contact details:** kfw.brussels@kfw.de

Instrument objective

The programme promotes new investment in energy efficiency technologies/measures that generate significant energy savings (i.e. consume at least 15% less final energy than the sector average of comparable technologies, as well as replacements that lead to a minimum improvement of final energy demand of 20%). One focus area is the support of measures/projects for the further development of such innovative technologies in the pre-commercialisation stage. Examples include energy efficient machinery for paper manufacturing and the construction of energy efficient buildings.

Target beneficiaries

Large companies with an annual (group) business volume of between EUR 500 million and 4 billion.

Eligibility criteria and specific contractual conditions

This programme finances large scale projects only. Companies can apply for a maximum of one project per year. Investments in scope include: buildings and machines (excluding for residential use); innovations in energy efficiency; energy production, storage and transmission; and renewable energy.

Eligible technology costs include: heating, cooling, lighting, CHP, building envelope, electric motors, pumps, compressed air, process heat and cold air, ICT. Also eligible are personnel costs and costs for travel, material, ICT, consultancy and services, investment costs, testing, and quality management.

Contractual conditions are suited to consortia. KfW contractual conditions are the same as with other commercial lenders. The loan application is done via local banks. Interest rates are set by the local bank according to a risk assessment (including the financial situation of the company and the quality of securities). The interest rate is fixed for a maximum of 10 years. The loan duration can be up to 20 years.

Market acceptance and relevance

No information could be obtained from the funder.

Effectiveness and efficiency

No information could be obtained from the funder.

[62] No interview was secured for this scheme and the information was obtained from limited information found via online sources.

[63] https://www.kfw.de/inlandsfoerderung/Unternehmen/Energie-Umwelt/Finanzierungsangebote/Finanzierungsinitiative-Energiewende-%28291%29/#

ICF assessment of appropriateness for financing SET projects

The fund manager was unavailable for an interview, despite repeated requests, so little background information could be gathered on this fund. The potential for this scheme to support first-of-a-kind projects is unlikely since the commercial terms offered are unlikely to attract these type of projects.

More realistically, the scheme appears to incentivise large-scale energy efficiency improvements in large businesses, including those that might be under threat from competitive pressures, including the risk of ‘carbon leakage’, as a result of falling within the EU Emissions Trading System.

Name	Industrifonden
Geographical area	Sweden
Year started	1979
Status	Open
Type of instrument	Equity capital and, in the past, risk sharing loans. The fund invests on commercial terms alongside other investors. Co-investors usually include venture capital funds and "angel investors" as well as public funding agencies and regional development agencies.
Annual budget	The fund was set up as a foundation with initial public funding of €34m. The fund receives no additional government funding. Through strategic investments the fund had a budget of €430m in 2012. Investment rounds are on a yearly basis and amount to €40m/year
Project funding amounts	€1m – €20m equivalent, corresponding to 15% to 50% of ownership.
TRL focus	TRL 4-9 but only 4-6 for energy generation projects[64]
SET sector	Technology neutral fund with clean-tech one of several priority areas[65].

http://www.industrifonden.se/sv

Contact details:
+46 8 587 919 00
info@industrifonden.se

Instrument objective

Industrifonden's aim is to support Swedish industry and to overcome market failure in the supply of finance to early stage and promising growth businesses. Industrifonden has evolved during the years according to the needs of the market. It initially focused on growing companies and making Swedish companies more competitive on the international market. It now focuses primarily on financing start-ups and SMEs in selected investment priority areas such as life science, technology, and industrial growth.

Target beneficiaries

Target beneficiaries are Swedish-based early-stage tech companies and established companies that want to expand. Active investments include Climatewell (solar air-conditioner with energy storage)[66], Sol Voltaics (nanomaterials and a novel production method for 3rd generation solar cells)[67], and SEEC (innovative energy storage systems)[68].

Eligibility criteria and specific contractual conditions

The scheme manager was not forthcoming on these aspects, saying only that they varied. No relevant information was obtained through online research.

[64] Demonstration-stage energy projects are avoided because their costs are seen to be too large
[65] In 2012, 21% of the fund's capital was invested in cleantech companies.
[66] http://www.climatewell.com
[67] http://www.solvoltaics.com
[68] http://www.seec.se

Market acceptance and relevance

Industrifonden has been operating for over 35 years and now has a total of €433m under management. It is a well-established player in the Swedish early-stage and growth-stage venture capital market. It also offers expertise and competence to its investee companies as well as an important network of contacts. However, its technology investment manager confirmed a move towards digital technologies and ICT, away from clean energy in recent years, citing low returns, high risk and fewer potential co-investors in clean energy projects.

Effectiveness and efficiency

Industrifonden is a very effective scheme for supporting innovative start-ups and SMEs. The fund has a strong signalling effect to other investors and has therefore been very good in leveraging additional capital into promising high growth companies, including (historically) within the clean technology sector.

ICF assessment of appropriateness for SET projects

From this current research, the ICF Team has determined that, despite being important for cleantech funding in Sweden in the past over several years, Industrifonden has moved away from clean energy technologies, especially demonstration stage projects due their large costs.

Name	**Programme for Demonstration and Commercialization- Swedish Energy Agency**	
Geographical area	Sweden	
Year started	2009 – 2011	
Status	Closed. (It was a one-off initiative. Some supported projects are still active.)	
Type of instrument	Grants	
Annual budget	Total budget of €95m (for the entire programme)	
Project funding amounts	5 projects were funded with funding amounts per project ranging from €15m-24m.[69] The percentage of project cost finance has so far varied from 25%-50%. Funding rates were dependent on the level of project development. The rest of the funds were covered by the project partners and/or other funding agencies.	Energimyndigheten http://www.energimyndigheten.se/
TRL Focus	TRL 6-9	**Contact details:**
Technology coverage	Second-generation biofuels demonstration, demonstration as well as commercialisation of energy technologies of national importance and large export potential.	+46 16 544 20 00 regist@energimyndigheten.se

Instrument objective

Support research that will bridge the gap between demonstration and commercial phase for new renewable technologies, by scaling up those technologies to industrial scale.

Target beneficiaries

Biofuels projects were specifically targeted by the programme because the development and diffusion of second-generation biofuels can play an important part in the Swedish energy system due to the large forestry industry and the Swedish car sector. More generally, any energy technology of significant national importance (because of availability of resources or relevance to Swedish industry) and relevant export potential were covered. All types of organisations were eligible.

Eligibility criteria and specific contractual conditions

Projects funded had to involve the use of technologies which had proven to be able to be implemented in the current energy system and to supply a significant amount of sustainable energy and which are able to incentivise economic growth and job generation. Projects also had to obtain co-financing from other sources. Projects had to refer to the whole or only to relevant parts of the energy technology process.

The application process was divided in two parts, the initial part composed by a short expression of interest (max 6 pages in Swedish or English) in order to lower initial hurdles for applicants and in order to give the Agency an overview of the demand and set priorities. Further information was then requested from individual project developers of interest.

[69] Projects funded includes: GoBiGas (phase 1) bio-methane production (€24m), Seabased wave power production (€15m), and Volvo C30 Electric for the demonstration of second generation fuels and other energy technology (€20m).

Market acceptance and relevance

The programme was targeted at first-of-a-kind demonstration projects in the energy sector. There was a very high demand for funding since projects in this group are not funded by any other programme in Sweden. In order to be able to fund large projects, only a small number of projects were funded (3 out of 5 selected projects) with funding levels of 25-50% in grants.

The NER 300 scheme was opened while this programme was already running, which forced the Swedish Energy Agency to reassess the programme.

Effectiveness and efficiency

No formal evaluation has been carried out so far. However only three out of five selected projects are considered to have been implemented successfully. Of these three, two projects spent significantly less money than they had been allocated.

ICF assessment of appropriateness for SET projects

The programme is currently closed. Nevertheless, the Swedish Energy Agency remains responsible for supporting financing in the whole energy sector from basic technology research and development through demonstration and deployment. Therefore, a similar programme might be introduced in the future.

Additionally, the application process and selection process might be relevant for national funding initiatives where low levels of funding are available or where authorities need to prepare a preselection of projects.

Lessons learned are that it is difficult to support demonstration projects in the energy sector due to the high levels of private investments which are required coupled with the uncertainty of outcomes. Additionally, the European Commission’s rules on state aid are reportedly challenging and complex to work with.

Name	**Energy Technologies Institute**	
Geographical area	United Kingdom	
Year started	2007-2017[70]	
Status	Open	
Type of instrument	Grants, debt and equity	
Annual budget	Potential investment fund of €1.3bn over 10 years (with industry investment and match funding from ministries). Yearly available budget: £50m (€71m) 50% government money/ 50% companies). 10 year agreement with members, £5m (€7m) per year per member, agreement runs out in 2017.	
Project funding amounts	Examples for costs of demonstration projects under development: floating wind: ~£60m (€85.3m); Waste Gasification: from £14m (€20m) up to £40m (€56.9m)	http://www.eti.co.uk/
TRL Focus	TRL 5-8	
Technology coverage	Low carbon technologies in SET sectors including energy storage, waste gasification, ocean energy and offshore wind.	**Contact details:** +44 1509 202020 info@eti.co.uk

Instrument objective

The ETI is a public-private partnership between global energy and engineering companies[71] and the UK Government. It acts as a conduit between academia, industry and the government to accelerate the development of low carbon technologies. ETI makes targeted commercial investments in nine technology programmes, similar to the SET sectors. It supports innovation from strategic planning to technology demonstration. Knowledge building is playing a more significant part in the budget than initially expected as needs and opportunities for SET demonstration projects need to be better understood.

Knowledge building is focused on:
– Informing industry decision-making through robust, shared evidence and commercially available projects;
– Building a better understanding of decarbonisation potential in developing industries; and,
– Informing the policy debates around low carbon technologies.

ETI is developing technology to:
– Build supply chain capabilities;
– Create economic opportunities for UK companies; and,
– Exploit UK technology knowledge and skills.

ETI is supporting the demonstration of technology to:
– De-risk new systems;
– Focus and accelerate low carbon innovation; and,
– Build the investor base.

[70] The ETI will not be prolonged thereafter due to lack of funding support

[71] ETI members include: BP, Caterpillar, EDF Energy, Rolls Royce and Shell

Target beneficiaries

ETI has no specific target beneficiaries. Private business and research institutions are both supported.

Eligibility criteria and specific contractual conditions

ETI has no specific eligibility criteria. Instead it sets out the selection criteria in each call for proposal. One of the most important aspects is that projects should have a UK angle. It is also important that the ETI member companies see some strategic value and alignment of their own corporate objectives in the projects awarded funding.

ETI also operates no standard contractual conditions; nor are there clawback conditions applied to projects. However, financial payback (if applicable) is linked to project deliverables. Project developers must also cash-flow the project from the start. In many projects, such as knowledge building, no royalties are involved.

Market acceptance and relevance

To date, ETI has implemented 120 projects over seven years (or 15-20 per year). Half or more of these projects are focused on knowledge building. For the remaining projects, the initial TRL focus of ETI was 7-8. However, ETI soon recognised that demonstrations are both risky and costly. Often there is also insufficient commercial interest to provide co-funding for these projects. ETI also found that during the economic downturn it proved much more difficult to get money for its proposed demonstration projects.

Applicant numbers for ETI calls have often not been high (for example, typically there are between 2 and 6 responses per call). On some calls ETI has failed to get any acceptable responses due to its very specific requests and high technical performance requirements outlined in call specifications. For any call, typically 3 or 4 parties are shortlisted.

Effectiveness and efficiency

No demonstration project backed by ETI has yet become fully commercialised. Those in planning or development are being held up, either because of additional financing requirements or the need to undertake further demonstration. Examples include: floating wind (on hold due to a lack of finance); CCS (failed on a technological point), marine power and bioenergy. Two demonstration projects in the field of waste gasification are working towards final investment decision.

For knowledge building projects there will be a product in return that can help to better understand needs and opportunities. For demonstration projects ETI tries to get a royalty arrangement in place. If debt is not paid back ETI takes IP as security (though this has not happened yet). However, many projects make a loss and profit is rare.

ICF assessment of appropriateness for SET projects

Demonstration is a key focus area of the ETI. However, the fund's financial model (partly financed through annual contributions made by its members) has proved to be unsustainable. After 2017 the ETI may well cease operations as private members are thinking hard about whether to pay the yearly fees any longer. The lack of real commercial success from the projects backed to date illustrate the challenge of getting innovative technologies into the market, even when backed by some of the most prominent and financially-secure companies in the world. A low success rate for commercialisation makes it hard to convince private funders to co-invest into what are often very high risk ventures.

A financial model practised by the fund in which support is based on clear deliverables could be replicated at the EU level[72] . The fund does not pay upfront and companies only get the support if they can provide tangible deliverables (for example, commissioning of a demonstration project). This means, that companies have to cash-flow the project. For smaller companies, this might pose a key barrier to enter funding competitions.

Other experience and lessons learned from ETI could be taken into account for future instruments, including:

[72] Such an approach is already used by the NER 300 mechanism, providing grant funding once projects become fully operational and achieving a minimum level of their forecast performance

- State aid limitations provide a real hurdle for first-of-a-kind projects and instances where funding limits under state aid actually work satisfactorily are regarded as very rare. ETI believes that the State aid framework for R&D at face value is sensible for managing support. However, it presumes that everything is in a similar market position. For example, for floating wind turbines, there is currently no market and the associated risks are very high. ETI is only allowed to support projects that are additional, i.e. do not have a full commercial case. However, the R&D framework only allows ETI to fund such a project at an intervention rate of around 40-50%. Some of ETI's projects however need 100% funding since they are not yet commercially viable. For a small company led project (company size being a critical element in the funding equation), if there is not yet a commercial market, ETI would often need to fund 90% of the project value. In such cases, the ETI might look for the extra money from European funding programmes. However, often this takes a very long time to arrange and the speed of change is too quick since uncertainty is too high;

- European funding/calls are not flexible enough to accommodate financing needs for specific projects which leads to projects having to be funded in isolation and hence potential lack of financial scale being possible;

- Consortia rules for European funds should be relaxed as technology needs are too different across Member States.

Name	**Green Investment Bank (GIB)**
Geographical area	UK and international
Year started	Operational since 2012
Status	Open - recent press reports indicate the GIB will be partly-privatised in the near future.[73,74]
Type of instrument	Loans and guarantees (on commercial terms)
Annual budget	ca. €1bn
Project funding amounts	Average spend to date by project and sector (see graphic below) illustrates that the GIB is committing to larger project finance deals, well over £50m (€65m).
TRL focus	The GIB approach to date has been to focus on mainly proven technologies (TRL 8-9)
Technology coverage	Offshore wind, energy efficiency, waste and bioenergy, community-scale renewables, and emerging sectors.[75]

Green Investment Bank

http://www.greeninvestmentbank.com/

Contact details:
+44 330 123 2167
enquiries@greeninvestmentbank.com

Instrument objective

The GIB aims to help fund the creation of new energy and waste infrastructure across the UK, generating new jobs in construction and operations. Given the GIB is using UK public money it must balance this objective with EC State Aid restrictions.

Target beneficiaries

Project developers, utilities, industry as well as asset managers / private equity funds seeking to invest into small-scale energy efficiency projects. State aid rules determine both the sectors in which the GIB is permitted to invest and the type of investments it can make.

Eligibility criteria and specific contractual conditions

The GIB business model includes the following:

- Each investment must contribute to UK environmental objectives and provide commercial returns in line with the project's risks;
- Investments take place on terms equivalent to others in the market (pari passu) - no low-cost finance or grants are provided;
- A key objective is to mobilise additional private sector capital, crowding in finance rather than displacing

Contractual arrangements are fund and deal dependent.

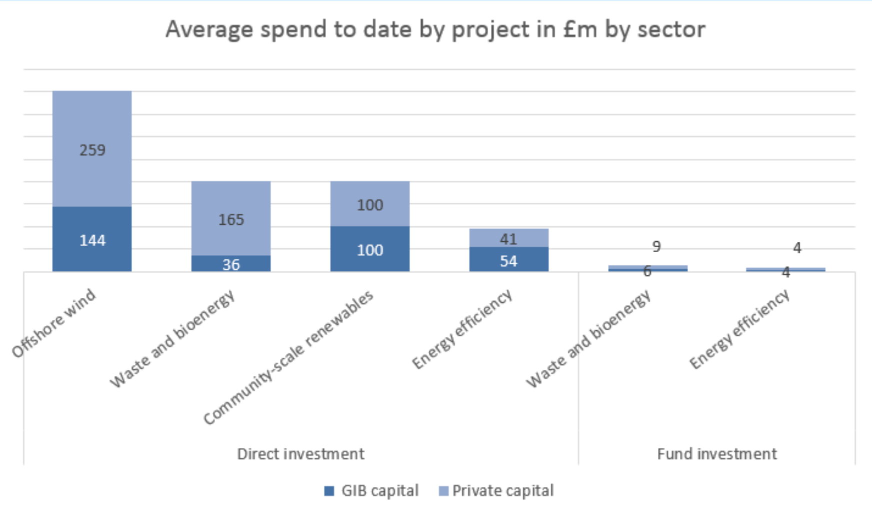
[73] No interview was secured for this scheme, despite repeated request and information was obtained from online sources. However, an interview was secured for the market participant interviews. Additional analysis was also made of GIB's portfolio.

[74] http://www.bbc.co.uk/news/business-33263710

[75] To date the GIB has mainly focused on the waste and bioenergy and energy efficiency sectors. There have been far fewer offshore wind projects (reflecting the significantly larger levels of required investment for this sector). However, the GIB's largest direct investments have been into the UK offshore wind sector.

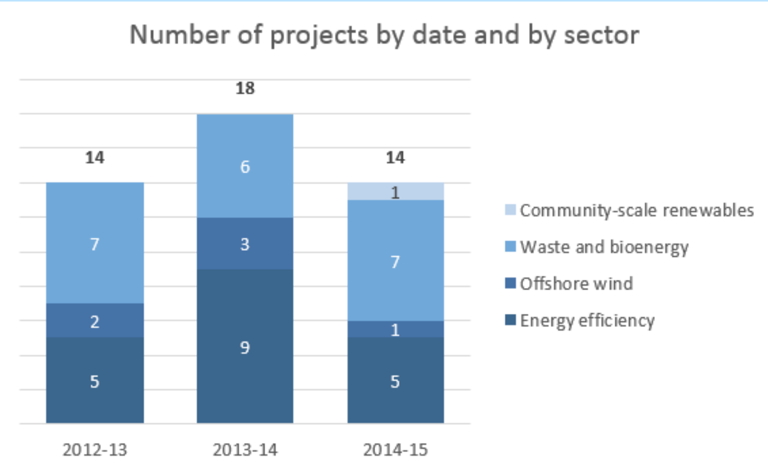
Market acceptance and relevance

Direct investments into projects dominate GIB investments to date and have remained fairly constant over time, albeit peaking in 2013-14 at £668m. In contrast, annual (drawn down) investments into funds remain modest, peaking in 2013-14 at £42m. In terms of project types, to date the GIB has backed 46 projects mainly focused on the waste and bioenergy sector and energy efficiency. In terms of average sector support, direct offshore wind project financing is much larger than in other sectors – around 2.5 times larger than those in energy efficiency; and four times larger than bioenergy/waste projects.



Source: ICF, based on reported GIB portfolio

Despite some large deals, GIB is also using its capital to target smaller projects. It has committed to capitalise five funds covering the waste/bioenergy and energy efficiency sectors. Such prospects require finance of less than £30m and to date GIB has committed a total of £250m to these funds. Three of these funds were allocated £50m of funding in November 2012 with the following managers: Foresight (waste/bioenergy), SDCL (non-domestic energy efficiency) and Equitix (non-domestic energy efficiency). At the same time, GIB allocated £30m to a fourth fund managed by Greensphere (waste/bioenergy). The fifth fund, managed by Aviva (non-domestic energy efficiency), had a capital allocation of £50m in March 2013. An additional capital allocation of £20m into Foresight was made in July 2013 to provide additional capital to finance a specific large project, the Evermore transaction. Consequently, GIB will be retaining funds to enable these commitments to be met (i.e. GIB funds are drawn down) as each fund continues to fulfil their investment strategy.



Source: ICF, based on reported GIB portfolio

To date, total fund investments (i.e. drawn down) are at least £85m, with over a third invested by Foresight (reflecting its larger commitment by GIB) and the balance spread across the three oldest remaining funds.

Effectiveness and efficiency

Several innovative bioenergy plants, using pyrolysis/gasification, have been supported by the GIB including a first-of-a-kind plant in Scotland[76]. This was a £111m (€151 m) project to construct a 12.3 MWe energy from waste (EfW) plant with an adjacent Materials Recycling Facility (MRF)[77]. GIB's £28.25m investment was made via UK Waste & Resource & Energy Investments (UKWREI), the Foresight-managed fund, in which GIB is a cornerstone investor. The project is also backed by an equity investment from Levenseat Limited and senior debt from Investec Bank plc.

Since inception GIB has worked with over 70 co-investors. GIB in 2014 reported[78] an average leverage factor of 3 for all projects supported. Average leverage of 4.5 has occurred for direct project investments into the waste and bioenergy sector. The lowest average leverage levels of 0.7 have been for directly invested energy efficiency projects.

ICF assessment of appropriateness for SET projects

Average spend by project / investment illustrates that the GIB operates in an area where mainstream project finance typically plays, with a focus on proven, readily deployable technologies; not at the smaller, higher risk end of the market where an obvious financing gap is prevalent, especially for first-of-a-kind demonstrators.

With a few smaller exceptions, such as the above mentioned bio-energy first-of-a-kind plant in Scotland, it appears that GIB has no strong interest in first-of-a-kind projects. This view was also confirmed by an expert from the UK Energy Technologies Institute (ETI) - see profile above - who commented that the GIB was not willing to cooperate on first-of-a-kind projects supported by the ETI.

Addendum
Given the scale of investment into SET projects, ICF identified the GIB as an important market participant in the EU context. ICF was successful in conducting an interview with GIB's VP of Strategy. He confirmed that:

- GIB funds 'green' projects, which have been proven, both technically and in terms of commercial capacity. Hence, their interest in first-of-a-kind business is marginal, unless they can see the project in question as being a significant stepping-stone to developing significant future markets.
- Unless there are reference projects (which may not necessarily be in the EU) with proven technology and performance, "first-of-a-kind" does not work for the GIB.
- When the bank was founded (becoming operational in 2012), the intention was as much about providing the debt that was not available from commercial banks. Typically, GIB's deals include the provision of both (senior) debt and equity. To date the ratio has been around 60/40, equity/debt, but it is increasingly more in favour of equity (70/30).
- At the outset of GIB's short history, they provided funds through renewable energy and energy efficiency investment funds (e.g. SDCL) as this enabled smaller-scale projects to be supported by way of aggregation by a third party. Today, GIB tends to operate more as a principal, not via such funds.
- GIB has to provide finance in whatever form at 'market rates', determined by benchmarking with co-investors (otherwise it falls foul of EU state aid requirements). Their funding must also be "additional", provided on market terms, to the extent that such terms can be identified.

[76] http://www.greeninvestmentbank.com/news-and-insight/2015/scotland-set-for-new-first-of-kind-111m-recycling-and-waste-plant/

[77] The project will recycle over a million tonnes of materials including plastics, metals, paper and aggregates over its lifetime and will generate the heat required by the MRF. It is also expected to save around 1.3 million tonnes of CO_2e emissions, divert over 1.4 million tonnes of waste from landfill and produce enough electricity to supply the equivalent of almost 18,000 homes over its lifetime.

[78] http://www.greeninvestmentbank.com/media/25360/ar14-web-version-v2-final.pdf

Name	**Support for the introduction of new technology – Enova**
Geographical area	Norway
Year started	2012[79]
Status	Open
Type of instrument	Grants
Annual budget	Enova has no strict budget for the programme; funding levels are dependent on the number and size of applications received. Enova spent €224m over three years 2012 - 2014 in project grants (although of this €190m (85%) was attributable to one grant in 2014)[80,81]
Project funding amounts	Support level is limited to what is necessary to trigger investments. Average grant size is €5.6m. The programme funds a maximum of 60% of additional costs of the innovative technology (in comparison to traditional technology)[82]
TRL focus	TRL 7-9
Technology focus	The programme supports innovative energy technologies including renewable energy production, recovery or conversion.

http://www.enova.no/finansiering/naring/ny-teknologi/stotte-til-introduksjon-av-ny-teknologi/124/0/

Contact details: svarer@enova.no

Instrument objective

The aim is to increase and accelerate the introduction of new technologies while helping competence in operations and technology environment in Norway.

Target beneficiaries

The funding is open to all type of organisations.

Eligibility criteria and specific contractual conditions

Projects need to be carried out in Norway and include a minimum one year operational phase. Feasibility, market potential, and additionality are also essential. The market potential of a specific technology and the underlying evidence supporting the market potential is very important are very important criteria in the selection process.

Market acceptance and relevance

Enova receives on average 28 applications a year under the programme with 22 (79%) being assessed successful. There is consistently a low percentage of power generation projects (around 5%).

Effectiveness and efficiency

An evaluation revealed that the market is satisfied with ENOVA's aid and advice.

---

[79] The fund started in January 2012 but is the continuation of a previous fund that was renamed in order to increase the focus on innovative solutions

[80] Hydro Aluminium on Karmøy received a funding commitment for investment support totalling €190m for a planned pilot plant to test a next generation energy efficient and climate friendly technology for producing primary aluminium. The ESA Surveillance Authority for EFTA approved the funding and found that it complied with state aid regulations.

[81] Enova (2014) Results and activities. Available at: http://viewer.zmags.com/publication/40751ba7#/40751ba7/26

[82] The grant is not given upfront but on presentation of incurred costs.

ICF assessment of appropriateness for SET projects

The fund is only applicable to first-of-a-kind energy projects undertaken in Norway and no direct link was reported to European funding programmes.

The low percentage of sustainable energy projects within the programme is mainly related to the fact that the projects need to be carried out in Norway and that in general terms the main markets for first-of-a-kind sustainable energy generation are usually outside Norway (e.g. tidal and wave technology). This means that their demonstration cannot be funded through the programme.

3 Descriptions and Consolidated List of relevant Market Participants

3.1 Approach

3.1.1 Scope of the research

For the Market Participant List deliverable, we identified 80 institutions who, individually, have a track record of investing or lending in Strategic Energy Technology (SET) Plan technologies without ownership issues and, collectively, cover:

- Different types of institutions (e.g., banks, private equity funds) from different countries;
- Relevant asset classes (e.g., debt, equity, hybrid[83]);
- Different types, sizes and profiles of investments in a wide range of EU Member States.

Specifically, to be eligible for inclusion on the list, a market participant has to have made a minimum of three SET-related investments since 2006, with at least one being in an EU Member State[84], and be a significant actor in the market. The market participants who satisfied the latter criterion all fall into one of the following investor types:

- Largest global banks by assets[85];
- Largest global asset managers by assets[86];
- Largest manufacturers in wind (and solar photovoltaic) by market share[87];
- Largest utilities by market value in Europe[88];
- Sovereign wealth funds[89];
- Pension funds[89];
- Prominent venture capital funds and green funds[89];
- Prominent asset-finance and venture capital/ private equity deal-makers[89].

Individual Market Participant Description Sheets in the format already approved by DG RTD are presented in Section 3.2. The remainder of this section summarises the data on market participants, particularly in terms of:

- Market participant type;
- Investment size;
- Geographic coverage; and
- Technology focus.

3.1.2 Establishing data on first-of-a-kind project investments is challenging

Before commencing the summary, it should be noted that data on first-of-a-kind projects are scarce, and there are no published sources specifically covering large-scale commercial demonstration projects at an aggregate level. The first-of-a-kind projects identified in this deliverable were found by targeted internet searches using terms such as “first of a kind”, “first commercial scale”, “commercial demonstration”, among others, in conjunction with the name of the identified market participant.

[83] A form of investment that combines equity and debt features, such as a convertible loan which may transfer into equity

[84] The exceptions are Cargill, Craton Equity Partners and Kleiner Perkins Caufield Byers who have made European investments in renewable energy technology in the past but not in this period.

[85] SNL 2013, available here

[86] IPE 2015, available here

[87] EnergyDigital 2015, available here; IHS 2014, available here

[88] EnergyDigital 2014, available here

[89] Bloomberg New Energy Finance Database

Not all the market participants provided in this deliverable have identified first-of-a-kind projects associated with them. In some cases, the same first-of-a-kind project will have multiple market participants connected with it.

Our understanding of the market suggests that first-of-a-kind commercial-scale demonstration projects are perceived as highly risky, and that the willingness to finance such projects changes significantly across time, most likely due to a combination of internal factors (such as in-house expertise and network connections with developers) and external factors (such as the maturity of the technology in question and the impact of recessions). Nonetheless, the market participants presented in this deliverable are those that have a track record of investments into SET projects, which will probably make them more likely than other parties to take on the uncertainty of first-of-a-kind deals in a similar field. Some of the participants who have not yet undertaken first-of-a-kind deals may opt into the market in the future, while some of those who have undertaken such deals previously may no longer be interested; however, we believe both to be of interest to this investigation. (Note: "SET project" means an energy project involving one of the nine technologies of interest to this study from the SET Plan. SET projects can be either first-of-a-kind SET projects or non-first-of-a-kind SET projects.)

3.1.3 The market participants identified are deemed to be a representative sample

We identified three sources of data on investments into SET that can be used as global benchmarks:

- BNEF – Bloomberg New Energy Finance[90] (2015);
- UNEP – United Nations Environment Programme[91] (2014);
- Preqin – alternative assets industry's source of data[92] (2014).

Due to copyright restrictions, we are unable to reproduce the information contained in these reports. However, having reviewed these sources, we believe that the market participant sample can be considered representative of the European renewable energy investment landscape relative to the global benchmark sources identified.

It is notable that there are differences in terms of the types of instruments, time periods and energy technologies taken into account by each of these sources. Unfortunately, no European-level data with a detailed breakdown on investments into SET projects were available, and we have not found any comprehensive stand-alone accounting of investments into first-of-a-kind SET projects. Our analysis is designed so as to ensure the best use of the data while accounting for these differences.

3.1.4 Market participant type

Market participants have been grouped together into four categories:

1. **Banks** (i.e., public, private and project banks) – 28
2. **General investors** (i.e., asset managers, pension funds, insurance companies, and foundations) – 11;
3. **Specialised investors** (i.e., venture capital, private equity firms) – 16;
4. **Producers** (i.e., utility and energy companies, industrial conglomerates and manufacturers) – 25.

[90] BNEF report "Global trends in clean energy investment q4 2014" (January 2015). Available at: http://about.bnef.com/presentations/clean-energy-investment-q4-2014-fact-pack/content/uploads/sites/4/2015/01/Q4-investment-fact-pack.pdf. Last accessed 16/04/2015

[91] "Global trends in renewable energy investment 2014" (February 2015). Available at : http://fs-unep-centre.org/system/files/globaltrendsreport2014.pdf. Last accessed 16/04/2015

[92] "Preqin Special Report: Renewable Energy Infrastructure" (October 2014). Available at https://www.preqin.com/docs/reports/Preqin-Special-Report-Renewable-Energy-Infrastructure-October-14.pdf. Last accessed 16/04/2015

3.1.5 Investment size

3.1.5.1 Aggregate size of the investments into SET projects by market participants: €40 billion

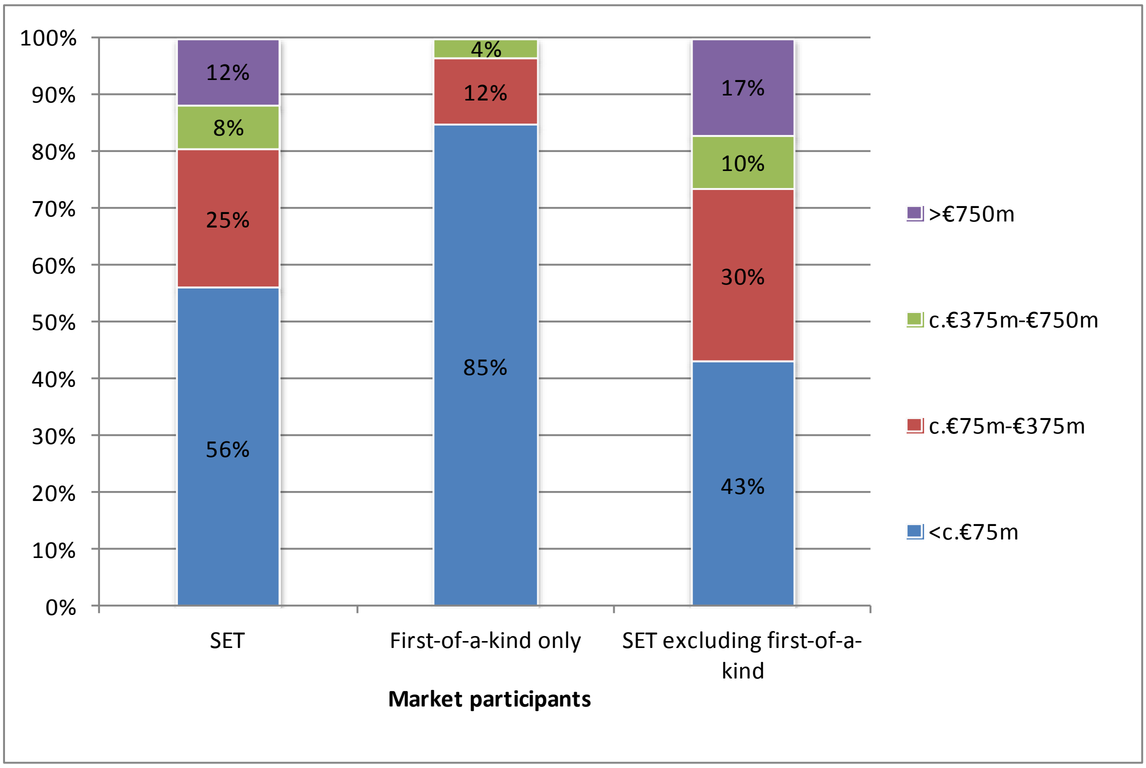
Prominent examples of investments into SET projects were identified for each market participant for the period 2006-2014, with a preference for investments which were larger in monetary terms, more recent, installed within Europe, and reflected either a given focus or diversification of the market participant's investments in asset category, geography and SET technology. **Taken together, the 80 market participants have contributed €40 billion through 297 investments to 270 SET projects, of which €2 billion has been contributed through 87 investments to 85 projects identified as first-of-a-kind according to the method set out in Section 3.1.2.** (Co-investors have invested €60 billion into the same projects.) Detailed breakdowns are provided in the individual market participant description sheets provided in Section 3.2 of this document.

3.1.5.2 Individual deals in SET projects range in size from under €75 million to over €750 million; first-of-a-kind SET projects have a greater number of small deals than other SET projects

Considering individual investments, the metric for investment size used is the deal value, which is the total monetary value of funds raised at a finance round going towards an asset, project, company loan or equity from one or in most cases a consortium of investors and lenders. The deal value is used for comparison as the breakdown of individual investments is not commonly disclosed in a transaction and similarly official sources provide finance sizes on a deal size basis. For this reason, deal size is used as metric for investment size.

Figure 3.1 shows the number of deals of four different size ranges (<€75m, €75m – €375m, €375m – €750m, and >€750m) for three different categories of investments: investments into first-of-a-kind SET projects, investments into non-first-of-a-kind projects, and investments into all SET projects (shown as "SET" in the figure). The number (and therefore the proportion) of deals in the smallest category (< €75 million) is much greater for investments into first-of-a-kind projects than for investments into all SET projects (85% of deals compared to 43%). Conversely, the number of deals in each of the other size categories is smaller for investments into first-of-a-kind projects than for investments into all SET projects.

Figure 3.1 Proportion of deals by number into first-of-a-kind and other SET projects[93]



[93] See Market Participant Description Sheets in Section 3.2

3.1.6 Geographic coverage

3.1.6.1 The 80 market participants are headquartered in 18 countries

The 80 market participants have their headquarters in 46 cities across 18 countries, of which 12 are EU Member States (Germany, UK, France, Denmark, Spain, Netherlands, Italy, Sweden, Finland, Portugal, Ireland, Belgium), two are EEA members (Norway, Switzerland), and another four are non-EU countries (USA, Japan, UAE, India) with a global reach in their renewable energy finance. The number of market participants headquartered in each country is shown in Figure 3.2.

As well as including global centres of renewable energy finance (Germany, UK, France, Denmark, Spain, the Netherlands and the US each feature five or more market participants), we have included several countries that feature three or fewer headquarters of market participants to ensure adequate coverage of countries with a more regional approach to financing renewable energy projects, such as Italy, Portugal and Sweden.

Figure 3.2 Geographical distribution of Market Participant headquarters[94]

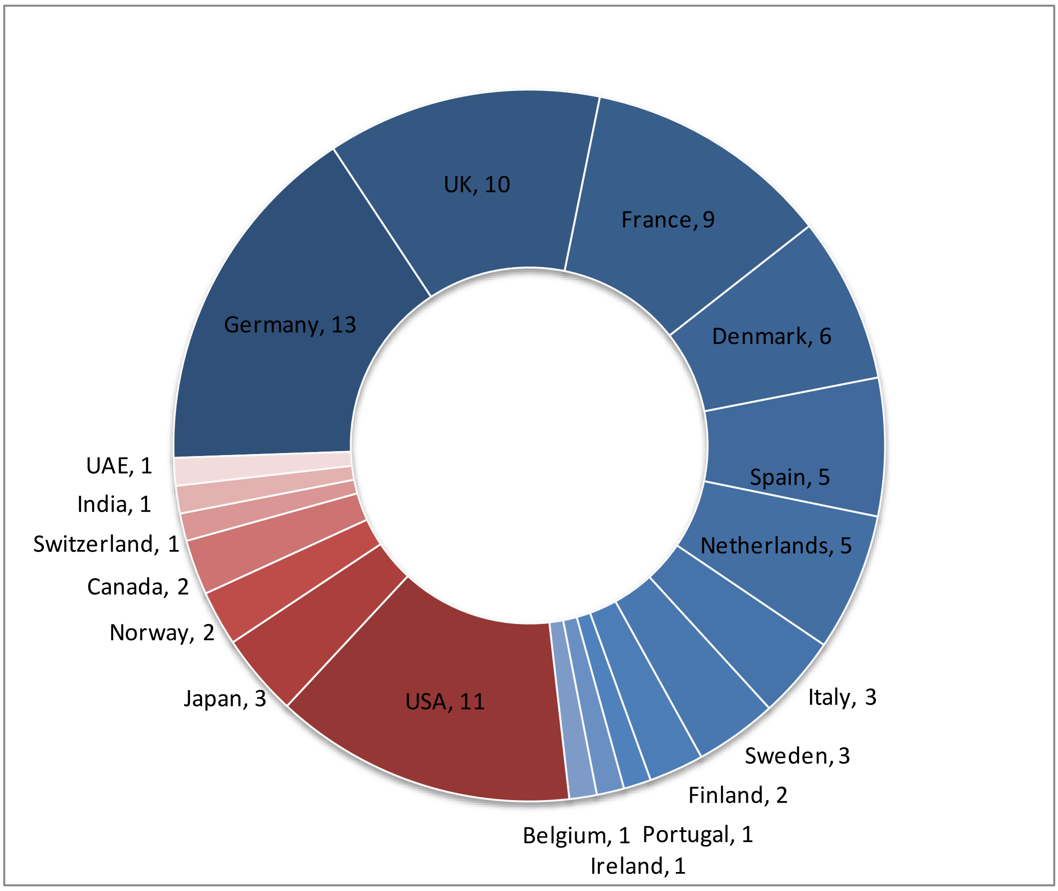


Figure 3.2 also highlights the attention provided to non-EU countries, which represent 21 out of 80 market participants. The considerable size, reach and influence of multinationals means that renewable energy finance is sourced and has potential investors from global finance centres and conglomerates. Just over half of the non-EU market participants are headquartered in the US which features a selection of 11 market participants.

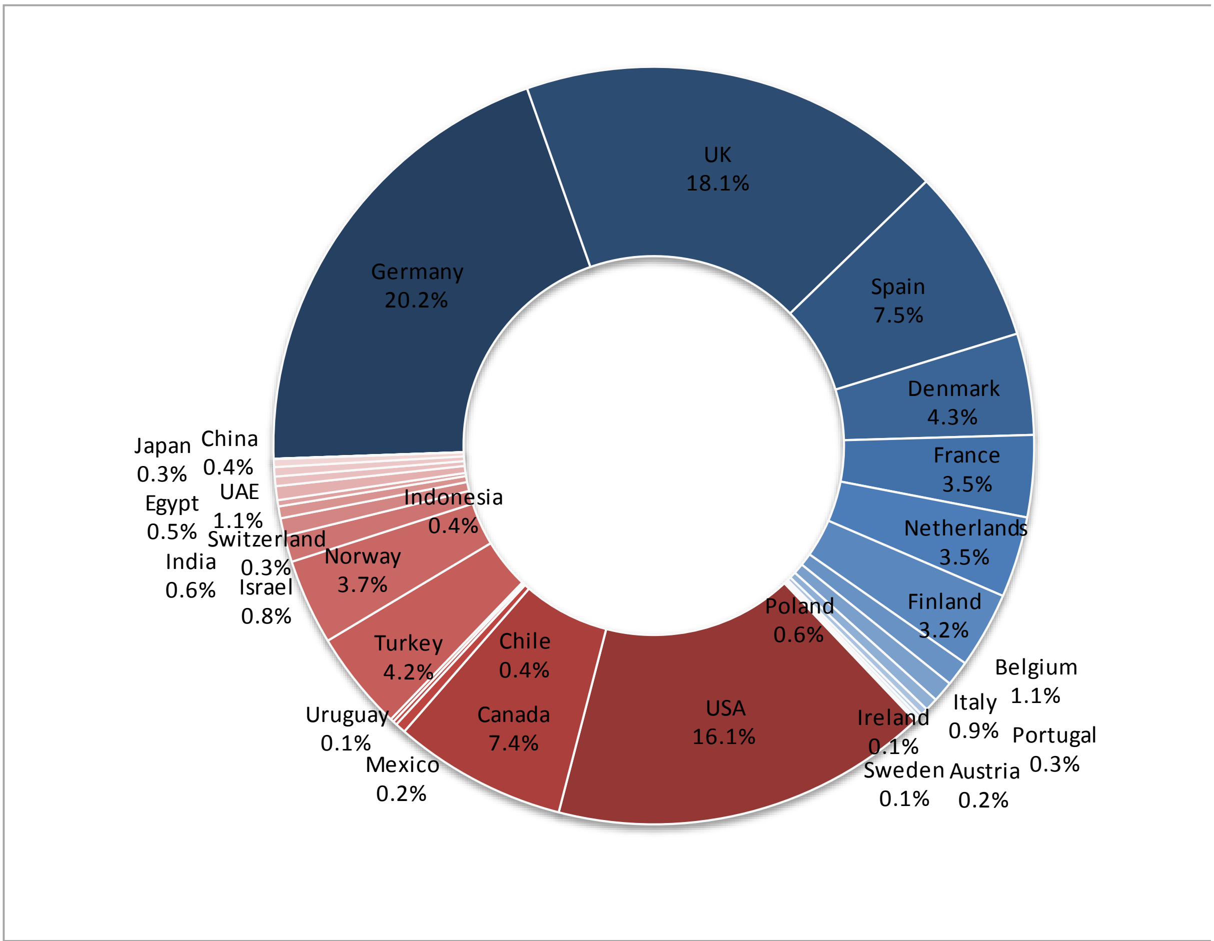
[94] See Market Participant Description Sheets in Sections 3.2

3.1.6.2 Market participants have invested mostly into SET projects located in European countries

Figure 3.3 shows the distribution of the overall value of investments by the market participants according to country of project location for the period 2006 – 2014.

The distribution is wide, both in terms of variety of EU Member States and in terms of EU versus non-EU presence; and, although some key players take up large shares (e.g. Germany and United Kingdom), smaller economies are also represented.

Figure 3.3 Overall value of investments (as a proportion of €40bn) by country of project location made by the Market Participants in the period 2006 – 2014 [95,96]



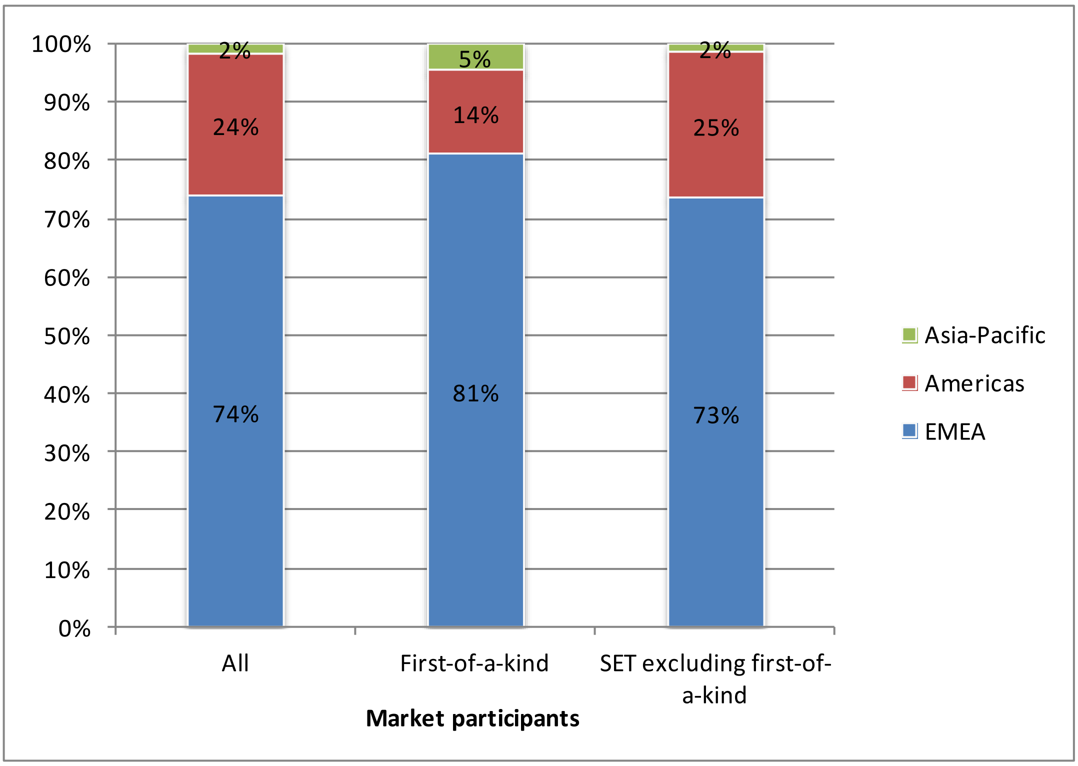
[95] See Market Participant Description Sheets in Sections 3.2

[96] Market participants have made less than €10m in identified investments into projects in Bulgaria, Australia and Singapore

Figure 3.4 groups the countries in Figure 3.3 according to global region (Europe/Middle East/ Africa; Americas; and Asia Pacific) and considers investment into first-of-a-kind SET projects as well as non-first-of-a-kind SET and all SET projects.

In monetary value terms, 73% of the investments made by market participants have been into projects located in the EMEA region. In the case of first-of-a-kind, however, the EMEA share rises to 81%, while the Americas drops to 14% of deal values. We would expect that market participants investing in SET projects in the EU would be more likely to be based in EMEA countries (particularly EU countries) but the higher proportion for first-of-a-kind projects is notable.

Figure 3.4 Overall value of investments (as a proportion of €40bn) by region of project location made by the Market Participants in the period 2006 – 2014 [97]



[97] See Market Participant Description Sheets in Section 3.2

3.1.7 Technology focus

For each of the SET technologies under consideration, the number of Market Participants described in Section 3.2 who have made an investment in an SET project is as follows:

- Advanced Electricity Networks – 29;
- Bioenergy – 51;
- Carbon Capture and Storage – 18;
- Concentrated Solar Power – 24;
- Geothermal – 12;
- Large-scale energy storage – 38;
- Ocean – 8;
- Solar photovoltaic – 62;
- Wind – 66.

Ensuring the representation of technologies such as Ocean Energy into which few Market Participants have invested will be an important factor in drawing up the Consolidated List of Market Participants.

3.1.8 Conclusion

The sample of 80 market participants can be considered representative of the European renewable energy investment landscape relative to the global benchmark sources identified. The 80 market participants offer a satisfactory range of countries and technology sectors, and reflect largely the use of financial instruments adopted at the global level.

3.2 Market Participant Description Sheets

This section contains the full 80 market participant description sheets, organised into four categories: **Banks** (i.e., public, private and project banks), **General investors** (i.e., asset managers, pension funds, insurance companies, and foundations), **Producers** (i.e., utility and energy companies, industrial conglomerates and manufacturers), and **Specialised investors** (i.e., private equity, venture capital firms).

Each market description sheet contains the following information:

- Name – name of the market participant;
- Type – identified sub-category for each of the four main categories;
- HQ – headquarter location of the market participants;
- Established – year of incorporation;
- Ownership – type of incorporation;
- Parent – institutions behind the establishment of the incorporation;
- Sectors – main areas of business;
- SET sector – main SET sector of investment;
- Type – preferred SET investment vehicles (not restricted to projects shown);
- Regional interest – preferred geographical area for SET investments;
- Signatory to – type of investment accord agreed to;
- Investment focus – tick boxes indicating the type of investment for the identified projects.

Additionally, each description sheet contains information on prominent investments into non-first-of-a-kind SET projects and into first-of-a-kind SET projects entered into (if applicable), as well as any exits from prominent investments into non-first-of-a-kind SET and first-of-a-kind SET projects. Finally, each description sheet contains a brief description of each market participant from their own website and a market comparison figure.

3.2.1 Explanatory note

3.2.1.1 Market comparison figures

The market comparison bar charts at the bottom of each market participant description sheet provide a visual comparison of each market participant against the average of all market participants in the overall list of 80. The values in the upper bars are based on the sum of the values of all the investments (whether into non-first-of-a-kind SET or first-of-a-kind-SET) listed on the market participant sheet:

- **Region (Euro)** – the proportions of investment value inside and outside the EU-28.

  The values in the upper bar are those of the named market participant. The values in the lower bar are those of the average market participant and are as follows: €24.1bn is invested inside the EU-28 (63.5%) and €13.8bn is invested outside the EU-28 (37.5%).

- **Investment size (number)** – the share of the number of finance deals (if the value is known/estimated) under €20m, between €20m and €100m, and €100m and above. In each instance only the contribution or estimated contribution of the market participant is used (instead of the total project investment size).

  The values in the upper bar are those of the named market participant. The values in the lower bar are those of the average market participant and are as follows: 123 finance deals are under €20m (41.4%), 98 finance deals are between €20m and $100m (33.0%), 76 finance deals are above €100m (25.6%).

- **Energy type (Euro)** – the proportion of investment value in wind, solar energy (solar PV and concentrated solar power) and other SETs (advanced electricity networks, biomass conversion technology, CCS, geothermal energy, large energy storage and ocean energy).

  The values in the upper bar are those of the named market participant. The values in the lower bar are those of the average market participant and are as follows: €26.1bn is invested in Wind (68.9%), €6.3bn in solar energy[98] (16.6%), and €5.5bn in other SET technologies[99] (14.4%).

- **Finance type (Euro)** – the proportion of investment value in the form of equity investments (or balance sheet), loans (including capital bonds) and mergers and acquisitions (M&A).

  The values in the upper bar are those of the named market participant. The values in the lower bar are those of the average market participant and are as follows: €25.7bn was in equity investments (67.9%), €6.7bn in loans (17.6%) and €5.5bn in M&A (14.4%).

In addition, the total amount of investments by the named market participant in the All-SET and in first-of-a-kind-SET projects listed is provided on the left-hand side of the bar charts.

3.2.1.2 Exchange rates

Regarding assumptions of the conversion of non-Euro currency transactions into Euro currency transactions (i.e. the Euro exchange rates) used for the IFI market participant sheets, in most of the cases, no exchange rate conversion is applicable. This is because either the transaction is conducted in Euro or the relevant source already contains a Euro conversion, if not approximation, of the transaction. In these cases, this note does not apply.

In the case a currency needs to be converted, the following methodology is applied. The conversion into Euro is applied through a rounded historical exchange rate in the year and surrounding months based on the monthly exchange rates of an exchange rate online

[98] 4.4 billion Euro in solar PV and 1.9 billion Euro in concentrated solar power

[99] 0.6 billion Euro in advanced electricity networks, 1.6 billion Euro in biomass conversion technology, 0.9 billion Euro in carbon capture and storage (CCS), 0.4 billion Euro in geothermal, 0.8 billion Euro in large scale energy capture and storage, and <0.1 billion Euro in ocean energy.

comparison tool[100]. The converted amount is then rounded to the nearest million, five million or ten million, depending on the accuracy of the sum. In order to communicate this conversion is an approximation. The conventional abbreviation c. (circa) is used for any converted value from the original source due to currency or other reasons. The disclosed transaction in the original currency and number of funders is provided in brackets.

This approach is justified as there are many caveats in the comparison of deals which transcend the application of exchange rates. To provide exact conversions would not represent the level of accuracy possible in the data. This might be due to a number of reasons, including the following:

- The entire deal and the number of funders is disclosed, however the exact share of the market participant in the funding is not disclosed (e.g. RBS provided a letter of credit to the Topaz PV plant in the USA in 2012 for $900m together with 22 other banks);
- The funding of the deal is disclosed as a rounded value, estimation, or otherwise non-exact amount;
- The date of the announcement of the deal does not necessarily correspond to the release of the funding and varies with the timing of the finance.

3.2.1.3 Splits

If available, the individual contribution towards a financial deal is provided. If no individual contributions are reported, an equal split is assumed between all parties, calculated at the highest level of detail and the individual contribution, and noted to be *circa* the equal split value. In brackets a note is made of the amount and the number of participants that this amount is divided between.

[100] http://www.x-rates.com/average

3.3 Market Participant Description Sheets for BANKS

Box 3.1 Green Investment Bank

Overview:

Name	**Green Investment Bank**
Type	**Public Bank**
HQ	**Edinburgh, United Kingdom**
Established	**2012**
Ownership	**Private limited company**
Parent	**HM Treasury**
Sectors	**Green energy**
SET sector	**Wind; biomass conversion technologies**
Type	**Asset finance; acquisitions**
Regional interest	**UK**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit http://www.greeninvestmentbank.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Sheringham Shoal offshore wind farm	2014	c.€300m (£240m, £1.2bn total)	Seed equity (20%)	317 MW	Wind	UK
Widnes CHP waste wood plant	2014	c.€35m (£30.1m)	Mezzanine, equity	20.2 MWe, 7.8 MWth	Biomass conversion technologies	UK
Westermost Rough offshore wind farm	2013	c.€310m (£261m in c.£500 total)	Equity	210 MW	Wind	UK

FIRST-OF-A-KIND SET

N/A

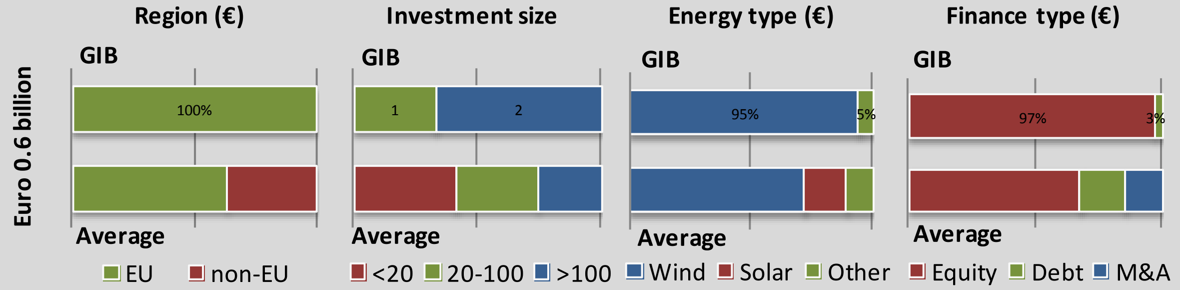
EXITS

N/A

DESCRIPTION

The UK Green Investment Bank is the first bank of its type in the world. It was created by the UK Government, its sole Shareholder, and capitalised with an initial 4.7 billion Euros (£3.8bn) of public funds. Finance is to back green projects on commercial terms and mobilise other private sector capital into the UK's green economy.

MARKET COMPARISON



Box 3.2 Nordic Investment Bank

Overview:

Name	**Nordic Investment Bank**
Type	**Public Bank**
HQ	**Helsinki, Finland**
Established	**1975**
Ownership	**Government owned**
Parent	**Government of Finland; Norway; Sweden; Denmark; Latvia; Lithuania; Estonia; Iceland**
Sectors	**General**
SET sector	**Biomass conversion technology; large scale energy storage solutions; solar photovoltaic; wind**
Type	**Asset finance; corporate debt; grants and loans**
Regional interest	**Finland; Sweden; Denmark; Norway; Iceland**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit http://www.nib.int/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Agder Energi Iveland Small Hydro Plant	2013	€58m	Debt	44MW	Large scale energy storage solutions	Norway
Vaskiluodon Voima Vaas Biomass	2012	€18m	Loan	140MW	Biomass conversion technologies	Finland
Gabrielsberget Nord Vind	2011	€33m (€70m project)	Debt	46MW	Wind	Sweden

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Lahti Energia Waste to energy plant	2010	€50m (project €160.5m)	Loan	50MW	Biomass conversion technologies	Finland

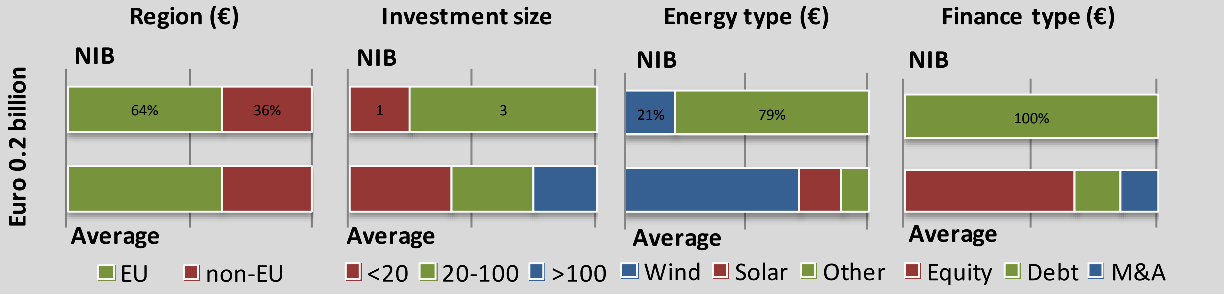
EXITS

N/A

DESCRIPTION

NIB finances projects that improve competitiveness and the environment of the Nordic and Baltic countries. The Bank offers long-term loans and guarantees on competitive market terms to its clients in the private and public sectors.

MARKET COMPARISON



Box 3.3 KfW

Overview:

Name	**KfW**
Type	**Public Bank**
HQ	**Frankfurt, Germany**
Established	**1948**
Ownership	**Government**
Parent	**Federal Republic of Germany**

Bank aus Verantwortung

Credit https://www.kfw.de

Sectors	**SMEs, home finance, housing, environment and climate, export, development**
SET sector	**Advanced electricity networks; biomass conversion technologies; concentrated solar power (CSP); geothermal energy; large scale energy storage; solar photovoltaics; wind**
Type	**Private equity; asset finance; corporate debt; grants guarantees and loans**
Regional interest	**Germany; Europe; Middle East; Asia**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
NREA & KFW Gulf of El Zeit Wind Farm	2010	€191.5m	Loan	200MW	Wind	Egypt
Karaburun Wind Farm	2012	c.€65m ($164.5m between 2 in $227m total)	Loan	120MW	Wind	Turkey
Thornton Bank windpark	2014	c.€150m (€1.3bn between 9)	Loan	325MW	Wind	Belgium

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Concentrator Optics GmbH	2012	c€1m (€3.5m between 3)	Grant	40MW	Solar PV	Germany
Electrochaea GmbH	2014	c€1m (several €m between 6)	Equity	N/A	Large scale energy storage	Germany
Yetu AG	2014	c.€4m ($8m between 2)	Equity	N/A	Advanced electricity networks	Germany

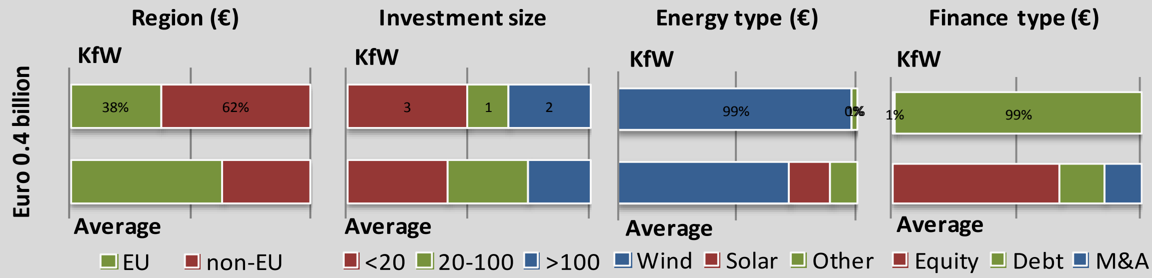
EXITS

N/A

DESCRIPTION

KfW is one of the world's leading promotional banks. It has been dedicated to improving environmental, social and economic conditions worldwide since 1948 in accordance to its mandate from the German Federal Government and federal states. KfW has been providing support for energy efficiency and renewable energy since 1990. Climate and environmental protection accounts for about 40% of promotional volume.

MARKET COMPARISON



Box 3.4

Box 3.5 Goldman Sachs

Overview:

Name	**Goldman Sachs Group**
Type	**Corporate Bank**
HQ	**New York, USA**
Established	**1869**
Ownership	**Public Listed Company**
Parent	**N/A**
Sectors	**General**
SET sector	**Advanced electricity networks; biomass conversion technologies; carbon capture and storage; large scale energy storage; solar photovoltaics; wind**
Type	**Private equity; public market equity; corporate debt**
Regional interest	**North America, Asia, Europe**
Signatory to	**UN Principles for Reasonable Investment**

Credit www.goldmansachs.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☑	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Energy Future Holdings	2007	c.€1.1bn ($1.5bn in $48bn total)	Equity (LBO)	700MW	Wind (through Luminant TXU Energy Plan)	USA
DONG Energy A/S	2013	c.€1,075m (DKK 8bn)	Equity (IPO)	2.1GW	Wind	Denmark
SolarCity	2014	c.€130m ($166.6m in $500m)	Convertible bond	153MW	Solar PV	USA

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Eden Energy Ltd	2007	c.€5m (5.4% A$130)	Equity (public market)	N/A	Large scale energy storage	Australia
Gridpoint	2006	c.€10m (part $21m)	Equity	N/A	Advanced electricity networks	USA

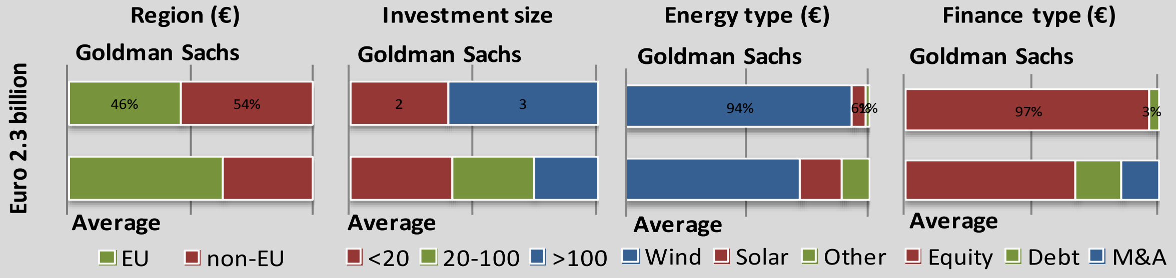
EXITS

N/A

DESCRIPTION

The Goldman Sachs Group is a leading global investment banking, securities and investment management firm that provides a wide range of financial services to a substantial and diversified client base that includes corporations, financial institutions, governments and high-net-worth individuals. In 2012, Goldman Sachs extended its clean energy commitment by establishing a 31 billion Euros ($40bn) target to finance and invest in companies that promote clean technology alternatives over the next decade.

MARKET COMPARISON



Box 3.6 Credit Suisse

Overview:

Name	**Credit Suisse**
Type	**Corporate Bank**
HQ	**Zurich, Switzerland**
Established	**1856**
Ownership	**Public limited company**
Parent	**N/A**
Sectors	**General**
SET sector	**Advanced electricity networks; biomass conversion technologies; concentrated solar power (CSP); carbon capture and storage (CCS); geothermal; solar photovoltaics; wind**
Type	**Private equity; public market equity; asset finance; corporate debt**
Regional interest	**North America, Asia, Europe**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit https://www.credit-suisse.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☑	☑	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Cancelled - TransAlta Corp	2008	c.€2.5bn ($7.8bn between 2)	¾ equity; ¼ debt	192MW	Wind	Canada
Sunrun Inc.	2012	c.€150m ($200m)	N/A	N/A	Solar PV	USA
Genesis Solar, NextEra Energy Resources	2011	c.€600m ($852m)	debt (project bonds)	250MW	Concentrated solar power (CSP)	USA

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Helius Energy PLC	2008	c.€2.5m (£2m)	Equity (public market)	N/A	Biomass conversion technologies	UK
SmartSynch Inc	2008	c.€2m ($20m between 10)	Equity (VC)	N/A	Advanced electricity networks	USA
Zero Point Clean Tech	2008	c.€1m ($1.5m)	Equity (VC)	N/A	Biomass conversion technologies	USA

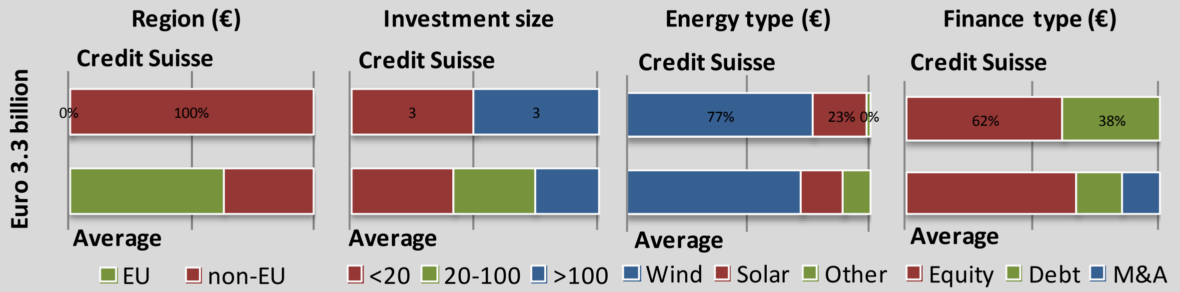
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
SmartSynch Inc	2012	2008	c.€70m ($100m)	Multiple: <1.25x	Advanced electricity networks	Switzerland

DESCRIPTION

Credit Suisse is a leading financial services provider to corporate, institutional and government clients, ultra-high-net-worth and high-net-worth individuals wordwide, as well as affluent and retail clients in Switzerland. Credit Suisse has 2.1 million clients world wide served by 45,800 employees and 1.37 trillion CHF (€1.07tn) in assets under management.

MARKET COMPARISON



Box 3.7 HSBC

Overview:

Name	**HSBC**
Type	**Corporate Bank**
HQ	**London, United Kingdom**
Established	**1980**
Ownership	**Public limited company**
Parent	**N/A**
Sectors	**General**
SET sector	**Biomass conversion technologies; concentrated solar power (CSP); solar photovoltaics; wind**
Type	**Asset finance**
Regional interest	**Canada; UK; China; Spain; Australia; Greece; Turkey; South Korea; Italy; USA**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit https://www.hsbc.co.uk

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Extremadura Solar Complex	2012	c.€85m (€340m between 4)	Debt	200MW	Concentrated solar power (CSP)	Spain
FCC Buckinghamshire Waste-to-Energy Plant	2013	c.€45m (£190m between 5)	Debt (senior)	22MW	Biomass conversion technologies	United Kingdom
Baicheng Baoshan wind farm	2011	c.€42m (£37m)	Debt	49.5MW	Wind	China

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Emerald Biogas Newton Aycliffe Biomass Plant	2012	c.€4.5m (£3.6m)	N/A	c.1.5MW	Biomass conversion technologies	United Kingdom
Partnership for Renewables	2011	c.€10m (<£10m)	Equity	N/A	Various	United Kingdom

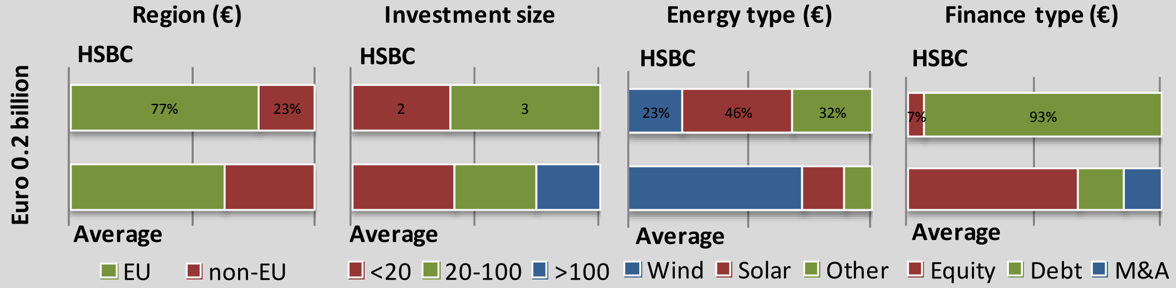
EXITS

N/A

DESCRIPTION

HSBC is one of the largest banking and financial services organisations in the world. HSBC provides a comprehensive range of financial services to around 51 million customers through its global businesses - Retail Banking and Wealth Management, Commercial Banking, Global Banking and Markets, and Global Private Banking - served by 266,000 employees in 74 countries and territories.

MARKET COMPARISON



Box 3.8 Royal Bank of Scotland

Overview:

Name	**Royal Bank of Scotland**
Type	**Corporate bank**
HQ	**Edinburgh, United Kingdom**
Established	**1727**
Ownership	**Public listed company**
Parent	**UK Financial Investments Ltd**
Sectors	**General**
SET sector	**Advanced electricity networks; biomass conversion technologies; solar photovoltaics; wind**
Type	**Asset finance**
Regional interest	**UK; Canada; USA**
Signatory to	**Equator Principles**

Credit www.rbs.co.uk

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Infinis Plc	2013	c.€200m (£329.5 between 2)	Debt (term loan, ancillary)	274MW	Wind	United Kingdom
Triodos Investment Walney Island	2012	c.€50m (£224m between 5)	Term loan	367.2MW	Wind	United Kingdom
Topaz PV plant	2012	c.€30m ($900m between 23)	Debt (letter of credit 5 year tenor)	800MW	Advanced electricity networks	USA

FIRST-OF-A-KIND SET

N/A

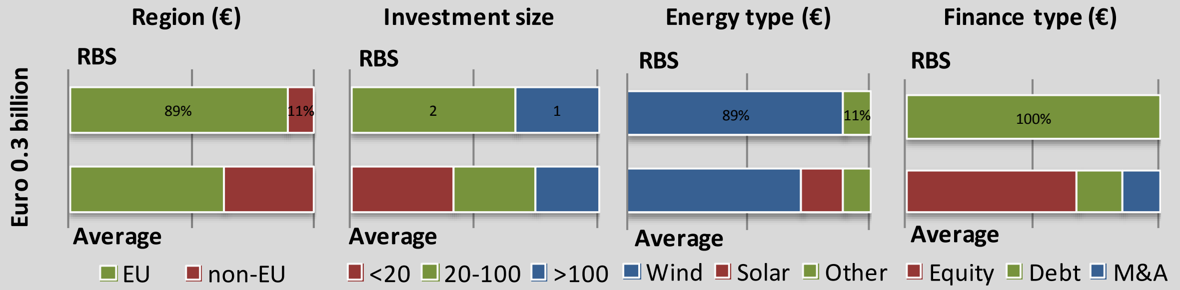
EXITS

N/A

DESCRIPTION

RBS provides a wide range of products and services to personal, commercial and large corporate and institutional customers through its two main subsidiaries, The Royal Bank of Scotland and Natwest, as well as through a number of other well-known brands including Citizens, Charter One, Ulster Bank and Coutts.

MARKET COMPARISON



Box 3.9 Rabobank International

Overview:

Name	**Rabobank International**
Type	**Investment Bank**
HQ	**Utrecht, Netherlands**
Established	**1980**
Ownership	**Private limited company**
Parent	**Cooperatieve Centrale Raiffeisen-Boerenleenbank BA/Netherlands**
Sectors	**General**
SET sector	**Solar photovoltaics, wind, biomass conversion technologies; wind**
Type	**Asset finance**
Regional interest	**Europe; North America; India; Chile**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit https://www.rabobank.com

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Belwind Offshore Wind Farm Phase I	2009	c.€30m (€63.43m between 2)	Mezzanine	165MW	Wind	Belgium
SunEdison, Inc.	2013	€33.9m	Debt (bridge)	100MW	Solar PV	Chile
Nautilus Solar Energy, LLC	2015	€29.4m	Debt (liens)	100MW	Solar PV	Canada

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Ampyx Power	2012	N/A	N/A	N/A	Wind	Netherlands

N.B. Rabobank as part of Dutch Greentech Fund

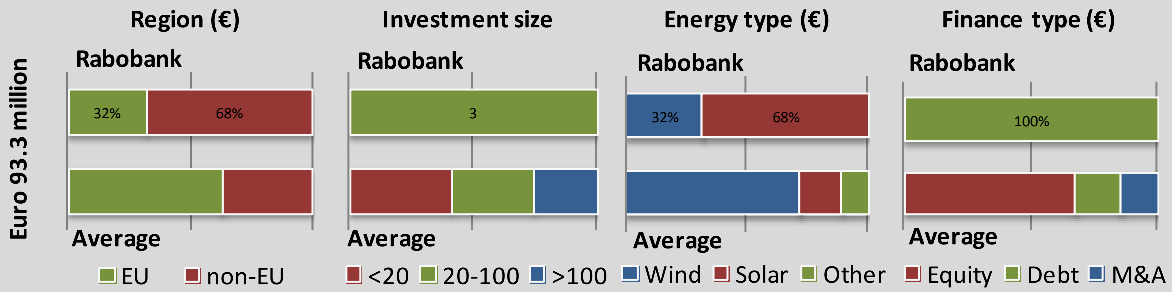
EXIT

N/A

DESCRIPTION

Rabobank is a cooperative bank with nearly two million members. Rabobank has grown over the past several decades from their home base in the Netherlands to become an international financial services provider with activities in banking, asset management, leasing, insurance and real estate.

MARKET COMPARISON



Box 3.10 ABN AMRO Bank NV

Overview:

Name	**ABN AMRO Bank NV**
Type	**Corporate Bank**
HQ	**Amsterdam, Netherlands**
Established	**1991 (roots 1720)**
Ownership	**Public listed company**
Parent	**ABN AMRO Group NV**
Sectors	**Energy**
SET sector	**Biomass conversion technologies; carbon capture and storage (CCS); concentrated solar power (CSP); solar photovoltaics; wind**
Type	**Asset finance**
Regional interest	**Germany; Netherlands; Spain; Brazil**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit https://www.abnamro.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
Examples:	☐	☑	☐	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Gemini Offshore Wind Farm	2014	€92.4m (€2.8 bn total)	17 year term loan	600MW	Wind	Netherlands
Nordsee 1 RWE Northland	2015	c.€84m (€840m between 10)	Debt (term loan)	332MW	Wind	Germany
Dioxipe Solar Astexol-2	2010	c.€40m (€288m between 7)	Debt (20 term loan VAT,credit)	50MW	Concentrated solar power (CSP)	Spain

FIRST-OF-A-KIND SET

N/A

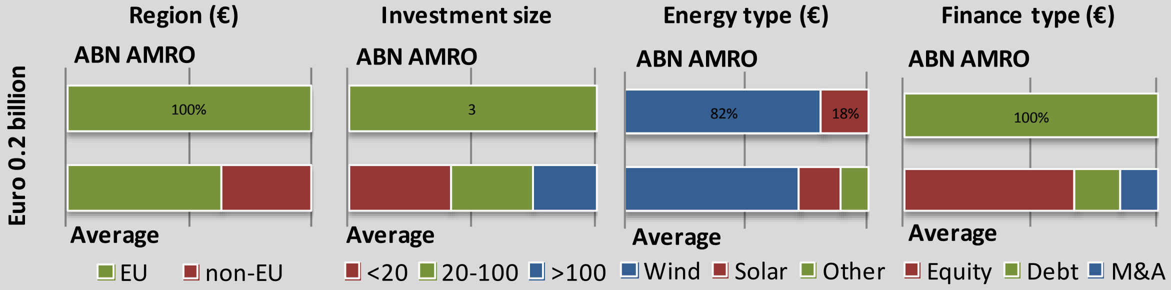
EXITS

N/A

DESCRIPTION

ABN AMRO serves retail, private and commercial banking clients in the Netherlands and across the globe with a comprehensive range of products and services. ABN AMRO also offers national and international advisory services, based on its in-depth financial expertise, extensive knowledge of numerous sectors and an international network.

MARKET COMPARISON



Box 3.11 BNP Paribas

Overview:

Name	**BNP Paribas**
Type	**Corporate Bank**
HQ	**Paris, France**
Established	**1966**
Ownership	**Public listed company**
Parent	**N/A**

Credit [*http://www.bnpparibas.com/*](http://www.bnpparibas.com/)

Sectors	**Asset finance, corporate debt**
SET sector	**Wind (predominant); biomass conversion technologies (rare); concentrated solar power (CSP); geothermal (rare); solar PV**
Type	**Asset finance; corporate debt**
Regional interest	**France; Italy; Spain; UK; Belgium; Other**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Northwind Offshore Wind Farm	2012	c.€75m (€595m between 8)	Debt	216MW	Wind	Belgium
Abengoa Solacor STEG	2010	c.€90m (€350m between 4)	Debt	100MW	Concentrated solar power (CSP)	Spain
Nextera Termosolar	2011	€30.4m (total: €589m)	Debt	99.8MW	Concentrated solar power (CSP)	Spain

FIRST-OF-A-KIND SET

N/A

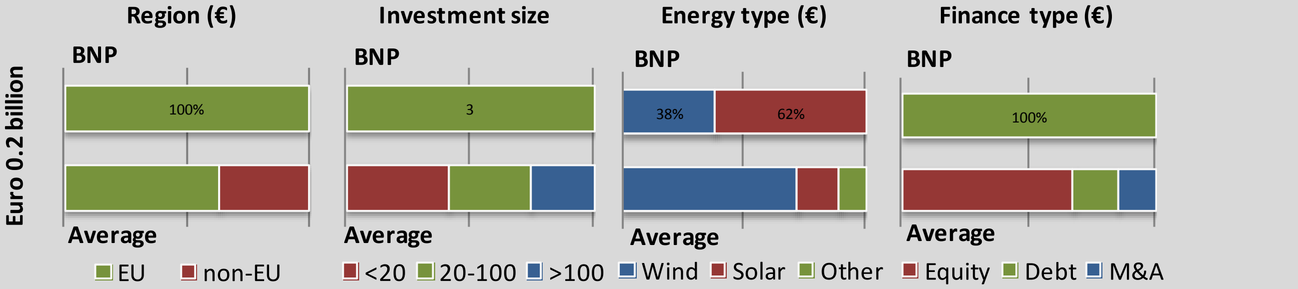
EXITS

N/A

DESCRIPTION

BNP Paribas is one of the euro zone's leading banks. The Group's European footprint includes its four domestic markets: France, Belgium, Italy and Luxembourg. It has nearly 141,500 employees in 30 European countries. In Europe, BNP Paribas is strongly positioned in its three core businesses: Retail Banking, Corporate & Institutional Banking and Investment Solutions.

MARKET COMPARISON



Box 3.12 Societe Generale SA

Overview:

Name	**Societe Generale SA**
Type	**Corporate Bank**
HQ	**Paris, France**
Established	**1864**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**General**
SET sector	**Biomass conversion technologies; concentrated solar power (CSP); geothermal energy; solar photovoltaics; wind**
Type	**Private market equity; asset finance; corporate debt**
Regional interest	**France; Spain; Italy; UK; Germany; USA; other**
Signatory to	**Equator Principles**

Credit http://www.societegenerale.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Saeta Yield SA IPO	2015	c.€15m (10% of total €441.4m between 3)	Equity (IPO)	538.5MW	Wind	Spain
C-Power Thornton Bank offshore wind	2010	c.€85m (€869m between 10)	Debt	325MW	Wind	Belgium
Gainesville biomass power plant	2011	c.€60m ($500m between 6)	Debt	100MW	Biomass conversion technologies	USA

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Block Island Offshore Wind	2015	c.€125m ($290m between 2, $360m total)	Debt	30MW	Wind	USA

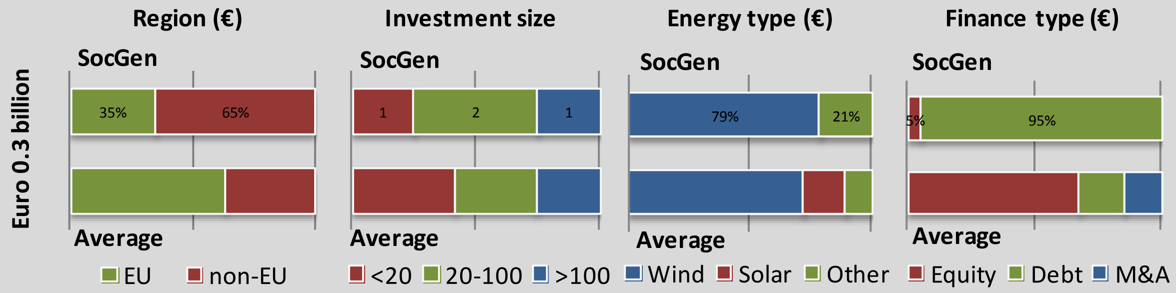
EXITS

N/A

DESCRIPTION

Societe Generale follows a universal banking model based on complementary businesses in France and around the world. Serving 32 million customers in 76 countries, Societe Generale is one of Europe's largest financial services organisations. Societe Generale has expertise in areas such as retail banking, corporate and investment banking, financial services, insurance, private banking and asset management.

MARKET COMPARISON



Box 3.13 Nordea Bank

Overview:

Name	**Nordea Bank**
Type	**Corporate Bank**
HQ	**Stockholm, Sweden**
Established	**2001 (merger, prior 1820)**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**General**
SET sector	**Solar photovoltaics; wind**
Type	**Asset finance; corporate debt**
Regional interest	**Norway; Sweden; Denmark; UK; Czech Republic; Poland; rest of world**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit www.nordea.com

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☑	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Lincs Offshore Wind Farm	2012	c.€50m (£425bn between 10)	Debt (16.5year term loan)	270MW	Wind	United Kingdom
REC Silicon ASA	2010	c.€400m (NOK 10bn between 3)	Capital market bonds (credit + guarantee)	N/A	Solar PV	Norway
Vestas	2014	c.€150m (€1bn between 6)	Debt (credit facility)	N/A	Wind	Denmark

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Hog Jaeren onshore wind farm	2011	c.€35m (€77m between 2)	Debt	59.8MW	Wind	Norway

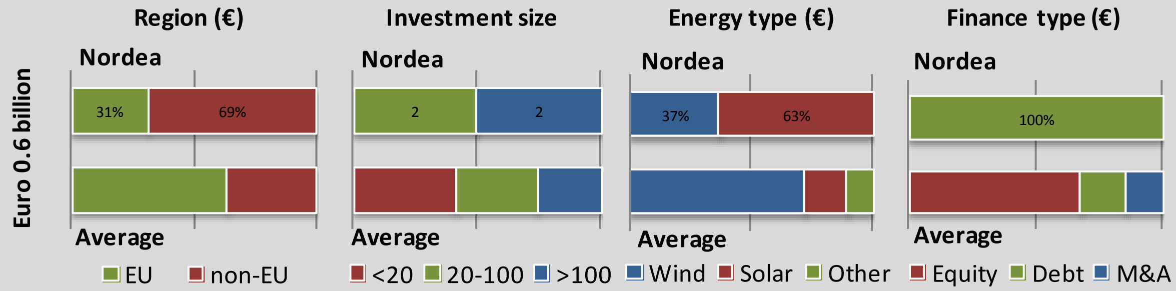
EXITS

N/A

DESCRIPTION

Nordea is the largest financial services group in the Nordic and Baltic region. Nordea holds leading positions in corporate and institutional banking as well as retail and private banking. Nordea is also the leading provider of life and pensions products in the Nordic countries. Nordea is among the ten largest full-service banks in Europe, based on market capitalisation.

MARKET COMPARISON



Box 3.14 UBI Banca

Overview:

Name	**Unione di Banche Italiane SCpA**
Type	**Corporate Bank**
HQ	**Bergamo, Italy**
Established	**2007 (merger, roots 1939)**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**General**
SET sector	**Concentrated solar power (CSP); solar photovoltaics; wind**
Type	**Asset finance; corporate debt**
Regional interest	**Italy; Spain**
Signatory to	
	N/A
Investment focus:	

Credit http://www.ubibanca.it/

Examples:

Equity	Loans	Capital market bonds	M&A
☐	☑	☐	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Abengoa Solnova 4 and three solar PV	2008	€20m(€280m between 14)	Term loan	50MW	¾ Concentrated solar power (CSP) ¼ Solar PV	Spain
Campania & Puglia PV from SunEdison	2011	€24.9m	Term loan	13MW	Solar PV	Italy
Petralia Sottana wind farm, Falck	2015	€8m (€24m between 3)	Term loan (12.5years)	22.1MW	Wind	Italy

FIRST-OF-A-KIND SET

N/A

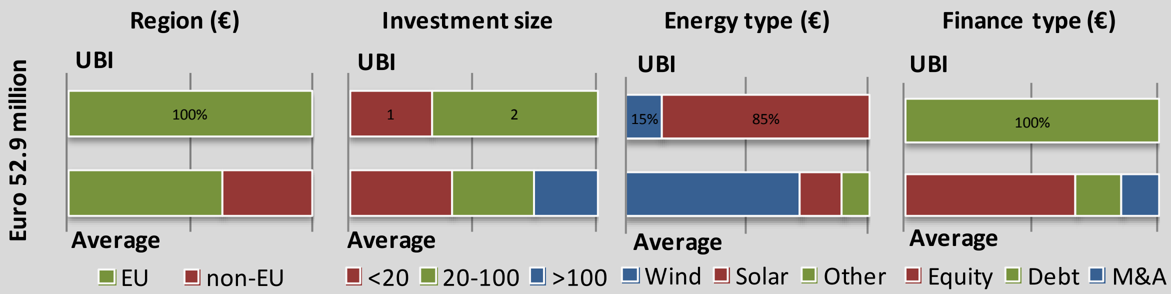
EXITS

N/A

DESCRIPTION

UBI Banca - Unione di Banche Italiane Scpa - was created on the 1st of April 2007 from the merger between BPU - Banche Popolari Unite and Banca Lombarda e Piemontese. UBI Banca is a mainly domestic cooperative Group with approx. 1,700 branches and over 18,000 employees.

MARKET COMPARISON



Box 3.15 Bank of Santander

Overview:

Name	**Bank of Santander**
Type	**Corporate Bank**
HQ	**Madrid, Spain**
Established	**1857**
Ownership	**Public limited company**
Parent	**N/A**

Santander

Credit http://www.santander.co.uk/

Sectors	**General**
SET sector	**Advanced electricity networks; biomass conversion technologies (rare); large scale energy storage (rare); concentrated solar power (CSP); solar photovoltaics; wind**
Type	**Asset finance; corporate debt**
Regional interest	**Spain, Brazil, Canada, Chile, the US, Italy, Australia, Mexico, Netherlands, UK and Uruguay**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☑	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Dioxipe Solar Astexol-2	2010	c.€40m (€288m between 7)	20 term loan VAT facility credit facility	50MW	Concentrated solar power (CSP)	Spain
Acciona S.A.	2013	€500m	Arranger debt	c.8,500MW	Wind, biomass conversion technologies, large storage, solar PV, solar thermal	Spain
Gemini Offshore Wind Farm	2014	€59m (€2.8 bn total)	17 year term loan	600MW	Wind	Netherlands

FIRST-OF-A-KIND SET

N/A

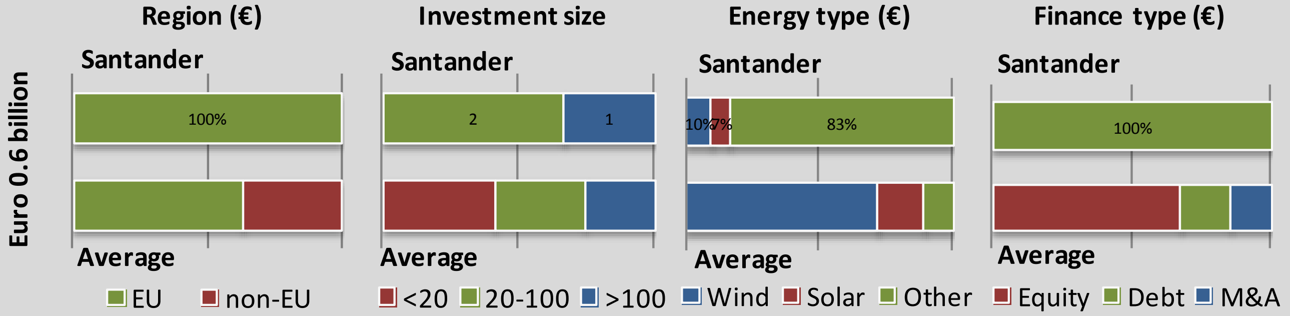
EXIT

N/A

DESCRIPTION

The Santander Group is one of the largest banks in the world with 102 million customers, 14,500 branches and 190,000 employees. A leading bank in Europe and Latin America, Santander is geographically and financially diversified. Santander ranked as the top Greenest Global Bank in 2013 by Bloomberg BusinessWeek and named 2013 Sustainable Global Bank of the Year - Transactions by the Financial Times.

MARKET COMPARISON



Box 3.16 Bank of Sabadell

Overview:

Name	**Bank of Sabadell**
Type	**Corporate Bank**
HQ	**Sabadell, Spain**
Established	**1881**
Ownership	**Public limited company**
Parent	**N/A**
Sectors	**General**
SET sector	**Biomass conversion technologies; concentrated solar power (CSP); large scale energy storage (rare) solar photovoltaics; wind**
Type	**Asset finance; corporate debt**
Regional interest	**Spain; USA; Mexico; Germany**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit https://www.bancsabadell.com

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☑	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Thermosol STEG Plant I & II NextEra	2011	c.€45m (€589.2 between 13)	Term loan (20 year)	50MW	Concentrated solar power (CSP)	Spain
Acciona	2011	c.€130m (€1,575m between 12)	Term loan (18 year)	c.8,500MW	Wind, biomass, small storage, solar PV, solar thermal	Spain
Cimarron Wind Holdings by NextEra	2012	c.€30m ($235.9m between 6)	Term loan (18 year)	165.6MW	Wind	USA

FIRST-OF-A-KIND SET

N/A

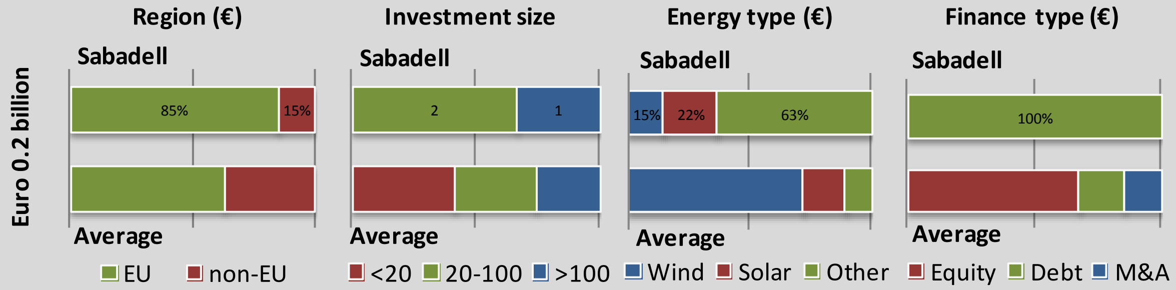
EXIT

N/A

DESCRIPTION

Banco Sabadell is Spain's fourth largest private banking group, which is comprised of different banks, brands, subsidiaries and part-owned companies covering all areas of the financial business sector. As of March 2015, the bank has 2,305 branches and 17,596 employees.

MARKET COMPARISON



Box 3.17 BBVA

Overview:

Name	**BBVA**
Type	**Corporate Bank**
HQ	**Bilbao, Spain**
Established	**1857**
Ownership	**Public limited company**
Parent	**N/A**
Sectors	**Clean energy focus**
SET sector	**Biomass conversion technologies; concentrated solar power (CSP); large scale energy storage; solar photovoltaics; wind**
Type	**Asset finance; corporate debt**
Regional interest	**Europe (focus on Spain), Latin America, USA**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit https://www.bbva.es

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☑	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Acciona	2011	c.€130m (€1,575m between 12)	Term loan (18 year)	c. 8,500MW	Wind, biomass, small storage, solar PV, concentrated solar power (CSP)	Spain
Ferroatlantica Galicia	2012	€25m	Term loan (10 years)	98.9MW	Energy storage (small hydro)	Spain
SunEdison Javiera PV Plant	2014	c.€60m ($160m with CorpBanca)	Loan and VAT facility	69.5MW	Solar PV	Chile

FIRST-OF-A-KIND SET

N/A

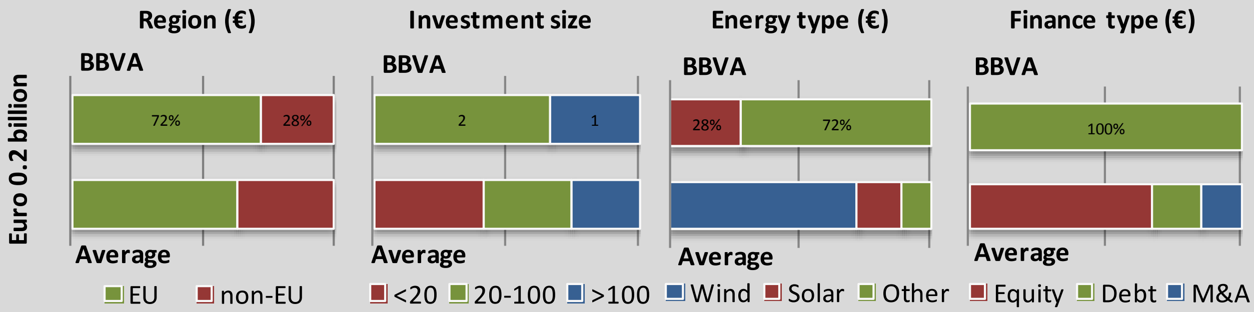
EXIT

N/A

DESCRIPTION

BBVA is a leading bank in Spain and Portugal, Mexico, South America and the Sunbelt Region of the USA, providing banking and insurance services. Cross-sectionally, BBVA also provides corporate investment banking and global retail and business banking and services in Eurasia. BBVA is a global financial group with presence in over 31 countries, more than 108,000 employees and 51 million customers worldwide.

MARKET COMPARISON



Box 3.18 SMBC

Overview:

Name	**Sumitomo Mitsui Banking Corporation**
Type	**Corporate Bank**
HQ	**Tokyo, Japan**
Established	**2001 (merger, prior 1876)**
Ownership	**Public listed company**
Parent	**Sumitomo Mitsui Financial Group Inc**
Sectors	**General**
SET sector	**Biomass conversion technologies; concentrated solar power (CSP); geothermal energy; large scale energy storage; solar photovoltaics; wind**
Type	**Asset finance; acquisitions; public market equity; corporate debt**
Regional interest	**Japan; Asia; Latin America; USA; Middle East; UK; France; Germany; Spain; Italy; Netherlands**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit http://www.smbc.co.jp/global/

Investment focus:	Equity	Loans	Capital market bonds	M&A
Examples:	☐	☑	☐	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Okayama Setouchi PV plant	2014	c.€25m (¥110bn total, ¥90bn between 28)	Loan	230MW	Solar PV	Japan
Extramadure Solar Complex phase I	2010	c.€85m (€340m between 4)	Loan	100MW	Concentrated solar power (CSP)	Spain
Gemini Offshore Wind Farm	2014	€92.4m (€2.8 bn total)	17 year term loan	600MW	Wind	Netherlands

FIRST-OF-A-KIND SET

N/A

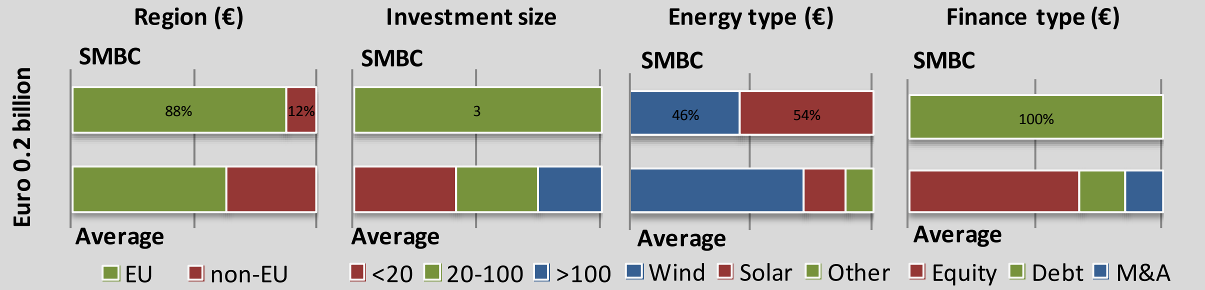
EXITS

N/A

DESCRIPTION

Sumitomo Mitsui Banking Corporation (SMBC) Corporate Bank was founded in 2001 through a merger of Sakura Bank and Sumitomo Bank. It has 439 branches in Japan and 15 branches overseas (excluding sub-branches, agencies and representative offices) and 25,573 employees. SMBC is Japan's second largest bank with one trillion Euros (¥144tn) in total assets.

MARKET COMPARISON



Box 3.19 Bank of Ireland

Overview:

Name	**Bank of Ireland**
Type	**Corporate Bank**
HQ	**Dublin, Ireland**
Established	**1783**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**General**
SET sector	**Biomass conversion technologies; solar photovoltaics; wind**
Type	**Asset finance**
Regional interest	**UK, Ireland, USA, Spain, Germany, Italy**
Signatory to	**N/A**

Credit https://www.bankofireland.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Cory Riverside Resource Recovery	2008	c.€200m (£470m between 3)	Debt	72MW	Biomass conversion technologies	United Kingdom
Centrica Lincs offshore wind	2009	c.€25m (£340m between 14)	Debt	270MW	Wind	United Kingdom
Eco Wind Corkermore Wind	2010	c.€4m (€12.1m between 3)	Debt	10MW	Wind	Ireland

FIRST-OF-A-KIND SET

N/A

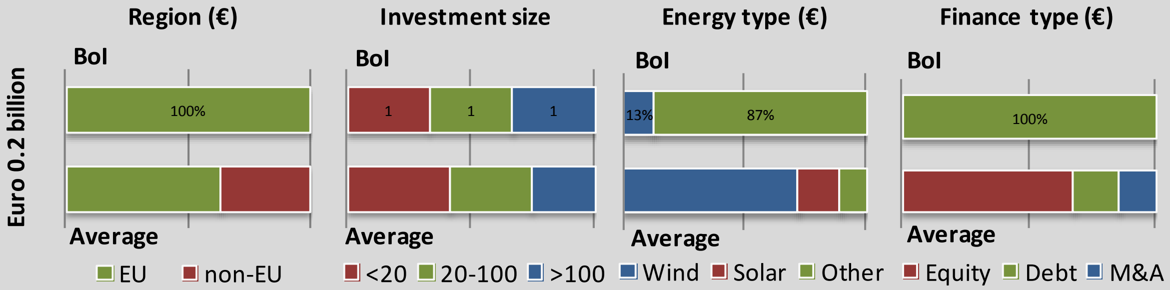
EXITS

N/A

DESCRIPTION

The Bank of Ireland Group is a traditional retail and commercial bank. It provides a diversified range of financial services, including corporate banking, treasury and international banking, business banking (including asset finance), corporate finance, retail banking, life and protection and general insurance. Its key markets are Ireland and the UK. In 2009 the Bank of Ireland received a €3.5 billion recapitalisation from Irish Government and in 2010 the European Commission approved its Restructuring Plan.

MARKET COMPARISON



Box 3.20 Caixa Geral de Depositos (CGD)

Overview:

Credit https://www.cgd.pt/

Name	**Caixa Geral de Depositos**
Type	**Corporate Bank**
HQ	**Lisbon, Portugal**
Established	**1876**
Ownership	**Public listed company**
Parent	**Portuguese Republic**
Sectors	**Energy**
SET sector	**Biomass conversion technologies; carbon capture and storage (CCS); concentrated solar power; wind**
Type	
Regional interest	**Asset finance**
Signatory to	**Portugal; Spain; USA**
	N/A

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Eolicas de Portugal (ENEOP) Wind	2009	c.€35m	Debt	480MW	Wind	Portugal
Nevada Solar One Lease	2007	c.€30m ($266m between 6)	Debt (lease)	64MW	Concentrated solar power (CSP)	USA
Parque Eólico Alto Minho I	2006	c.€80m (total €343m, assume 70% debt between 3)	Debt	240MW	Wind	Portugal

FIRST-OF-A-KIND SET

N/A

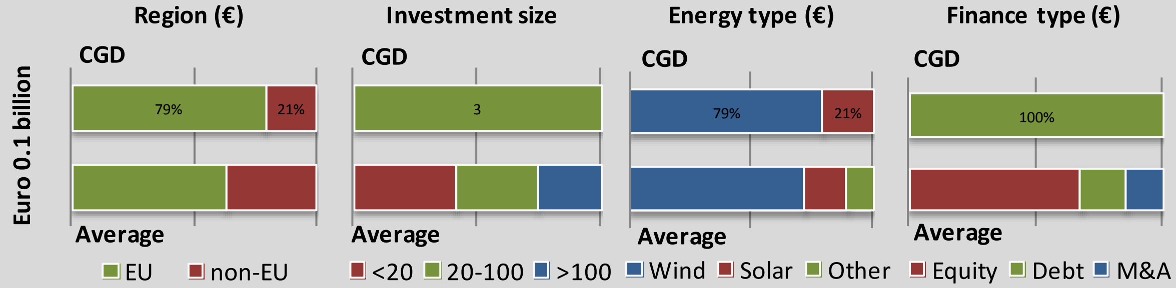
EXITS

N/A

DESCRIPTION

The CGD Group is the largest financial institution in the Portuguese financial market, and is present in 23 countries world wide in countries or territories which maintain strong cultural or commercial ties to Portugal. CGD provides commercial banking, investment banking and venture capital, asset management, specialised credit, real estate and other services. The CGD Group has over 4 million customers served by 15,896 employees and has over 100 billion Euros in assets.

MARKET COMPARISON



Box 3.21 Triodos Bank

Credit https://www.triodos.co.uk

Overview:

Name	**Triodos Bank Group**
Type	**Project Bank**
HQ	**Zeist, Netherlands**
Established	**1980**
Ownership	**Public limited company**
Parent	**N/A**
Sectors	**Clean energy focus**
SET sector	**Advanced electricity networks; ocean energy; large scale energy storage; solar photovoltaics; wind**
Type	
Regional interest	**Private equity; asset finance**
Signatory to	**UK; Netherlands; Italy; Spain; France; Germany; Ireland**
	UN Principles for Reasonable Investment
Investment focus:	

Examples:

Equity	Loans	Capital market bonds	M&A
☑	☑	☐	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Boardinghouse Wind Farm Cambridgeshire	2015	c.€10m(£15.4m equity + debt)	Equity (55% stake)	10.25MW	Wind	United Kingdom
Hainsford Energy Wansbeck Blyth Harbour Ltd	2006	c.€22m (£14.8m)	Equity: acquisition	20.05MW	Wind	United Kingdom
Ampere, Solairedirect France Portfolio	2012	c.€23m (€115m between 5)	Debt (15 year loan)	34MW	Solar PV	Ireland

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Marine Current Turbines Ltd	2007	c.€2m (£1.8m)	Equity - PE	1.2MW	Ocean	United Kingdom

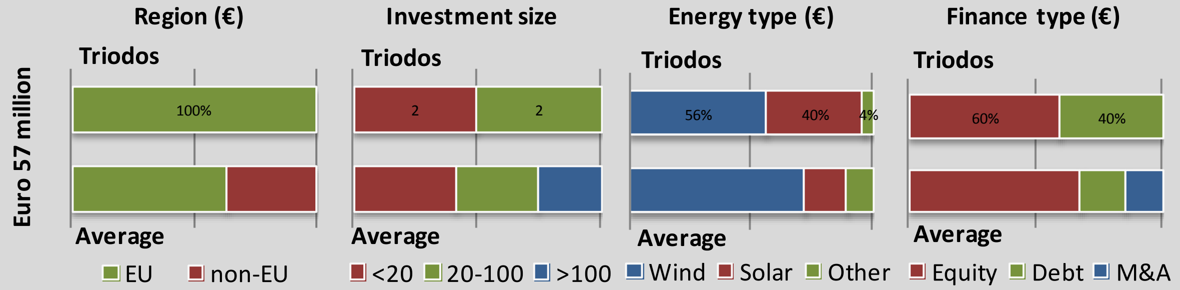
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Marine Current Turbines Ltd to Siemens	2012	2007	N/A	N/A	Ocean	United Kingdom

DESCRIPTION

Triodos Bank is one of the world's leading sustainable banks. Triodos Bank finances companies, institutions and projects that add cultural value and benefit people and the environment through its depositors and investors. Triodos Bank has banking activities in the Netherlands, Belgium, the United Kingdom, Spain and Germany. 44% of its loans are to fund environmental projects and companies. In 2014, Triodos Bank had 10.6 billion Euros in assets under management.

MARKET COMPARISON



Box 3.22 Deutsche Bank

Overview:

Name	**Deutsche Bank**
Type	**Corporate Bank**
HQ	**Frankfurt, Germany**
Established	**1870**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**General**
SET sector	**Biomass conversion technologies; solar photovoltaics; wind**
Type	**Asset finance, corporate debt, private equity M&A finance (debt only)**
Regional interest	**Germany; Italy; Spain; France; UK; Europe; Canada; USA; rest of world**
Signatory to	**N/A**

Credit https://www.db.com

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☑	☐

Examples:

NON-FIRST-OF-A-KIND SET

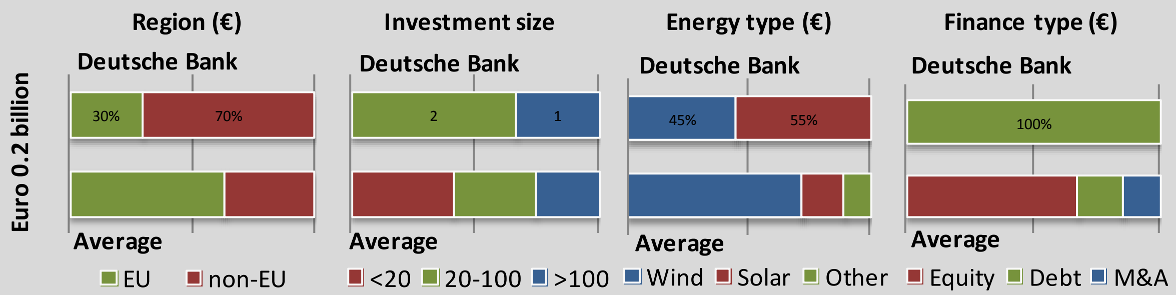
Name	Year	Value	Instrument	Scale	Sector	State
Senvion SE	2014	c.€60m (€850m between 14)	Loan (mainly guarantee)	N/A	Wind	Germany
SunEdison LLC	2014	c.€110m ($150m, $300m total)	Revolving credit	N/A	Solar PV	USA, Canada
SoWiTec Wind Farm	2015	c.€30m ($92m between 3, $144m total)	Construct-ion loan	52MW	Wind	Uruguay

FIRST-OF-A-KIND SET
N/A

EXITS
N/A

DESCRIPTION
Deutsche Bank is one of the world's leading financial service providers. In renewable energy, Deutsche Bank is one of the largest financiers. In 2014, DB provided around Euro 1 billion in capital which helped finance projects of value more than Eur 4.3bn and with a total capacity of approximately 1.8GW. In total, DB has 1.7 trillion Euro in assets and close to 100,000 employees worldwide.

MARKET COMPARISON



Box 3.23 Commerzbank AG

Overview:

Name	**Commerzbank**
Type	**Corporate Bank**
HQ	**Frankfurt, Germany**
Established	**1870**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**General**
SET sector	**Biomass conversion technologies; solar photovoltaics; wind**
Type	**Asset finance, corporate debt, private equity M&A finance (debt only)**
Regional interest	**Germany; Western Europe; USA**
Signatory to	**N/A**

Credit https://www.commerzbank.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Nordsee 1 Offshore Wind	2015	c.€84m (€840m between 10)	Term loan	332MW	Wind	Germany
Apex Clean Energy INC	2015	c.€60m ($397m between 6)	Construction loan	299MW	Wind	USA
Meerwind offshore wind farm	2013	€75m (total €1.2bn)	Term loan	288MW	Wind	Germany

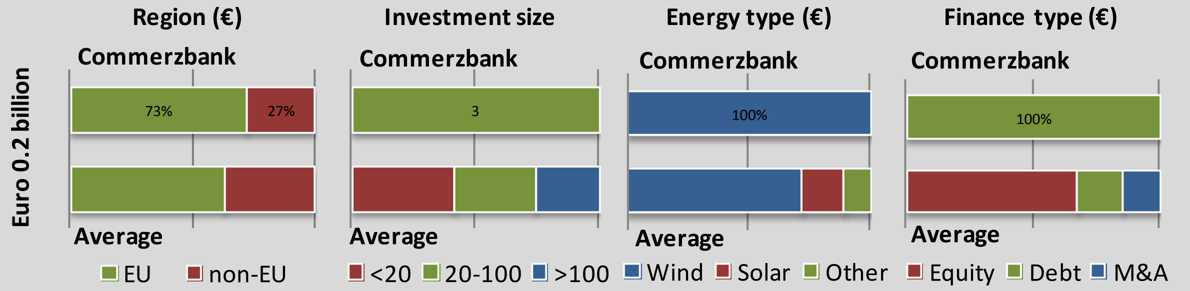
FIRST-OF-A-KIND SET

N/A

DESCRIPTION

Commerzbank is a leading international commercial bank with branches and offices in more than 50 countries. The core markets of Commerzbank are Germany and Poland. Commerzbank finances more than 30 per cent of Germany's foreign trade and is the unchallenged leader in financing for SMEs. Commerzbank has approximately 15 million private customers, as well as one million business and corporate clients with approximately 52,000 employees on average, with a balance sheet of 558 billion Euros.

MARKET COMPARISON



Box 3.24 Intesa SanPaolo

Overview:

Name	**Intesa SanPaolo**
Type	**Corporate Bank**
HQ	**Turin, Italy**
Established	**2006 (merger)**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**General**
SET sector	**Biomass conversion technologies; concentrated solar power; solar photovoltaics; wind**
Type	**Asset finance, corporate debt**
Regional interest	**Italy; rest of world**
Signatory to	**Equator Principles**

Credit http://www.intesasanpaolo.com/

Investment focus:

Examples:

Equity	Loans	Capital market bonds	M&A
☐	☑	☑	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Acciona Energia SA	2009	€20m (total €602m)	Corporate bond	149.7MW	Concentrated solar power (CSP)	Spain
ForVEI acquisition OPDE Piedmont PV	2011	€88m	Lease	c.20MW	Solar PV	Italy
SoWiTec Wind Farm	2015	c.€25m ($92m between 3)	Construct-ion loan	52MW	Wind	Uruguay

FIRST-OF-A-KIND SET

N/A

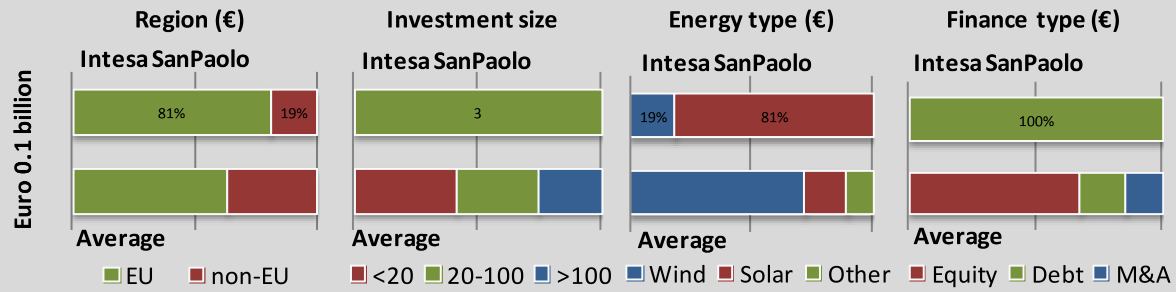
EXITS

N/A

DESCRIPTION

Intesa Sanpaolo is the banking group which was formed by the merger of Banca Intesa and Sanpaolo IMI. Intesa Sanpaolo is among the top banking groups in the euro zone, with a market capitalisation of 50.3 billion Euros. Intesa Sanpaolo is the leading banking group in Italy, with approximately 4,500 branches and 11.1 million customers.

MARKET COMPARISON



Box 3.25 Natixis SA

Overview:

Name	**Natixis**
Type	**Corporate Bank**
HQ	**Paris, France**
Established	**2006 (merger)**
Ownership	**Public listed company**
Parent	**BPCE**
Sectors	**General**
SET sector	**Biomass conversion technologies; concentrated solar power; large scale energy storage; solar PV; wind**
Type	**Asset finance, corporate debt**
Regional interest	**France; Italy; Spain; UK; Germany; Netherlands; USA; Canada; rest of world**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit https://www.natixis.com

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Nordsee 1 Offshore Wind Farm	2015	c.€84m (€840m between 10)	Term loan	332MW	Wind	Germany
Gemini Offshore Wind Farm	2014	c.€92.4m (€2.8bn total)	17 year term loan	600MW	Wind	Netherlands
Nuova Rete Solare Srl Italian PV Refinance	2011	c.€50m (€252 between 5)	18 year tenor loan	78MW	Solar PV	Italy

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Akuo Energy Bardzour PV Plant	2014	c.€11m (€34m between 3)	N/A	9MW	Solar PV and large scale energy storage	La Réunion, France
Dalkia Merritt Green Energy Project SA	2014	c.€25m ($180m between 5)	Project loan	40MW	Biomass conversion technologies	Canada

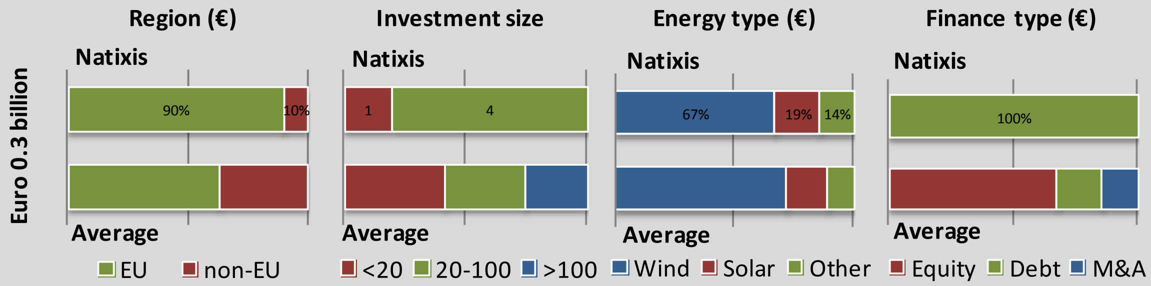
EXITS

N/A

DESCRIPTION

Natixis is the corporate, investment, insurance and financial services arm of Groupe BPCE, the second-largest banking group in France.In 2014, it had 590.4 billion Euros in assets with net revenues of 7.7 billion Euros. Natixis has 20,287 employees of which 37% are outside of France.

MARKET COMPARISON



Box 3.26 Crédit Agricole

Overview:

Name	**Crédit Agricole**
Type	**Corporate Bank**
HQ	**Paris, France**
Established	**1885**
Ownership	**Public limited company**
Parent	**N/A**
Sectors	**General**
SET sector	**Biomass conversion technologies; solar photovoltaics**
Type	**Asset finance, private equity**
Regional interest	**France; USA**
Signatory to	**Equator Principles and UN Principles for Reasonable Investment**

Credit http://www.credit-agricole.fr/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Akuo Energy SAS	2013	c.€25m (€150m between 6)	Term loan	29MW	Biomass conversion technologies	France
Biowatts Roseraie Energie Biomass Plant	2013	€58m	Lease	22MW	Biomass conversion technologies	France
EOSOL Solar plant	2011	N/A	N/A	5.1MW	Solar PV	France

FIRST-OF-A-KIND SET

N/A

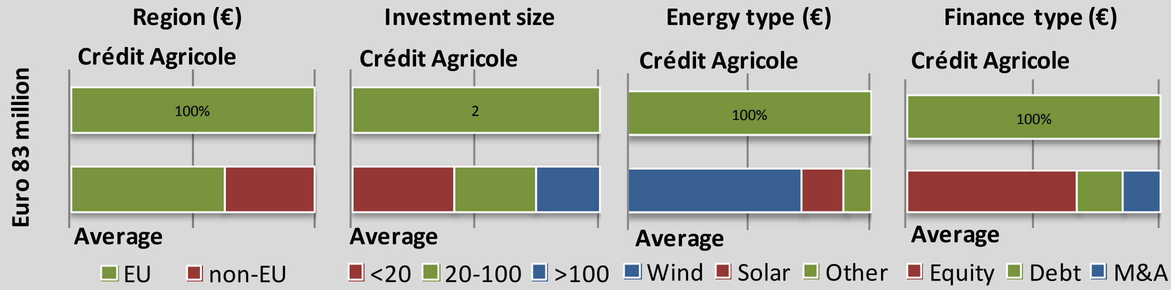
EXITS

N/A

DESCRIPTION

Crédit Agricole Group is a leading financial partner in the French economy and one of the largest banking groups in Europe built on cooperative and mutual principles. It is a leading retail bank in Europe as well as the first European asset manager, the first bancassurer in Europe and the third European player in project finance. Through its 140,000 employees and the 31,500 directors of its Local and Regional Banks, Crédit Agricole Group serves 50 million customers, 8.2 million mutual shareholders and 1.1 million individual shareholders.

MARKET COMPARISON



Box 3.27 Dexia

Overview:

Name	**Dexia N.V./S.A.**
Type	**Corporate Bank**
HQ	**Brussels, Belgium**
Established	**1996 (merger)**
Ownership	**Quoted company (5.4%)**
Parent	**Belgian state (50.2%), French state (44.4%)**

Credit http://www.dexia.com/

Sectors	**General**
SET sector	**Biomass conversion technologies; solar photovoltaics; wind**

Type	**Asset finance, private equity, M&A (debt only)**
Regional interest	**France; Germany; Spain; Italy; Belgium; UK; Greece; USA; other**
Signatory to	**N/A**

Investment focus:

	Equity	Loans	Capital market bonds	M&A
Examples:	☐	☑	☐	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Meerwind Sud und Ost Offshore Wind MW	2011	c.€90m (€822m between 9, €1.2bn total)	Debt	288MW	Wind	Germany
Silver Ridge Cellino San Marco PV Plant	2010	c.€35m (€173m between 5)	Term loan	43MW	Solar PV	Italy
Babcock & Brown Kallista French Wind Portfolio Refinancing	2008	c.€55m (€220m between 4	Term loan	164MW	Wind	France

FIRST-OF-A-KIND SET

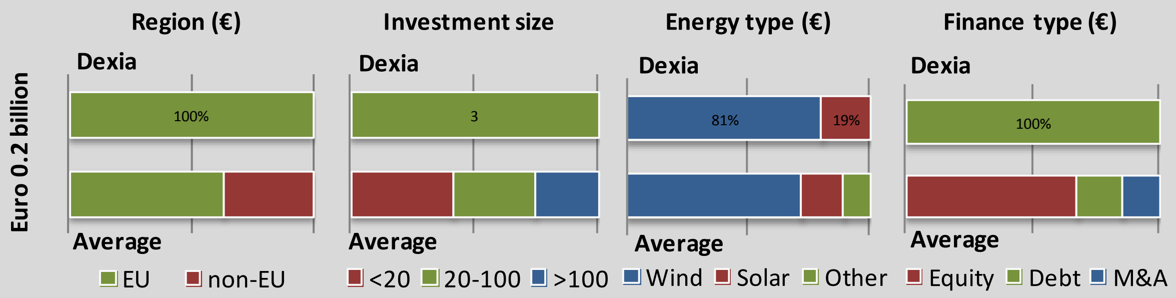
N/A

EXITS: N/A

DESCRIPTION

Dexia is a 94.4% State-owned Belgian-French banking institution managed in orderly resolution, as approved by the European Commission on 28 December 2012. Dexia has reduced the number of staff from 36,700 employees in 2008 to 1,205 employees in 2015, with a reduction in its balance sheet from 651 billion Euros to 268 billion Euros. In 2013-2014, Dexia Crédit Local was able to grant new loans up to €600 million in order to speed up the desensitisation of structured loans according to certain procedures approved by the European Commission.

MARKET COMPARISON



Box 3.28 Nord/LB

Overview:

Name	**Norddeutsche Landesbank Girozentrale**
Type	**Public bank**
HQ	**Hannover, Germany**
Established	**1970 (merger)**
Ownership	**Government owned**
Parent	**State of Lower Saxony**

Credit https://www.nordlb.com/

Sectors	**General**
SET sector	**Solar photovoltaics; wind**
Type	**Asset finance, corporate debt**
Regional interest	**Germany; France; UK; USA; Ireland Canada; rest of world**
Signatory to	**N/A**

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Wind Farms Jack's Lane & Woolley Hill	2015	c.€44m (£32m)	Debt	25MW	Wind	UK
Brandenburg-Briest PV Plant Luxcara	2012	€104m (project €200m)	Debt	90.4MW	Solar PV	Germany
Global Tech I Offshore Wind GmbH	2011	€50m (project €1bn)	Debt	400MW	Wind	Germany

FIRST-OF-A-KIND SET

N/A

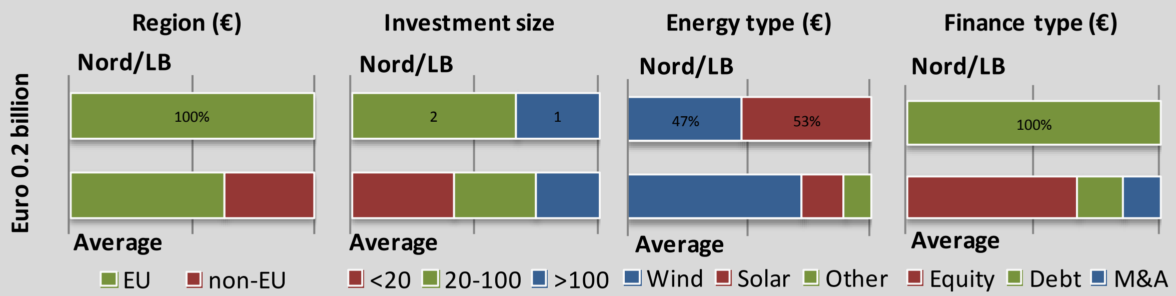
EXITS

N/A

DESCRIPTION

NORD/LB is a leading universal bank in the north of Germany. As the Landesbank of Lower Saxony and Saxony-Anhalt, it supports the public sector in municipal financing and assumes the responsibilities of a central bank for the savings banks in these two states as well as Mecklenburg-Western Pomerania. NORD/LB is a market leader in northern Germany for private customers as well as small and medium-sized businesses with roughly 1 million customers. Since the beginning of the 1990s, NORD/LB has done business as a financer in the energy sector and is considered one of the pioneers of wind power financing. Furthermore, biomass and solar energy (photovoltaic) have been the focus of its business activities. As of March 2015, NORD/LB had over 200 billion Euros in assets.

MARKET COMPARISON



3.4 Market Participant Description Sheets for GENERAL INVESTORS

Box 3.29 Industrifonden

Overview:

Name	**Industrifonden**
Type	**Foundation**
HQ	**Stockholm; Sweden**
Established	**1979**
Ownership	**Private limited company**
Parent	**N/A**

Credit http://www.industrifonden.se/

Sectors	**Life science; technology**
SET sector	**Advanced electricity networks; large scale energy storage; solar photovoltaics; wind**

Type	**Private equity**
Regional interest	**Sweden**
Signatory to	**N/A**

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
SEEC - Borehole Thermal Energy Storage Systems	2011	c.€0.55m (5m SEK)	Equity	N/A	Large scale energy storage	Sweden

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Flexenclosure AB	2008	€0.9m	Equity	N/A	Advanced electricity networks	Sweden
Sol Voltaics AB	2011, 2013	€2.1m + <€1m (€6m between 6)	Equity	N/A	Solar PV	Sweden
TranSiC	2008	c.€1.4m (13m SEK)	Equity	R&D stage	Advanced electricity networks	Sweden

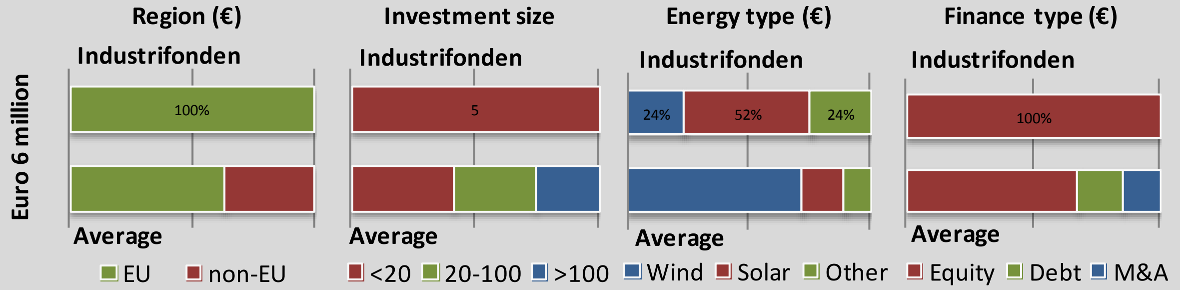
EXITS

N/A

DESCRIPTION

Established in 1979 as a foundation by the Swedish government, Industrifonden invests in small and medium-sized Swedish growth companies. It works on a commercial basis in partnership with entrepreneurs and other investors to generate a return and to strengthen the Swedish venture capital market. Industrifonden investment per company ranges between 0.55 and 11 million Euros (SEK 5 and 100 million) between 5 and 15 years. In total, Industrifonden holds 420 million Euros (SEK 3.8bn) of investments in companies.

MARKET COMPARISON



Box 3.30 Euler Hermes

Overview:

Name	**Euler Hermes**
Type	**Insurance**
HQ	**Paris, France**
Established	**1927**
Ownership	**Public listed company**
Parent	**Allianz SE**
Sectors	**Export**
SET sector	**Concentrated solar power; wind**
Type	**Asset finance (credit insurance and export credit)**
Regional interest	**Turkey; Spain; South Africa; Netherlands; Belgium; Taiwan**
Signatory to	**N/A**

Credit http://www.eulerhermes.com

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Gemini Offshore Wind Farm	2014	€350m (€2.8 bn total)	Credit insurance	600MW	Wind	Netherlands
Novatec Biosol	2009	€90m (project: €120m)	Export credit	30MW	Concentrated solar power (CSP)	Spain
Fina Enerji Utopya, Duzova, Samandag Wind Farm	2012	€41.3m	Credit insurance	80.3MW	Wind	Turkey

FIRST-OF-A-KIND SET

N/A

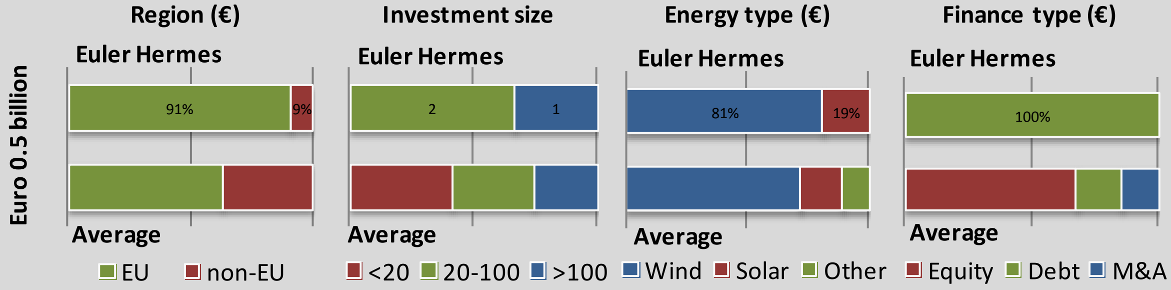
EXITS

N/A

DESCRIPTION

Euler Hermes is a world-leading provider of trade-related credit insurance solutions with more than 100 years of client support and responsiveness to changing business environments. It is backed by Allianz, one of the leading financial services providers worldwide. Euler Hermes serves over 52,000 customers, has over 6,000 employees and €789bn of business transactions protected world wide.

MARKET COMPARISON



Box 3.31 Allianz

Overview:

Name	**Allianz**
Type	**Insurance / Asset Management**
HQ	**Munich, Germany**
Established	**1890**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**General**
SET sector	**Solar photovoltaics; wind**
Type	**Asset finance**
Regional interest	**Germany; Italy; France**
Signatory to	**UN Principles for Reasonable Investment**

Credit https://www.allianz.com

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

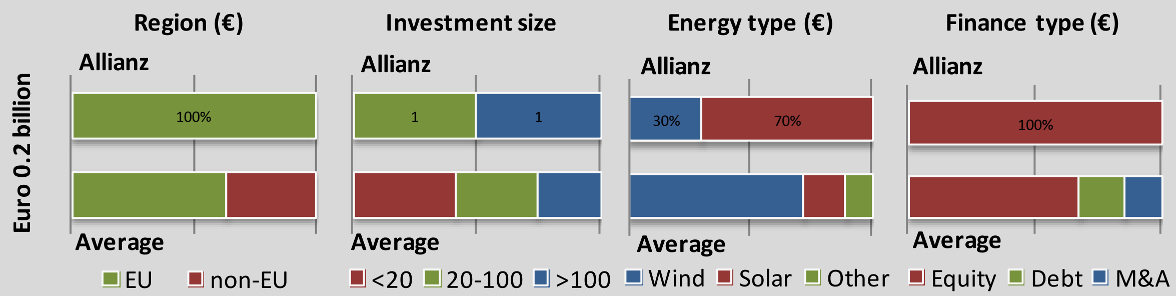
Name	Year	Value	Instrument	Scale	Sector	State
Prottlin Wind Farm from Denker & Wulf	2008	c.€65m ($100.4m)	Equity (balance sheet)	20MW	Wind	Germany
La Coste PV Portfolia from BayWa	2014	c.€150m	Equity (balance sheet)	58MW	Solar PV	France
Calau II C/D	2014	N/A	Equity (balance sheet)	30.8MW	Wind	Germany

FIRST-OF-A-KIND SET
N/A

EXITS
N/A

DESCRIPTION
The Allianz Group is a global financial services provider. Allianz is a leading property and casualty insurer globally, top 5 in life insurance business globally, a worldwide leader in credit insurance and one of the leading asset managers globally. Allianz has 85 million retail and corporate clients in more than 70 countries. In fiscal year 2014 Alliaz had over 147,000 employees worldwide, achieved total revenues of 122.3 billion euros and an operating profit of 10.4 billion euros.

MARKET COMPARISON



Box 3.32 AIG

Overview:

Name	**AIG**
Type	**Insurance / Asset management**
HQ	**New York, USA**
Established	**1996**
Ownership	**Public listed company**
Parent	**America International Group, Inc.**
Sectors	**General**
SET sector	**Solar photovoltaics; wind**
Type	**Private equity**
Regional interest	**USA; Canada; UK; Germany**
Signatory to	**N/A**

Credit http://www.aig.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Sulfurcell	2008	c.€5m (€49m between 11)	Equity	75MW	Solar PV	Germany

FIRST-OF-A-KIND SET

N/A

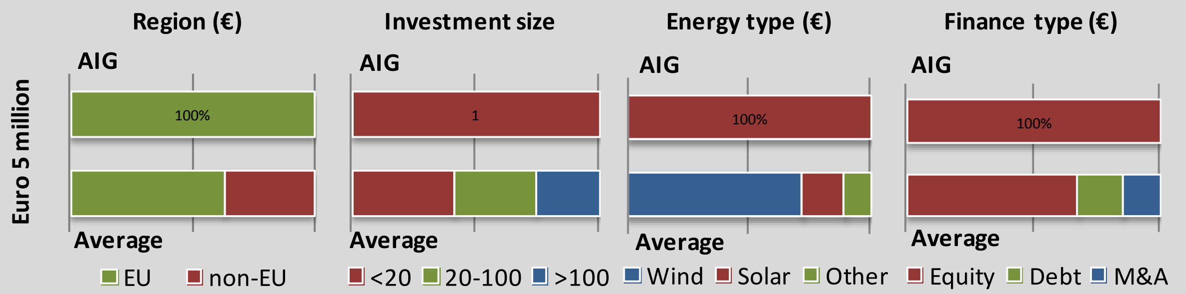
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Spain Solar PV Portfolio	2009	N/A	c.€370m ($405m)	N/A	Solar PV	Spain
Staton Wind LLC	2009	N/A	c.€90m (42.5% $240m)	N/A	Wind	USA

DESCRIPTION

American International Group, Inc. (AIG) is a leading international insurance organization serving customers in more than 100 countries and jurisdictions. AIG companies serve commercial, institutional, and individual customers through one of the most extensive worldwide property-casualty networks of any insurer. In addition, AIG companies are leading providers of life insurance and retirement services in the USA.

MARKET COMPARISON



Box 3.33 La Caisse

Overview:

Name	**Caisse de dépôt et placement du Québec**
Type	**Pension fund**
HQ	**Québec, Canada**
Established	**1965**
Ownership	**Private limited partnership**
Parent	**N/A**

Credit https://www.lacaisse.com/en

Sectors	**General**
SET sector	**Large scale energy storage; solar photovoltaics; wind**
Type	**Private equity; public market equity; acquisitions; asset finance; corporate debt**
Regional interest	**Canada, USA, UK, Germany**
Signatory to	**UN Principles for Reasonable Investment**

	Equity	Loans	Capital market bonds	M&A
Investment focus:	☑	☑	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
London Array Offshore Wind Farm from DONG	2014	c.€750m (£644m)	Equity (25% stake)	630MW	Wind	United Kingdom
Vents du Kempt Wind Farm	2013	c.€65m ($50m)	Senior debt	101.2MW	Wind	Canada
Invenergy Wind LLC (Wind Farms USA/Canada)	2013	c.€375m ($500m)	Equity	1.5GW	Wind	USA Canada

FIRST-OF-A-KIND SET

N/A

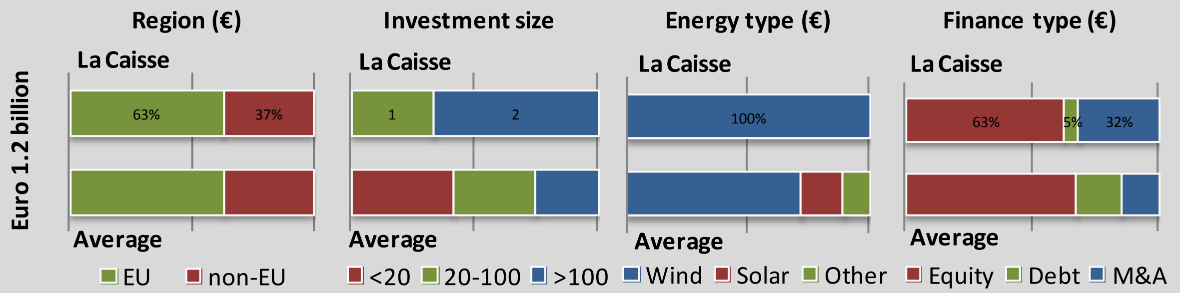
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
H20 Power LP to BluEarth Renewables	2011	2007	c.€120 (25% of $640m)	N/A	Large scale energy storage	Canada

DESCRIPTION

La Caisse de dépôt et placement du Québec is a long-term institutional investor that manages funds primarily for public and parapublic pension and insurance plans. As one of Canada's leading institutional fund managers, La Caisse invests in major financial markets, private equity, infrastructure and real estate, globally.

MARKET COMPARISON



Box 3.34 PensionDanmark

Overview:

Name	**PensionDanmark**
Type	**Pension fund**
HQ	**Copenhagen, Denmark**
Established	**1993**
Ownership	**Non-profit**
Parent	**N/A**
Sectors	**General**
SET sector	**Biomass conversion technologies; wind**
Type	**Asset finance**
Regional interest	**Denmark; UK; USA; Belgium; Sweden**
Signatory to	**N/A**

PensionDanmark

Credit https://www.pension.dk/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Rodsand I Nysted Offshore Wind Farm	2010	c.€95m (700m DKK)	Equity (50% ownership)	165.6MW	Wind	Denmark
Northwind Offshore Wind Farm	2012	c.€35m (260m DKK)	Loan	216MW	Wind	Belgium
Cape Wind Nantucket Sound Offshore Wind Farm	2013	c.€150m ($200m, $2.6bn in total)	Mezzanine (loan)	468MW	Wind	USA

FIRST-OF-A-KIND SET

N/A

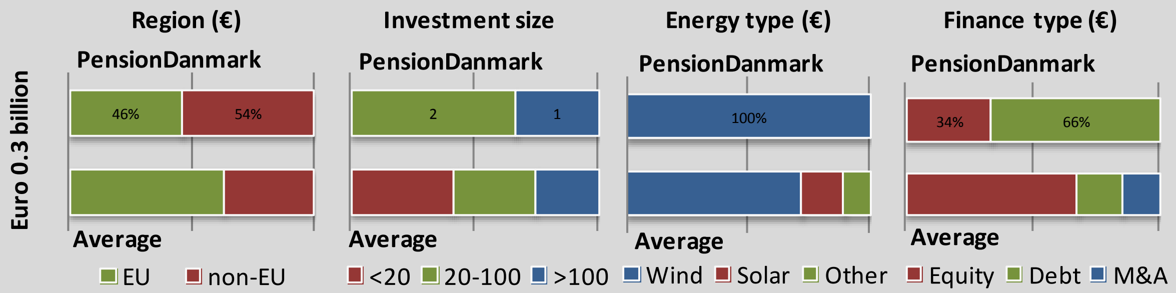
EXITS

N/A

DESCRIPTION

PensionDanmark is a not-for-profit labour market pension fund established in 1993. It offers defined contribution pension, insurance and health care products on the basis of collective agreements covering more than 660,000 individuals employed in more than 24,000 companies within the private and public sector. In 2014, premiums of 1.7 billion euros (DKK12,489m) made PensionDanmark the fourth largest pension company in Denmark. Assets under management were 23 billion Euros (DKK 171bn) at the end of 2014.

MARKET COMPARISON



Box 3.35 Industriens Pension

Overview:

Name	**Industriens Pensionsforsikring A/S**
Type	**Pension fund**
HQ	**Copenhagen, Denmark**
Established	**1993**
Ownership	**Private limited company**
Parent	**N/A**
Sectors	**General**
SET sector	**Wind**
Type	**Asset finance**
Regional interest	**Germany**
Signatory to	**N/A**

Credit https://www.industrienspension.dk

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Butendiek Offshore Wind Farm (WPD AG)	2013	€100m (c.€460 between 5)	Equity	288MW	Wind	Germany
Gode Wind II PKA Acquisition from DONG	2014	€126m (10.5% of €1.2bn)	Equity	252MW	Wind	Germany

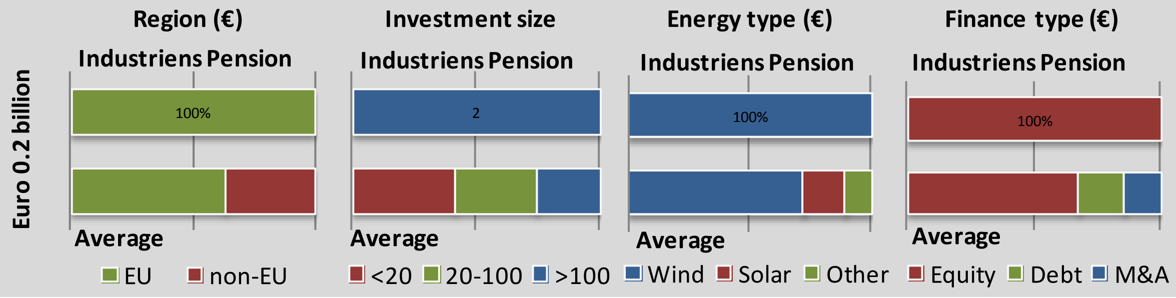
FIRST-OF-A-KIND SET

N/A

DESCRIPTION

Industriens Pension administrates the labour market pension scheme for the employees under the Collective Bargaining Agreement for industrial employees. Industriens Pension has currently around 400,000 members in approximately 8,000 companies and holds 17.2 billion Euros (DKK 128bn) in total assets under management.

MARKET COMPARISON



Box 3.36 PFA

Overview:

Name	**PFA Pension**
Type	**Pension fund**
HQ	**Copenhagen, Denmark**
Established	**1917**
Ownership	**Private limited company**
Parent	**PFA Holding A/S**
Sectors	**General**
SET sector	**Wind**
Type	**Private equity; asset finance**
Regional interest	**Denmark, UK**
Signatory to	**N/A**

Credit pfa.dk

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
DONG Energy	2013	c.€100m (DKK 800m of 11bn)	Equity (1.8%)	2.5GW	Wind	Denmark
Danish onshore wind business from DONG	2013	c.€50m (DKK 760m between 2)	Equity	196MW	Wind	Denmark
Bord Gais Lisheen Wind Farm	2012	c.€30m (240m DKK)	Loan (export)	24MW	Wind	UK

FIRST-OF-A-KIND SET

N/A

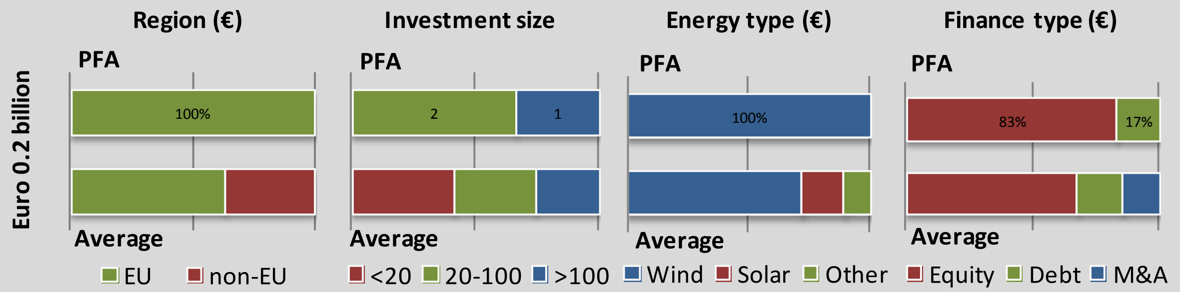
EXITS

N/A

DESCRIPTION

PFA is one of Denmark's largest financial companies and provides pension and insurance cover to about 500,000 individual customers. In 2014, PFA had 74 billion Euros (DKK 550bn) in assets.

MARKET COMPARISON



Box 3.37 PGGM

Overview:

Name	**PGGM**
Type	**Pension fund**
HQ	**Zeist, Netherlands**
Established	**1969**
Ownership	**Private limited company**
Parent	**PFZW, ABP (major investors)**
Sectors	**General**
SET sector	**Biomass conversion technologies; wind**
Type	**Private equity; asset finance**
Regional interest	**Mexico, UK, rest of Europe**
Signatory to	**UN Principles for Reasonable Investment**

Credit https://www.pggm.nl

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Walney offshore wind from DONG	2010	c.€10m (£16m between 2)	Equity (24.8% £1bn project)	367MW	Wind	UK
Marena Revonables	2012	c.€65m (33.75% of MXN3.4bn)	Equity	396MW	Wind	Mexico
Evelop International Ampere Equity Fund	2007	€100m	Equity	N/A	Various	Europe

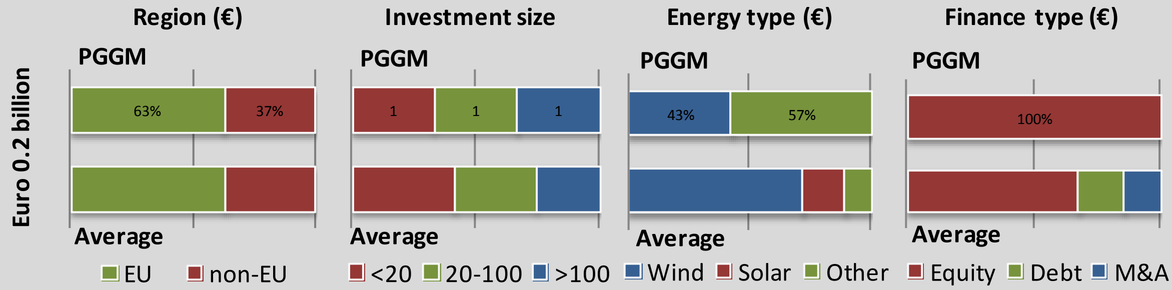
FIRST-OF-A-KIND SET

N/A

DESCRIPTION

PGGM is a pension fund service provider and manages the pensions for different pension funds, the affiliated employers and their employees. Currently, PGGM manages pension assets worth in excess of approximately EUR 188.7 billion.

MARKET COMPARISON



3.5 Market Participant Description Sheets for PRODUCERS

Box 3.38 Centrica

Overview:

Name	**Centrica**
Type	**Utility**
HQ	**Windsor, United Kingdom**
Established	**2006 (merger, prior 1997)**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Energy (distribution, production)**
SET sector	**Biomass conversion technologies; carbon capture and storage (CCS); solar photovoltaics; wind**
Type	**Asset finance; mergers and acquisitions**
Regional interest	**UK**
Signatory to	**N/A**

Credit http://www.centrica.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Braes of Doune Wind Farm	2007	c.€60m (£42m)	Equity	72MW	Wind	UK
Solar Technologies Group	2008	c.€3.5m (£2.8m)	M&A	N/A	Solar PV	UK
Toyota Motor Burnaston PV Plant	2011	c.€12m (£10m)	Equity	4MW	Solar PV	UK

FIRST-OF-A-KIND SET

N/A

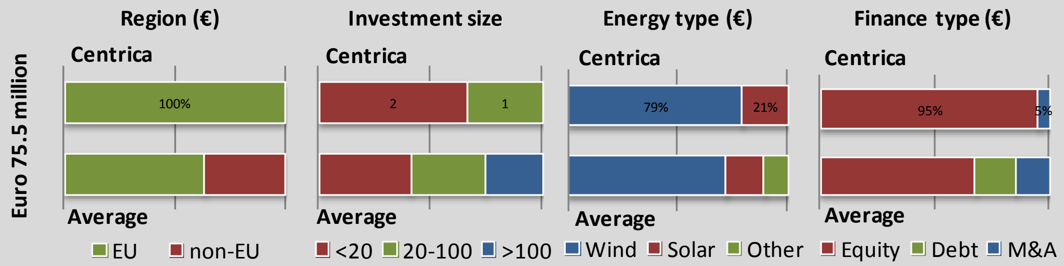
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Braes of Doune Wind Farm	2013	2007	c.€70m (£59m)	ROI: 12.2% Multiple: 2.0x	Wind	UK
Burnaston PV Plant to Bluefield Solar	2013	2011	N/A	N/A	Solar PV	UK
BOW Barrow Offshore Wind Farm Dong acquisition III	2014	2006	c.€60m (£50m)	ROI: -1% Multiple:0.9x	Wind	UK

DESCRIPTION

Centrica is an international downstream and upstream energy company with a focus on the UK. Its main brands are British Gas, Bord Gáis Energy, Direct Energy, Centrica Energy and Centrica Storage. In addition to its main UK market, Centrica operates in Ireland, Europe, North America and Trinidad.

MARKET COMPARISON



Box 3.39 ENGIE

Overview:

Name	**ENGIE (former GDF Suez)**
Type	**Utility**
HQ	**Courbevoie, France**
Established	**2008 (predecessor 1858)**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Energy (distribution, production)**
SET sector	**Advanced electricity networks; biomass conversion technologies; carbon capture and storage (CCS); geothermal energy; large scale energy storage; solar photovoltaics; wind**
Type	**Asset finance; mergers and acquisitions**
Regional interest	**France; United Kingdom; Poland; Canada; USA; Netherlands; Indonesia; Singapore; Australia; Vanuatu; Chile; South Africa**
Signatory to	**N/A**

Credit http://www.gdfsuez.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Polaniec Biomass Plant	2010	c.€210m ($290m)	Equity	205MW	Biomass conversion technologies	Poland
Announced - Supreme Rantau Dedap Geothermal Project	2010	c.€150m (<$700m between 3)	Equity	220MW	Geothermal	Indonesia
Caribou Wind Park	2009	c.€130m (CND $200m)	Equity	99MW	Wind	Canada

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Renewable energy integration demonstration micro-grid	2014	c.€0.5m (minor role in $8m total)	N/A	N/A	Advanced electricity networks	Singapore
Green Lys	2014	c.€6m (€40m between 5, €9.6m govt finance)	N/A	N/A	Advanced electricity networks	France

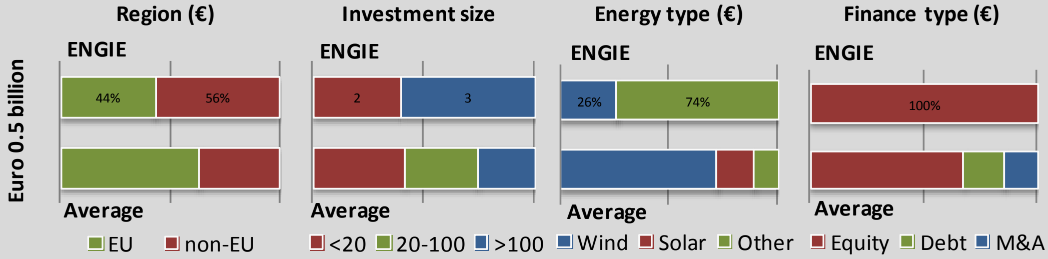
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Canadian renewable energy portfolio	2012	N/A	c.€850m (CND $1.1bn)	N/A	Wind	Canada
Announced - Futures Energies Investissement Holding	2013	N/A	€400m	N/A	Wind	France
UK renewable energy portfolio	2014	N/A	N/A	N/A	Wind	United Kingdom

DESCRIPTION

ENGIE is a global energy player and operator in the three key sectors of electricity, natural gas and energy services. ENGIE employs 152,900 people worldwide and achieved revenues of 74.7 billion Euros in 2014.

MARKET COMPARISON



Box 3.40 RWE

Overview:

Name	**RWE Innogy GmbH**
Type	**Utility**
HQ	**Essen, Germany**
Established	**2008**
Ownership	**Private limited company**
Parent	**RWE AG**
Sectors	**Clean energy**
SET sector	**Biomass conversion technologies; solar photovoltaics; wind; ocean energy**
Type	**Asset finance; private equity**
Regional interest	**Europe (focus on Germany)**
Signatory to	**N/A**

Credit http://www.rwe.com/web/cms/en/86134/rwe-innogy/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Announced - Juist ENOVA Nordsee One,2,&3	2008	c.€840m (30% equity* €2.8bn total)	Equity (Asset)	1000MW	Wind	Germany
Nordsee Ost Offshore Wind Farm	2009	€1bn	Equity (Asset)	295MW	Wind	Germany
Markich Biomass Plant	2010	c.€230m (£200m)	Asset Finance	65MW	Biomass conversion technologies	United Kingdom

*based on the debt / equity structure of Norsee 1

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Topell	2010	€15m	Equity (50% stake)	N/A	Biomass conversion technologies	Netherlands
Heliatek	2009	c.€2m (€18m between 8)	Equity	N/A	Solar PV	Germany
Quiet Revolution Ltd	2008	€7.5m	Equity	6kW	Wind	United Kingdom

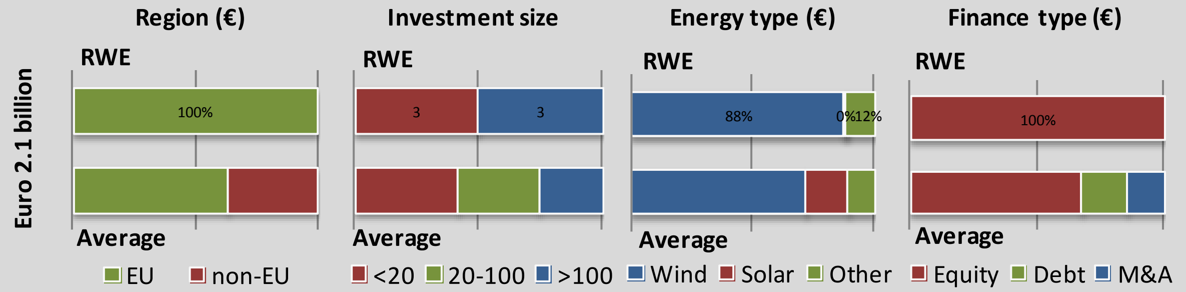
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Gwynt y Mor Offshore Wind Farm to GIB	2014	2010	c.€275m (£220m 10 % stake)	N/A	Wind	United Kingdom
Voith Hydro Ocean Current Technologies	2013	2009	c.€5m	N/A	Ocean energy	Germany
Nordsee One to Northland Power	2014	2008	€306m (85%*30% €1.2bn)	N/A	Wind	Germany

DESCRIPTION

RWE is one of Europe's five leading electricity and gas companies. RWE activities are in in lignite production, in electricity generation from gas, coal, nuclear and renewables, and in energy trading as well as electricity and gas distribution and supply, RWE is active at all stages of the energy value chain. Around 60,000 employees supply over 16 million electricity customers and 7 million gas customers with energy, both reliably and at fair prices. In fiscal 2014, RWE recorded approximately 48 billion Euros in revenue.

MARKET COMPARISON



Box 3.41 Dong Energy

Overview:

Name	**DONG Energy**
Type	**Utility**
HQ	**Skaerbeak, Denmark**
Established	**2006 (merger, active since 1972)**
Ownership	**Majority government owned**
Parent	**Kingdom of Denmark**
Sectors	**Energy (generation and distribution)**
SET sector	**Advanced electricity networks; biomass conversion technologies; carbon capture and storage (CCS); wind**
Type	**Asset finance; mergers and acquisitions**
Regional interest	**Denmark; UK; Germany; Poland; Norway; Spain; Ireland; Greece; Sweden**
Signatory to	**N/A**

Credit http://www.dongenergy.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Westermost Rough Offshore Wind	2013	c.€1bn (£800m)	Equity	210MW	Wind	United Kingdom
Lincs offshore wind farm	2013	c.€200m (25% £725m)	Equity	270MW	Wind	United Kingdom
Borkum Riffgrund 1	2011	€1.25bn	Equity	320MW	Wind	Germany

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Cancelled - Hunterston CCS Demonstration	2008	N/A	Equity	1852MW	Carbon capture and storage	United Kingdom
PowerSense	2006	N/A	Equity	N/A	Advanced electricity networks	Denmark
Kalundborg Bioethanol Demonstration Plant	2009	€34.6m (€54m minus grants €10.3 and €9.1)	Equity	N/A	Biomass conversion technologies	Denmark
Pyroneer Demonstration plant at Asnæs	2011	N/A	Equity	6MW	Biomass conversion technologies	Denmark
Frederikshavn demonstration project	2014	c.€32.5m ($45m)	Equity	48MW	Wind	Denmark

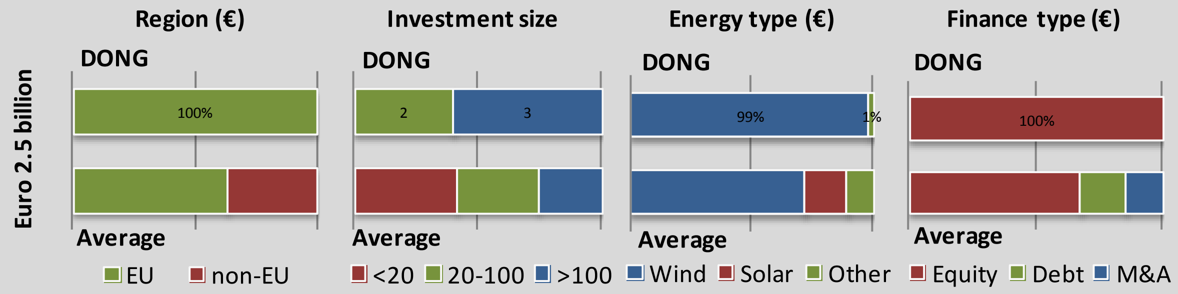
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
PowerSense to Landis+Gyr AG	2014	2006	N/A	N/A	Advanced electricity networks	Denmark
E ON Renovables Iberia	2007	N/A	€722m	N/A	Wind	Spain
Kraftgarden AB to EPV Energia Oy	2013	N/A	€523m	N/A	Large scale energy storage	Sweden
Borkum Riffgrund 1	2012	2011	c.€630m (DKr4.7bn for 50%)	Multiple: c. 1.0x	Wind	Germany

DESCRIPTION

DONG Energy is one of the leading energy groups in Northern Europe. DONG explores and produces oil and natural gas, generates electricity and heat from its offshore wind farms and power stations, and supplies energy to residential and business customers. Dong has 6,500 employees in 10 countries and approximately 9.0 billion Euros in revenue. DONG can supply 6 million Europeans with electricity from its offshore wind farms.

MARKET COMPARISON



Box 3.42 E.on

Overview:

Name	**E.on**
Type	**Utility**
HQ	**Dusseldorf, Germany**
Established	**2000 (merger)**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Energy**
SET sector	**Biomass conversion technologies; concentrated solar power; carbon capture and storage (CCS); large scale energy storage; solar photovoltaics; wind**
Type	**Mergers and acquisitions; asset finance**
Regional interest	**Europe; USA; Brazil; Turkey**
Signatory to	**N/A**

Credit https://www.eonenergy.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☑	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Abengoa Solar	2009	€275m (€550m between 2)	Equity (balance sheet)	100MW	Concentrated solar power (CSP)	Spain
Endessa Europa SA	2008	€11.5bn*	Cash & corporate debt	12.2GW	Wind (part)	Italy (and France)
Enerjisa Enerji AS	2013	€1.5bn	M&A (asset swap)	1.7GW	Large scale energy storage; wind	Turkey

**Not exclusive renewable energy generation and excluded from market participant overview*

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Falkenhagen Wind to hydrogen pilot plant	2011	€5m	Equity (balance sheet)	360m³ p.h.	Large scale energy storage	Germany
Subsea trenching Humber Gateway wind farm	2015	c.€5m (GBP multi million)	Equity (balance sheet)	N/A	Wind	United Kingdom

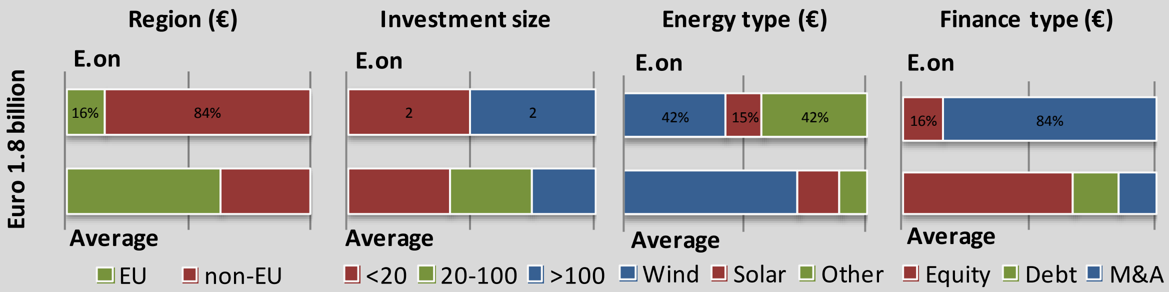
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Rödsand II Offshore Wind Farm to SEAS-NVE	2013	2010	c.€430m (total €470m)	N/A	Wind	Denmark
US wind portfolio to Enbridge	2014	2012	c.€520m ($650m)	N/A	Wind	USA
US wind farms to PensionDanmark	2012	2009	c.€300m (USD several hundred million)	N/A	Wind	USA

DESCRIPTION

E.ON is one of the world's largest investor-owned power and gas companies, with annual sales of 122 billion Euros and more than 62,000 employees. E.ON, headquartered in Dusseldorf, Germany, plays a leading role in the development of the renewable industry worldwide and is already active in onshore and offshore wind, photovoltaic, and concentrated solar power (CSP). E.ON currently operates over 10 gigawatt of renewable capacity including large hydro. Since 2007, E.ON has already invested more than 9.5 billion Euros and intends to continue expanding the share of renewable energy in E.ON's power generation portfolio.

MARKET COMPARISON



Box 3.43 General Electric (GE)

Overview:

Name	**General Electric**
Type	**Industrial conglomerate**
HQ	**Fairfield, USA**
Established	**1892**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Technology manufacturing and financial services**
SET sector	**Advanced electricity networks; biomass conversion technologies; large scale energy storage; solar photovoltaics; wind**
Type	**Private equity; mergers and acquisitions; asset finance (equity and debt)**
Regional interest	**North America; Europe; India; China**
Signatory to	**N/A**

Credit http://www.ge.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Iberdola SA France Wind Farm	2012	€140m (€350m between 3)	M&A	321.4 MW	Wind	France / Spain
Su Scioffu PV Plant	2011	c.€40m ($58m)	Equity (asset financed)	20MW	Solar PV	Italy
Trilliant Networks Inc	2010	c.€10m ($106m between 8)	Equity (VC / PE investment)	N/A	Advanced electricity networks	USA

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Oregon Solar Highway Demonstration Project	2008	c.€0.5m (with U.S. Department of Transport)	N/A	0.1 MW	Solar PV	USA
Danotek permanent magnet generators	2011	c.€2.5m ($15m between 4+)	Equity	N/A	Wind	USA

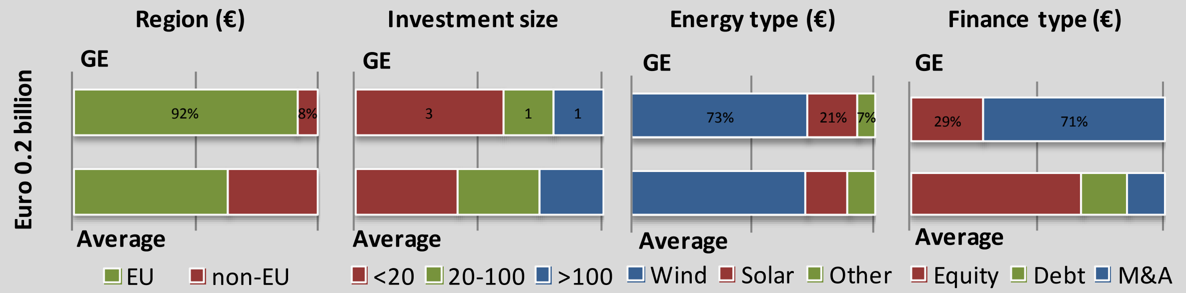
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Theolia	2008	2007	c.€20m	ROI: -55% Multiple: 0.2x	Wind	France
Newark crystalline silicon module assembly plant	2009	2004	$4.5m	N/A	Solar PV	USA

DESCRIPTION

GE's energy investing business is GE Energy Financial Services. GE Financial Services offers expertise for essential, long-lived and capital-intensive power, oil and gas infrastructure, GE's core business. GE Energy Financial Services holds approximately 12 billion Euros ($16bn) in assets.

MARKET COMPARISON



Box 3.44 Cargill

Overview:

Name	**Cargill Environmental Finance**
Type	**Industrial / Conglomerate**
HQ	**Minneapolis, USA**
Established	**1972**
Ownership	**Private limited company**
Parent	**N/A**
Sectors	**Agriculture**
SET sector	**Biomass conversion technologies; wind**
Type	**Asset finance**
Regional interest	**USA; Canada; Brazil; rest of world**
Signatory to	**N/A**

Credit http://www.cargill.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Announced – High River Waste-to-Energy plant	2011	c.€25m (CAD 36m + 10m from Gov't)	Equity (balance sheet)	1.4MW	Biomass conversion technologies	Canada
Bettencourt Dairy B6 Farm II	2010	N/A	Equity	2.1MW	Biomass conversion technologies	USA
PT Budi Acid Jaya	2007	c.€2m ($3m)	Equity (asset financed)	5MW	Biomass conversion technologies	Indonesia

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Bettencourt Dairy Farm I	2007	c.€6m (c.$8.5m)	Equity	2.4MW	Biomass conversion technologies	USA

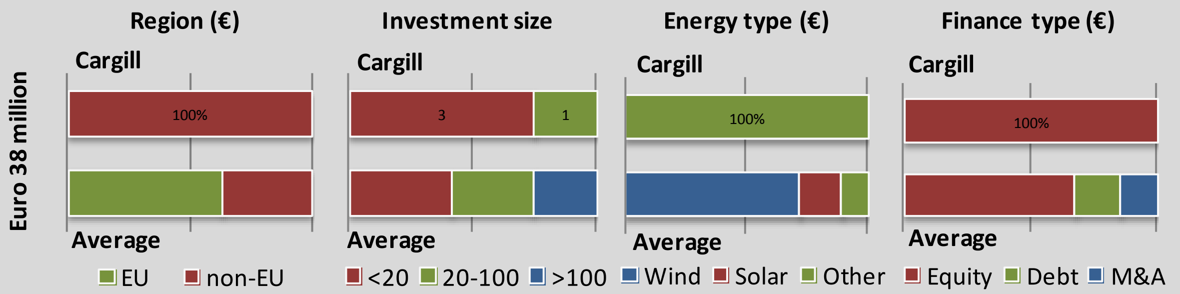
EXITS

N/A

DESCRIPTION

Cargill is among the largest companies in the agricultural sector with a very substantial financial arm and considerable share of employment (14%) and revenues (18%) in Europe. With 102 billion Euros ($134.9bn) in global revenues, its circa 18.5 billion Euros annual revenue in Europe makes it a large European player from the industry with over 20,000 employees. Cargill is active in 22 European countries and is the sixth largest company in Switzerland with over 25 billion Euros (over CHF 30bn) in sales, provding a diverse trading portfolio in energy, grains and oilseeds production, distribution, transportation, structured finance and risk.

MARKET COMPARISON



Box 3.45 Honeywell International

Overview:

Name	**Honeywell International Inc.**
Type	**Industrial**
HQ	**New Jersey, USA**
Established	**1906**
Ownership	**Public Limited Company**
Parent	**N/A**

Credit http://honeywell.com/

Sectors	**Technology and manufacturing**
SET sector	**Advanced electricity networks, solar photovoltaics**

Type	**Mergers and acquisitions**
Regional interest	**USA; China; Switzerland; UK**
Signatory to	**N/A**

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Saia-Burgess Controls AG	2012	€100m ($130m)	M&A 100% stake	N/A	Advanced electricity networks	Switzerland
E-MON LLC	2010	N/A	M&A 100% stake	N/A	Advanced electricity networks	USA
Cancelled: Ningxia Yinxing Energy PV equipment manufacturing	2010	c.€1m ($1.1m)	M&A 25% stake	2.4MW+ turbines	Solar PV	China

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Akuacom	2010	N/A	M&A 100% stake	N/A	Advanced electricity networks	USA

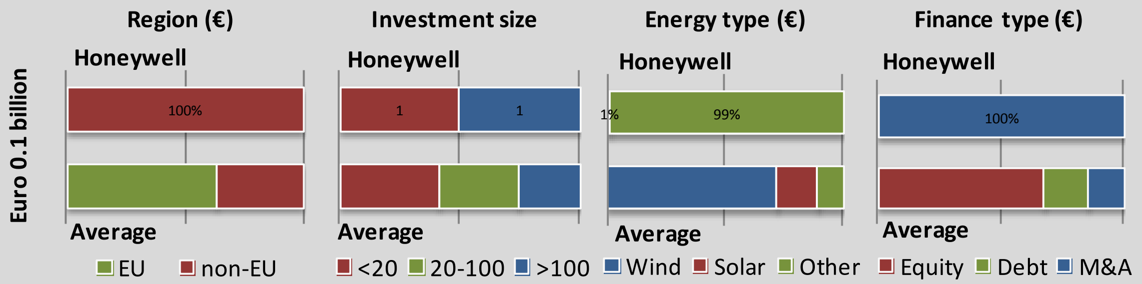
EXITS

N/A

DESCRIPTION

Honeywell creates energy solutions with nearly 50% of its products linked to energy efficiency. Honeywell has principal research and development activities in four locations across Europe and the European market accounts for a quarter of its 30 billion Euros ($40bn) in sales. The company has more than 127,000 employees worldwide, including 22,000 engineers and scientists.

MARKET COMPARISON



Box 3.46 Metso

Overview:

Name	**Metso**
Type	**Industrial**
HQ	**Helsinki, Finland**
Established	**1999**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Mining, aggregates, oil & gas, pulp and paper, recycling**
SET sector	**Biomass conversion technologies; carbon capture and storage (CCS)**
Type	**Mergers and acquisition; asset finance**
Regional interest	**Finland, Netherlands, France**
Signatory to	**N/A**

Credit http://www.metso.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Eneco Delfzijl Biomass Plants	2011	c€52m (third of €155m)	Equity (asset financed)	49MW	Biomass conversion technologies	Netherlands
MW Power Oy	2012	N/A	M&A	1-500MW boilers	Biomass conversion technologies	Finland

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Metso-Fortum Tempere CCS Pilot Plant	2009	c.€2m (c.€5m total)	Equity (asset financed)	4MW	Carbon capture and storage (CCS)	Finland

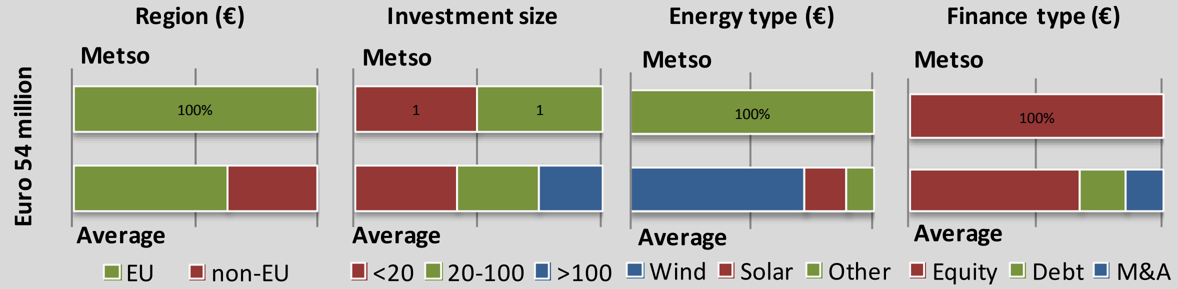
EXITS

N/A

DESCRIPTION

Metso is a world-leading industrial company in the mining and aggregates industries and in the flow control business. Metso employs approximately 14,000 industry experts and serves customers in more than 50 countries.

MARKET COMPARISON



Box 3.47 Danfoss

Overview:

Name	**Danfoss**
Type	**Industrial**
HQ	**Nordborg, Denmark**
Established	**1933**
Ownership	**Private limited company**
Parent	**N/A**
Sectors	**Green buildings and clean technology**
SET sector	**Geothermal energy; solar photovoltaics**
Type	**Mergers and acquisitions**
Regional interest	**Denmark; Norway; Finland; Germany**
Signatory to	**N/A**

Credit http://www.danfoss.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
SMA Solar Technology	2014	€302.4m	M&A	N/A	Solar PV	Germany
Normann Etek AS	2007	€2.1m (DKK 16m)	M&A	N/A	Geothermal energy	Norway
Vacon	2014	€1.04bn	M&A	N/A	Solar PV	Finland

FIRST-OF-A-KIND SET

N/A

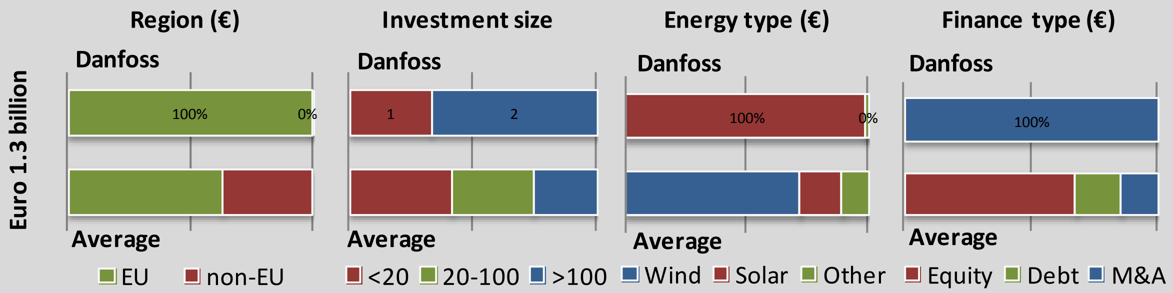
EXITS

N/A

DESCRIPTION

Danfoss produces grid-connected photovoltaic inverters for all PV applications and is active in the field of wind power as well as district heating and cooling infrastructure for cities and urban communities. The Group employs around 22,500 employees and sells its products in more than 100 countries around the world. In 2012, Danfoss generated net sales of 4.56 billion Euros.

MARKET COMPARISON



Box 3.48 Doosan Babcock

Overview:

Name	**Doosan Babcock**
Type	**Industrial**
HQ	**Crawley, United Kingdom**
Established	**2006 (acquisition)**
Ownership	**Subsidiary / Division**
Parent	**DHI European Holdings**
Sectors	**Power generation**
SET sector	**Carbon capture and storage (CCS)**
Type	**Public market equity; asset finance**
Regional interest	**UK; Canada**
Signatory to	**N/A**

Credit http://www.doosanbabcock.com/

Investment focus:
Examples:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
HTC Purenergy Inc	2008	c.€6.5m (CDN 10m)	Equity (public equity)	N/A	Carbon capture and storage (CCS)	Canada

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Doosan Renfrew CCS Demonstration Project	2009	c.€0.75m (£7.4m w/ £2.2m grant between 11)	Equity	40MWth	Carbon capture and storage (CCS)	United Kingdom
Ferrybridge CCS Pilot Project	2011	c.€5m (£14m between 3, £20m total)	N/A	5MW	Carbon capture and storage (CCS)	United Kingdom

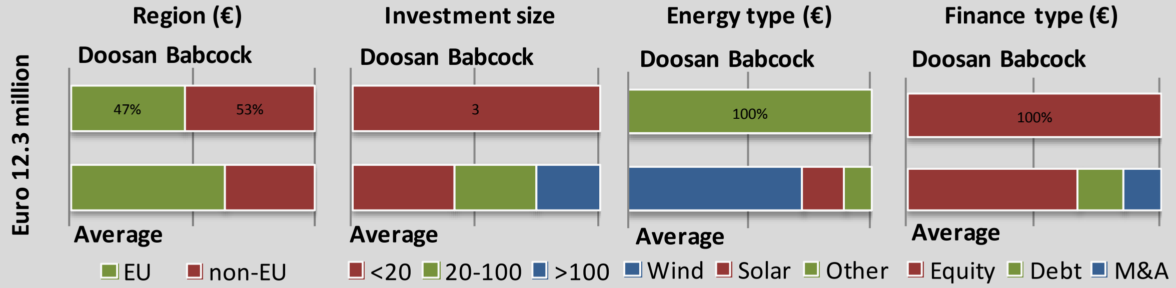
EXITS

N/A

DESCRIPTION

Doosan Babcock is a specialist in the delivery of engineering, aftermarket and upgrade services to the thermal power, nuclear, oil and gas, petrochemical and process industries. Doosan Babcock has conducted R&D in the thermal energy sector for over a century and produces high efficiency boiler and emissions-reduction technologies. Doosan Babcock is part of the Doosan Group, which in 2013 had 43,000 employees in 38 countries with a turnover of 15 billion Euros ($20bn).

MARKET COMPARISON



Box 3.49 Robert Bosch GmbH

Overview:

Name	**Robert Bosch GmbH**
Type	**Industrial**
HQ	**Stuttgart, Germany**
Established	**1997**
Ownership	**Subsidiary (charity and private family)**
Parent	**Robert Bosch Stiftung**
Sectors	**Heavy machines**
SET sector	**Solar photovoltaics, wind**
Type	**Mergers and acquisitions**
Regional interest	**Germany**
Signatory to	**N/A**

Credit https://www.bosch-si.com

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Ersol (Bosch Solar Energy AG)	2008	€1.1bn	M&A	N/A	Solar PV	Germany
aleo solar AG	2009	c.€50m	Equity	N/A	Solar PV	Germany

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Heliatek	2009	c.€2m (€18m between 8)	Equity	N/A	Solar PV	Germany
IGUS ITS	2009	N/A	Equity	N/A	Wind	Germany

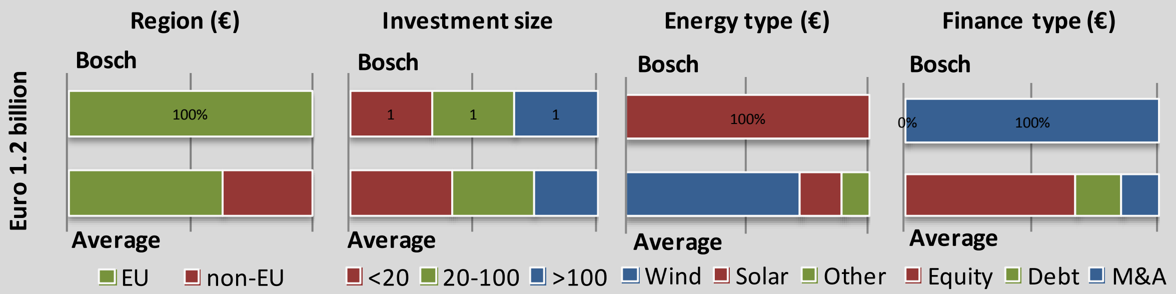
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Ersol/Aleo Solar (Bosch Solar CISTech)	2014	2008	€0m	Multiple: 0x	Solar PV	Germany

DESCRIPTION

The Bosch Group is a leading global supplier of technology and services. The company employs roughly 360,000 associates worldwide (as per April 1, 2015), and generated sales of 49 billion euros in 2014. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiary and regional companies in some 60 countries.

MARKET COMPARISON



Box 3.50 Viessmann Werke

Overview:

Name	**Viessmann Werke GmbH & Co KG**
Type	**Industrial**
HQ	**Allendorf, Hessen**
Established	**1917**
Ownership	**Private limited company**
Parent	**N/A**
Sectors	**Heating technology**
SET sector	**Biomass conversion technologies; concentrated solar power**
Type	**Mergers and acquisitions**
Regional interest	**Germany; Austria; France**
Signatory to	**N/A**

Credit http://www.viessmann.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☐	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Schmak Biogas AG	2010	N/A (insolvency)	M&A	N/A	Biomass conversion technologies	Germany
Mawera	2006	N/A	M&A	0.1 - 13MW plants	Biomass conversion technologies	Austria

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
SAED (Sophia Antipolis Energie Developpement)	2013	N/A (bankruptcy)	M&A	N/A	Concentrated solar power (CSP)	France

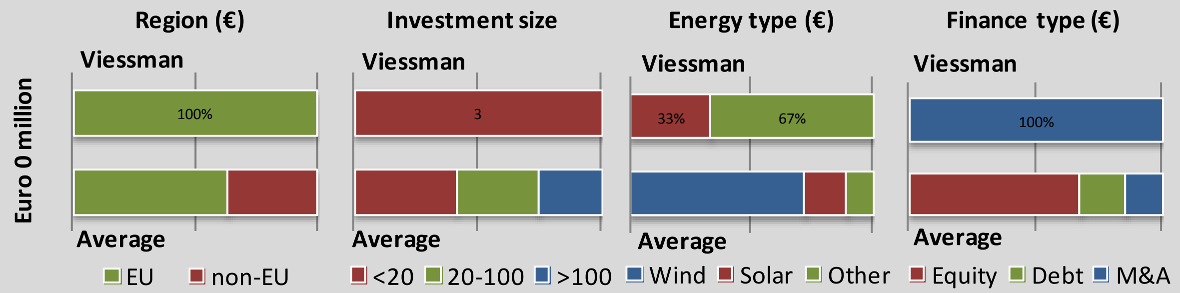
EXITS

N/A

DESCRIPTION

The Viessmann Group is one of the leading international manufacturers of heating, cooling and climate control technology. Founded in 1917, the family business maintains a staff of approximately 11,500 employees and generates 2.2 billion Euro in annual group turnover.

MARKET COMPARISON



Box 3.51 Itochu Corporation

Overview:

Name	**Itochu Corp**
Type	**Industrial Conglomerate**
HQ	**Osaka, Japan**
Established	**1949**
Ownership	**Subsidiary / Division**
Parent	**DHI European Holdings**
Sectors	**General**
SET sector	**Biomass conversion technologies; concentrated solar power; large scale energy storage; solar photovoltaics; wind**
Type	**Private equity; mergers and acquisitions; asset finance**
Regional interest	**Japan; USA; Canada; Norway; Italy**
Signatory to	**N/A**

ITOCHU ITOCHU Corporation

Credit http://www.itochu.co.jp/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Norsun	2006, 2009	c.€9m ($8.5m, +$3.3m in $272m total)	Equity (PE / VC)	430MW (over 4 years)	Solar PV	Norway
Scatec Solar ASA	2008	c.€6.5m ($8.5m, $31.5m tot.)	M&A, 10% stake	N/A	Solar PV	Norway
Greenvision Ambiente Photo-Solar	2008	€7.7m	M&A, 43% stake	N/A	Solar PV	Italy

FIRST-OF-A-KIND SET

N/A

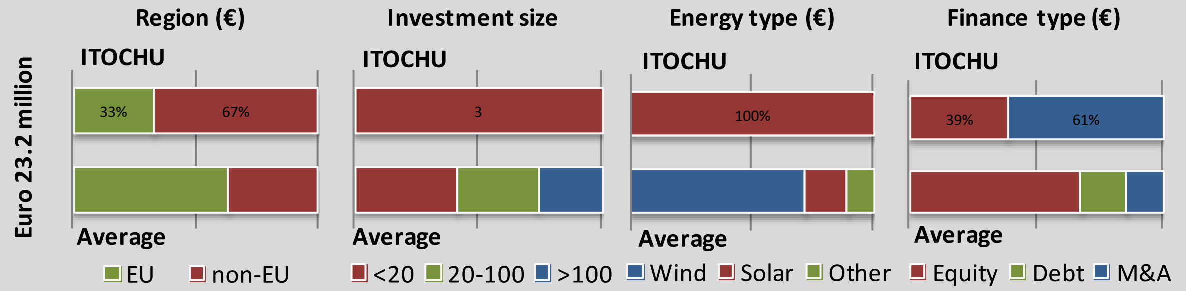
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Scatec Solar ASA	2015	2008	c.€9m ($9.7m)	ROI: 16% Multiple: x2.8	Solar PV	Norway

DESCRIPTION

With approximately 130 bases in 65 countries, ITOCHU, one of the leading *sogo shosha*, is engaging in domestic trading, import/export, and overseas trading of various products such as textile, machinery, metals, minerals, energy, chemicals, food, information and communications technology, realty, general products, insurance, logistics services, construction, and finance, as well as business investment in Japan and overseas.

MARKET COMPARISON



Box 3.52 Statkraft

Overview:

Name	**Statkraft SF**
Type	**Utility**
HQ	**Oslo, Norway**
Established	**1992**
Ownership	**Government owned**
Parent	**N/A**
Sectors	**Energy distribution and generation**
SET sector	**Advanced electricity networks; carbon capture and storage; geothermal; large scale energy storage; ocean energy; solar photovoltaics; wind**
Type	**Private equity, mergers and acquisitions, asset finance**
Regional interest	**Norway; UK; Italy; other**
Signatory to	**N/A**

Credit http://www.statkraft.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Dudgeon Offshore Wind Farm	2014	c.€540m (NOK 4.5bn of 15bn)	Equity	402MW	Wind	UK
Trøndelag Fosen onshore wind farms	2014	c.€420m (50% of NOK 7bn)	Equity	395MW	Wind	Norway
Sheringham Shoal offshore wind farm	2009	c.€575m (50% of NOK 10bn)	Equity	315MW	Wind	UK

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
SOLVit Trondheim laboratory	2009	c.€2m (NOK 15m of 317m)	R&D support	N/A	Carbon capture and storage (CCS)	Norway
Atlantis Resources Corporation – Solon Turbo trials in Singapore	2009	c.€5m (NOK 45m)	Equity	1 MW	Ocean energy	UK
Tofte Osmotic Pilot Marine Plant	2009	c.€11.5m (NOK 100m)	Equity	N/A	Ocean energy	Norway

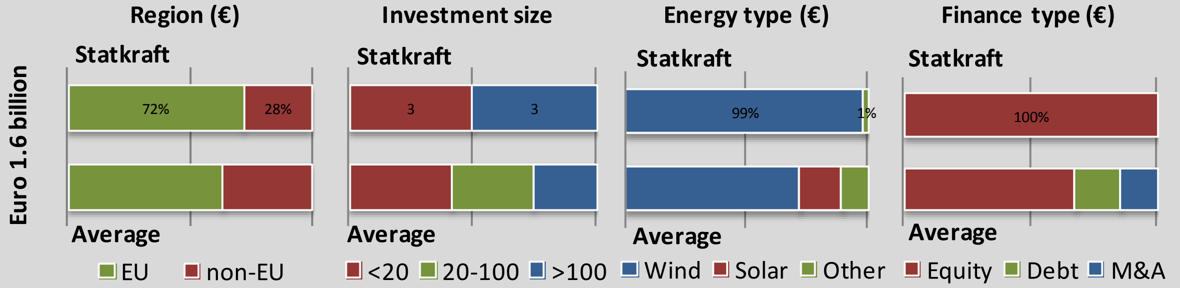
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
UK onshore wind portfolio to Gingko Tree Investment	2014	2009-2014	N/A	Account gain c.€130m (NOK 1063m) on 49% sale	Wind	UK
Sheringham Shoal Offshore to GIB	2013	2009	c.€150m (half £240m for 10%)	Multiple: x1.3 ROI: 7% p.a.	Wind	UK
RA 2 S.r.l. to ITS Power AG	2010	2007	N/A	N/A	Solar PV	Norway

DESCRIPTION

Statkraft is a leading company in hydropower internationally and Europe's largest generator of renewable energy. In 1997, Statkraft decided to focus on the development of wind power projects. The Group produces hydropower, wind power, gas-fired power and district heating and is a global player in energy market operations. Statkraft has 3,700 employees in more than 20 countries.

MARKET COMPARISON



Box 3.53 Statoil ASA

Overview:

Name	**Statoil ASA**
Type	**Energy**
HQ	**Stavanger, Norway**
Established	**1992**
Ownership	**Government owned**
Parent	**N/A**
Sectors	**Oil, gas, new energy**
SET sector	**Advanced electricity networks; carbon capture and storage; geothermal; large scale energy storage; solar photovoltaics; wind**
Type	**Private equity, mergers and acquisitions, asset finance**
Regional interest	**Norway; UK; Italy; other**
Signatory to	**N/A**

Credit http://www.statoil.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Dudgeon Offshore Wind Farm	2014	c.€660m (NOK 5.5bn of 15bn)	Equity	402MW	Wind	UK

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Cancelled - Statoil Mongstad CHP CCS Demonstration Project	2009-2013	c.€140m (20% NOK 5.8bn)	Equity	0.1 Mt/a (85% of 350MWth 280MWe)	Carbon capture & storage (CCS)	Norway
Statoil Hydro Snohvit CCS Demonstration Project	2008	c.€50m (33.75% of est. €150m)	Equity	0.7 Mt/a	Carbon capture & storage (CCS)	Norway
Danotek permanent magnet generators	2011	c.€2.5m ($15m between 4+)	Equity	N/A	Wind	USA
Chapdrive AS	2010, 2007	c.€3m (€11m between 5, €2.25m between 3)	Equity	5MW	Wind	Norway
Abandoned - Shell/Statoil Halten CCS Commercial Project	2006	c.€240m (c.4bn NOK between 2)	Equity	2-2.5 Mt/a	Carbon capture & storage (CCS)	Norway

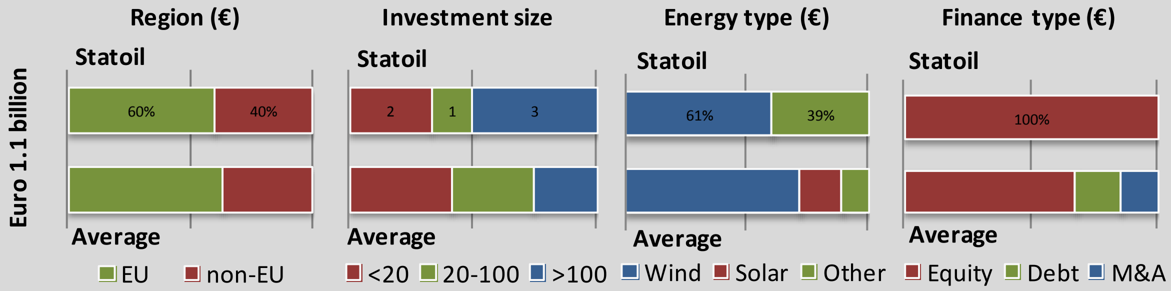
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Dudgeon Offshore Wind Farm to Masdar	2014	2012	c.€660m (£525 for 35%)	Multiple: 1x	Wind	UK
Sheringham Shoal Offshore to GIB	2013	2009	c.€150m (half £240m for 10%)	Multiple: x1.3 ROI: 7% p.a.	Wind	UK
Sarepta Energi AS to TronderEnergi AS	2011	N/A	50% stake	N/A	Wind	Norway

DESCRIPTION

Statoil is an international energy company present in more than 30 countries around the world. Its biggest activities are located in Norway. Statoil's operations include oil exploration and production; natural gas; trading; pipelines and transport; and new energy. Statoil is focusing on establishing a position in certain markets in offshore wind energy. Since 1996, it has been and continues to be a champion for the development of CCS.

MARKET COMPARISON



Box 3.54 Masdar

Overview:

Name	**Masdar Abu Dhabi Future Energy Co**
Type	**Energy**
HQ	**Abu Dhabi, UAE**
Established	**2006**
Ownership	**Private limited company**
Parent	**Mubadala Development Co PJSC**

Credit http://www.masdar.ae/

Sectors	**Renewable energy**
SET sector	**Biomass conversion technologies; concentrated solar power; carbon capture and storage (CCS); solar photovoltaics; wind**
Type	**Private equity, public market equity, asset finance**
Regional interest	**UAE; UK; USA; Spain; Middle East and Africa; other**
Signatory to	**N/A**

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Dudgeon Offshore Wind Farm	2014	c.€660m (£525m)	Equity	402MW	Wind	UK
London Array offshore wind farm first phase	2009	c.€440m (20% €2.2bn)	Equity	630MW	Wind	UK
WinWinD Oy	2008	€120m	Equity	1-3MW turbines	Wind	Finland

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Announced - BP/Masdar HPAD CCS Demonstration Project	2009	c.€380m (assume 50% cost of 60% AED 7bn)	Equity (balance sheet)	1.7 Mt/a	Carbon capture and storage (CCS)	UAE
Masdar Emirates Steel CCS Pilot Project	2013	c.€44m (49% AED 450m)	Equity (balance sheet)	0.8 Mt/a	Carbon capture and storage (CCS)	UAE
NanoGram Solar Module Pilot	2008	c.€1.5m ($32m between 16)	Equity	N/A	Solar PV	USA

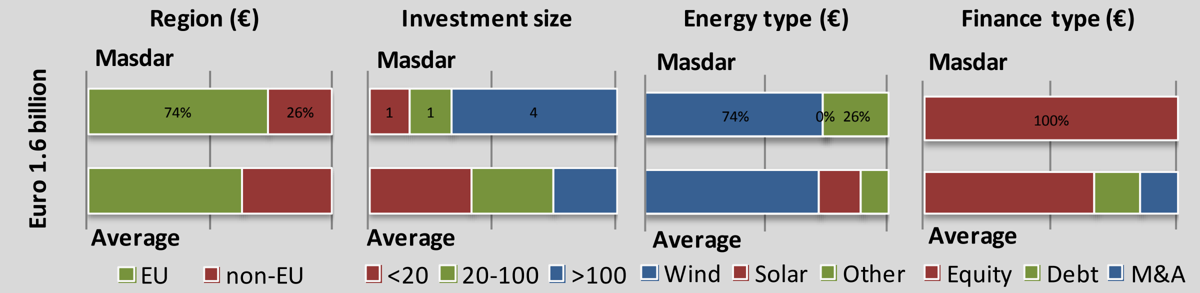
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
London Array Wind Farm refinance by GIB	2013	2009	c.€70m (£58.6 refinance)	N/A	Wind	UK

DESCRIPTION

The Mubadala Development Company, which is owned by the Abu Dhabi government, established Masdar as a wholly owned subsidiary in 2006. Masdar is on a mission to advance the clean energy industry in Abu Dhabi and around the world, and it is a catalyst for the economic diversification of the Emirate.

MARKET COMPARISON



Box 3.55 Iberdrola

Overview:

Name	**Iberdrola S.A.**
Type	**Utility**
HQ	**Bilbao, Spain**
Established	**1992**
Ownership	**Public Listed Company**
Parent	**N/A**
Sectors	**Energy generation and distribution**
SET sector	**Advanced electricity networks; biomass conversion technologies; concentrated solar power; ocean energy; large scale energy storage; solar photovoltaics; wind**
Type	**Asset finance, private equity**
Regional interest	**Spain, Germany, France, other**
Signatory to	**N/A**

Credit http://www.iberdrola.es/

Investment focus:	Equity	Loans	Capital market bonds	M&A
Examples:	☑	☐	☐	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
STAR smart grid project	2010-2012	€300m	Equity (balance sheet)	10.3m meters	Advanced electricity networks	Spain
Announced - St Brieuc Offshore Wind Farm	2012	c.€420m (70% of €2bn project)*	Equity (balance sheet)	500MW	Wind	France
Wikinger Offshore Wind Park	2013	c.€480m (€1.6bn)*	Equity (balance sheet)	<400MW	Wind	Germany

**assumes 30% equity funded, 70% debt support*

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Morgan Solar Inc	2011	c.€8.5m ($28.8m between 3)	Equity (round B)	N/A	Concentrated solar power (CSP) and Solar PV	Canada
Fenosa Madrid PRICE Smart Grid	2011	c.€5m (€10m between 2, total€34m)	Equity (balance sheet)	N/A	Advanced electricity networks	Spain

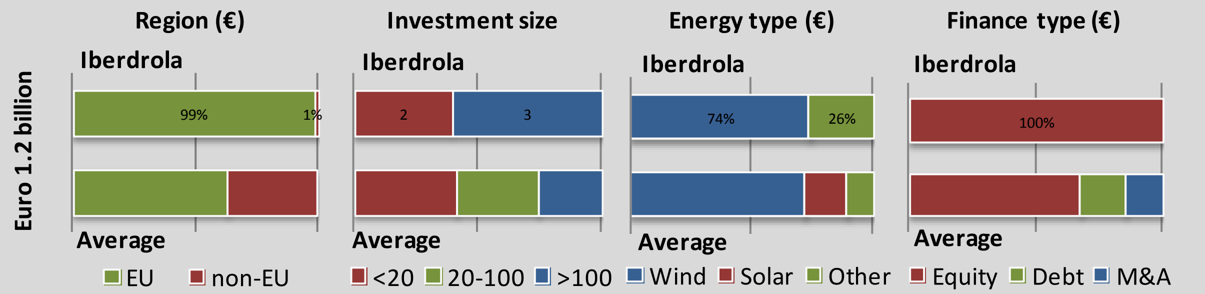
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
France Wind Portfolio to EDF, ERGO, and GE	2012	N/A	€350m	N/A	Wind	France
Germany Wind Portfolio to MVV	2012	N/A	€52.7m	N/A	Wind	Germany
Poland Wind Portfolio to PGE and Energa SA	2013	N/A	€203m	N/A	Wind	Poland

DESCRIPTION

Iberdrola is the world leader in wind power. One of the top electric utilities in the world. Spain's number one energy group. Iberdrola has staff reaching 30,000. In 2014, Iberdrola accounted €2,848 million in net investments of which 54% in networks and 27% in renewables.

MARKET COMPARISON



Box 3.56 Vestas

Overview:

Name	**Vestas Wind Systems A/S**
Type	**Industrial**
HQ	**Aarhus, Denmark**
Established	**1898**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Wind**
SET sector	**Wind; large scale energy storage (rare)**

Credit http://www.vestas.com/

Type	**Asset finance (incl. manufacturing), mergers and acquisitions**
Regional interest	**China, Denmark, Germany, Spain, Czech Republic, USA, other**
Signatory to	**N/A**

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Vestas Daimiel Blade Manufacturing Plant	2008	€76m	Equity (balance sheet)	1200 blades p/a	Wind	Spain
Vestas Pueblo Wind Turbine Tower Manufacturing Plant	2008	c.€150m ($240m)	Equity (balance sheet)	900 towers p/a	Wind	USA
Talinay Oriente Wind Portfolio Acquisition	2011	c.€75m (between €50m and €100m)	Equity (balance sheet)	100MW	Wind	Chile

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Vestas Denmark Energy Storage Pilot Project	2013	c.€1m ($2.7 between 2)	Equity (balance sheet)	1.2MW	Large scale energy storage	Denmark

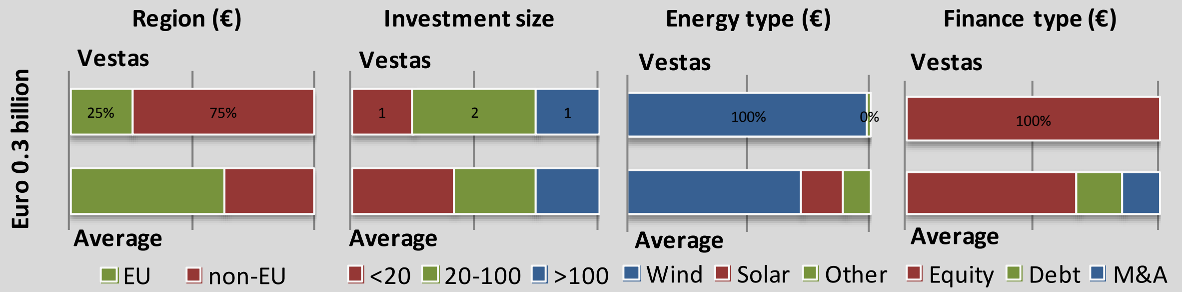
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Romania and Bulgaria power plants to LUKERG Renew GmbH	2013	N/A	€127m	N/A	Wind	Romania and Bulgaria
Talinay Oriente Wind to Enel SpA	2012	2011	c.€130m ($165m)	N/A	Wind	Chile
Titan Varde Tower Manufacturing plant to Titan Wind Suzhou Ltd	2012	N/A	c.€15m ($19m)	N/A	Wind	Denmark

DESCRIPTION

Vestas is a global energy manufacturer dedicated to wind power. Vestas started producing wind turbines in 1979, and have since gained a market-leading position with more than 64 GW of installed wind power and more than 42 GW under service globally.

MARKET COMPARISON



Box 3.57 Enercon

Overview:

Name	**Enercon GmbH**
Type	**Industrial**
HQ	**Aurich, Germany**
Established	**1984**
Ownership	**Private limited company**
Parent	**N/A**
Sectors	**Wind; large scale energy storage**
SET sector	**Wind; large scale energy storage**
Type	**Asset finance (incl. manufacturing)**
Regional interest	**Germany, Poland, Turkey, other**
Signatory to	**N/A**

Credit http://www.enercon.de/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

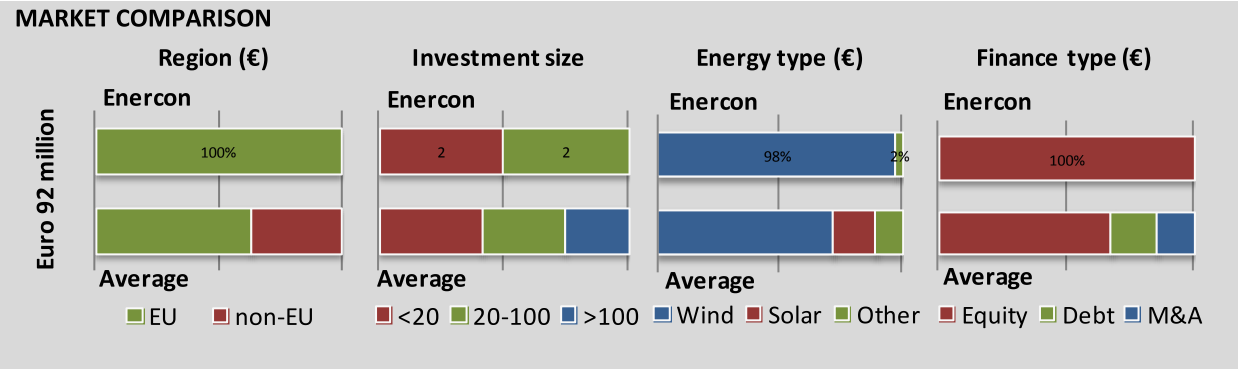
Name	Year	Value	Instrument	Scale	Sector	State
Enercon Galicia nacelle, steel components and control plants	2010	€40m	Equity (balance sheet)	N/A	Wind	Spain
Enercon Zurndorf Wind converters	2012	€40m	Equity (balance sheet)	N/A	Wind	Austria
Gabrielsberget Nord wind farm	2011	c.€10m (€70m project, equity between 2, assume 30%)	Equity (balance sheet)	46MW	Wind	Sweden

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
ENERCON & Energiequelle Feldheim Energy Storage Pilot Project	2014	c.€2m (€13m, 40% grant, €4m loans)	Shared equity	10MW	Large scale energy storage	Germany
Enercon Emden Energy Storage Project	2009	N/A	N/A	0.8MW	Large scale energy storage	Germany

DESCRIPTION

Enercon has been a leading supplier in the German wind turbine market for around twenty years. With over 22,000 Enercon wind turbine machines installed in more than 30 countries, it is also one of the leading manufacturers internationally.


MARKET COMPARISON
Euro 92 million
Region (€)
Enercon
100%
Average
EU
non-EU
Investment size
Enercon
2
2
Average
<20
20-100
>100
Energy type (€)
Enercon
98%
2%
Average
Wind
Solar
Other
Finance type (€)
Enercon
100%
Average
Equity
Debt
M&A

Box 3.58 Siemens

Overview:

Name	**Siemens AG**
Type	**Conglomerate**
HQ	**Munich, Germany**
Established	**1847**
Ownership	**Public Listed Company**
Parent	**N/A**

SIEMENS

Credit http://www.siemens.com/

Sectors	**Industry, energy, healthcare, infrastructure**
SET sector	**Advanced electricity networks; concentrated solar power; large scale energy storage; ocean energy; solar photovoltaics; wind**
Type	**Asset finance (incl. manufacturing), mergers and acquisitions, private equity**
Regional interest	**Germany, UK, Spain, Italy, Denmark, other Europe, USA, rest of world**
Signatory to	**N/A**

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Hutchinson Nacelle Manufacturing Plant	2009	c.€35m ($50m)	Equity (balance sheet)		Wind	USA
Siemens Green Port Hull Nacelle Manufacturing Plant	2011	€190m (£310m project)	Equity (balance sheet)	450-600 unit p/a	Wind	UK
Abandoned - Sacyr-Siemens Solucia STEG Portfolio Phase II	2012	c.€150m (50% €300m)	Equity (balance sheet)	50MW	Concentrated solar power (CSP)	Spain

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Marine Current Turbines Ltd	2009, 2010	>€10m (in excess of £8.5m)	M&A (100%)	N/A	Ocean energy	UK
Solel Solar Systems	2009	c.€290m ($418m)	Equity	N/A	Concentrated solar power (CSP)	Israel
Siemens Aspern Smart Grid Project	2013	c.€18m (€40m with Wien Energy, €3.7m grant)	Equity	N/A	Advanced electricity networks	Austria

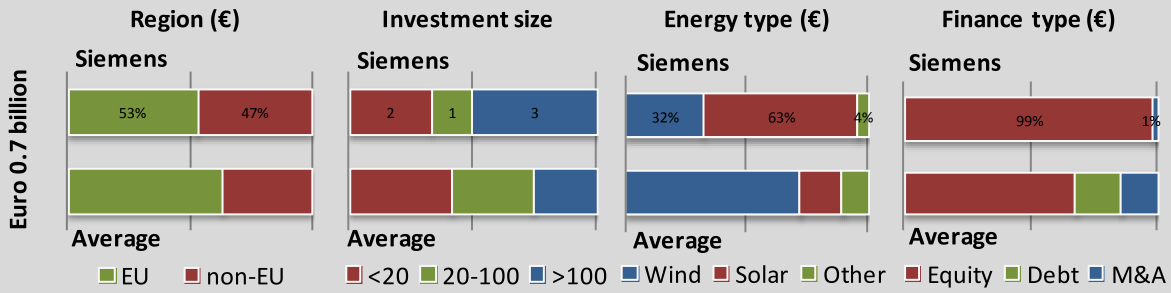
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Marine current turbines to Atlantis Resources Ltd	2015	2009	c.€3m (£2.6m)	N/A	Ocean energy	UK

DESCRIPTION

Siemens is a global powerhouse focusing on the areas of electrification, automation and digitalization. One of the world's largest producers of energy-efficient, resource-saving technologies, Siemens is a leading supplier of systems for power generation and transmission as well as medical diagnosis. Siemens Financial Services joined forces with the Carbon Trust in 2011 to create the Energy Efficiency Financing scheme (EEF) - designed to help facilitate investment in new technology. As of September 30, 2014, Siemens had around 343,000 employees in more than 200 countries. In fiscal 2014, employees generated revenues of 71.9 billion Euros from continuing operations.

MARKET COMPARISON



Box 3.59 Suzlon

Overview:

Name	**Suzlon Group**
Type	**Industrial**
HQ	**Pune, India**
Established	**1995**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Wind**
SET sector	**Wind**
Type	**Asset finance (incl. manufacturing), mergers and acquisitions, private equity**
Regional interest	**India, Germany, USA, Spain, Belgium**
Signatory to	**N/A**

Credit http://www.suzlon.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☑	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
REpower (renamed Senvion SE)	2007, 2008, 2008, 2009	c.€750m (c.€1.8bn, 1.36x D/E)	M&A	N/A	Wind	Germany
Big Sky Wind Farm Suzlon Acquisition	2009	c.€160m ($228m)	Equity for loan	240MW	Wind	USA
Suzlon Carboneras Blade Manufacturing Plant	2014	€22m	Equity	750 blades p/a	Wind	Spain

FIRST-OF-A-KIND SET

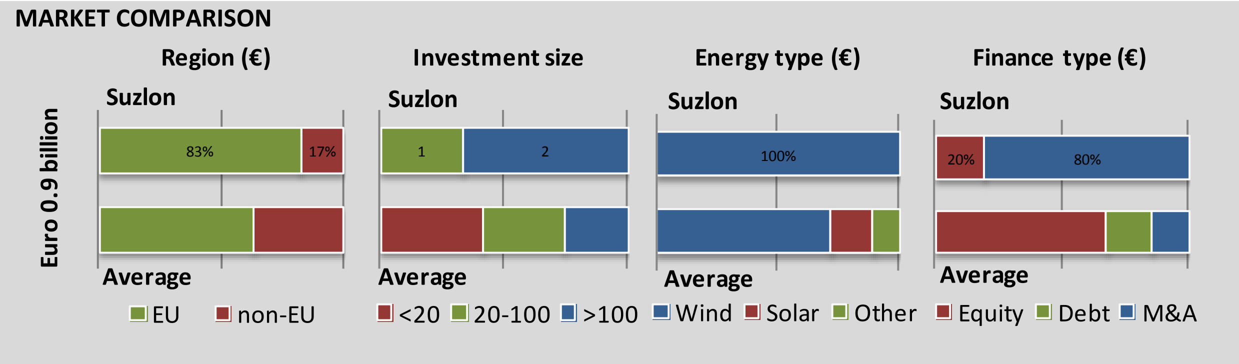
N/A

EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Hansen Transmission to ZF Friederichshafen	2011	2006	c.€130m (£115m)	N/A	Wind	Belgium
Big Sky Wind Farm Suzlon	2014	2012	c.€85m (<50% $226)	Multiple: <0.5x	Wind	USA
Senvion SE to Centerbridge Capital Partners	2015	2007-2011	€1bn	Multiple: <0.6x	Wind	Germany

DESCRIPTION

The Suzlon group is one of the World's leading Wind Turbine Manufacturers. Over the past two decades, Suzlon has built its presence in over 30 countries and has achieved a milestone by crossing 26,000 MW of wind power installations globally.


MARKET COMPARISON
Region (€)
Investment size
Energy type (€)
Finance type (€)
Euro 0.9 billion
Suzlon
Average
83%
17%
1
2
100%
20%
80%
EU
non-EU
<20
20-100
>100
Wind
Solar
Other
Equity
Debt
M&A

Box 3.60 Gamesa

Overview:

Name	**Gamesa**
Type	**Industrial**
HQ	**Zamudio, Spain**
Established	**1976**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Wind; solar photovoltaics**
SET sector	**Wind; solar photovoltaics**
Type	**Asset finance (incl. manufacturing), mergers and acquisitions**
Regional interest	**Spain, Germany, Greece, Portugal, Poland, other**
Signatory to	**N/A**

Credit http://www.gamesacorp.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
Examples:	☑	☐	☐	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Kithaironas Wind farm	2013	N/A	Equity (balance sheet)	25.5MW	Wind	Greece
Conesa II and Savalla Wind farms	2011	N/A	Equity (balance sheet)	50MW	Wind	Spain
Piecki Wind Farm	2011	N/A	Equity (balance sheet)	32MW	Wind	Poland

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Announced -FLOATGEN project	2013	c.€8.5m (€36 - €19m EC funds between 2)	Equity (balance sheet)	2MW + 3MW	Wind	France
Gamesa Gran Canaria Demonstration Offshore Wind Farm	2013	N/A	Equity	5MW	Wind	Spain

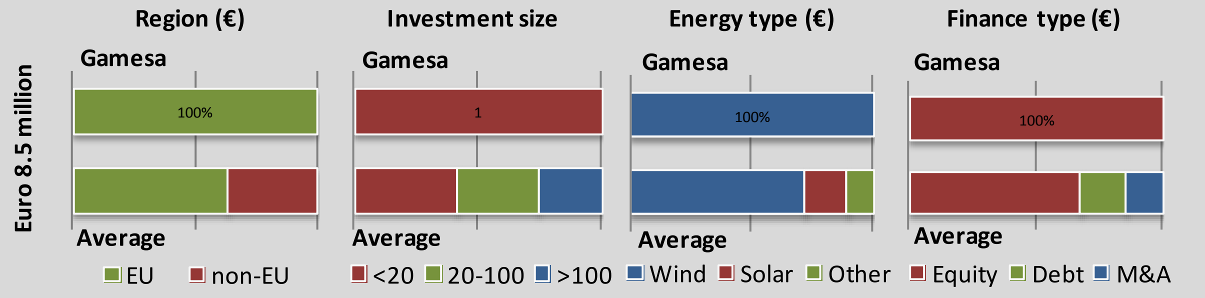
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Gamesa Solar 9REN to First Reserve	2008	2005	€261m	N/A	Solar PV	Spain
Kithaironas Wind Farm to EREN Developpement SAS	2014	2013	N/A	N/A	Wind	Greece
Zuromin Wind Farm to PGE Energia Odnawialna	2012	2011	N/A	N/A	Wind	Poland

DESCRIPTION

Gamesa is a global leader in the wind industry with 21 years' experience and more than 30,000 MW installed in 50 countries. Gamesa is also a world leader in the development, construction and sale of wind farms, having installed 6,400 MW worldwide. The company has production centres in the main wind markets: Spain and China, as the global production and supply hubs, while maintaining its local production capacity in India, US, and Brazil.

MARKET COMPARISON



Box 3.61 MHI

Overview:

Name	**Mitsubishi Heavy Industries**
Type	**Industrial**
HQ	**Tokyo, Japan**
Established	**1950**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Electrical equipment and electronics**
SET sector	**Advanced electricity networks; carbon capture and storage (CCS); large scale energy storage, solar photovoltaics; wind**
Type	**Asset finance (incl. manufacturing), mergers and acquisitions**
Regional interest	**Japan; other Asia; USA; UK; other Europe**
Signatory to	**N/A**

Credit https://www.mhi-global.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
MHI Nagasaki Nacelle Plant	2007	c.€12.5m (approx. half of ¥4bn)	Equity	600MW	Wind	Japan
Kaliakra Wind Power Project	2008	€7m (70% of €10m, total €47m)	Equity	35MW	Wind	Bulgaria

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Vestas – MHI joint offshore venture	2013	€100m (up to €300m)	Equity	8MW	Wind	Denmark
MHI lithium-ion Nagasaki shipyard test plant	2010	c.€90m (c.¥10bn)	Equity	N/A	Large scale energy storage (part)	Japan
Artemis Intelligent Power Ltd	2010	c.€18m (c.£15m)	M&A	N/A	Wind	UK

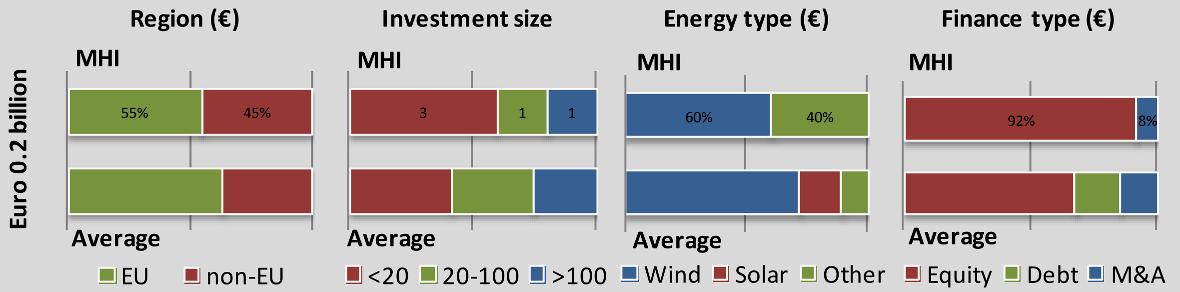
EXIT

N/A

DESCRIPTION

Mitsubishi Heavy Industries (MHI) is a Japanese conglomerate group of 393 companies active in energy, aircraft, space, ship and ocean, transportation, material handling, environment, automotive, industrial machinery, infrastructure, living and leisure and other activities. MHI has over 80,000 employees and 21.4 billion Euros (¥3tn) in sales.

MARKET COMPARISON



Box 3.62 EDF Energies Nouvelle

Overview:

Name	**EDF Energies Nouvelle**
Type	**Utility**
HQ	**Paris, France**
Established	**2004**
Ownership	**Subsidiary of a quoted company**
Parent	**Électricité de France (EDF)**
Sectors	**Renewable energy**
SET sector	**Advanced electricity networks, biomass conversion technologies, large scale energy storage, solar photovoltaics, wind**
Type	**Asset finance, mergers and acquisitions, private equity**
Regional interest	**France, Italy, Portugal, Greece, UK, other Europe, USA**
Signatory to	**N/A**

Credit http://www.edf-energies-nouvelles.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☑

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Iberdrola France Wind Portfolio	2012	€70m (20% €350m)	M&A (20%)	305MW	Wind	France
Blanquefort PV Plant	2009	c.€50m (c.€100m between 2)	Equity	100MW	Solar PV	France
Sechilienne-Sidec Wind Business	2013	€59m	Equity	56.5MW	Wind	France

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Announced - Toucan photovoltaic facility in French Guiana	2015	N/A	N/A	5MW	Solar PV and energy storage	France
Vestas Stealth Blade Technology	2014	N/A	N/A	96MW	Wind	France
Nanosolar	2008	c.€35m ($50m)	Equity	N/A	Solar PV	USA
Verdesis	2007	c.€0.8m (€1.2m in €2.4m total)	M&A (68.9%)	N/A	Biomass conversion technologies	Belgium
Barking smart meter trial	2011	c.€5m (£4.6m, total £29.5m)	N/A	5,000 meters	Advanced electricity networks	United Kingdom

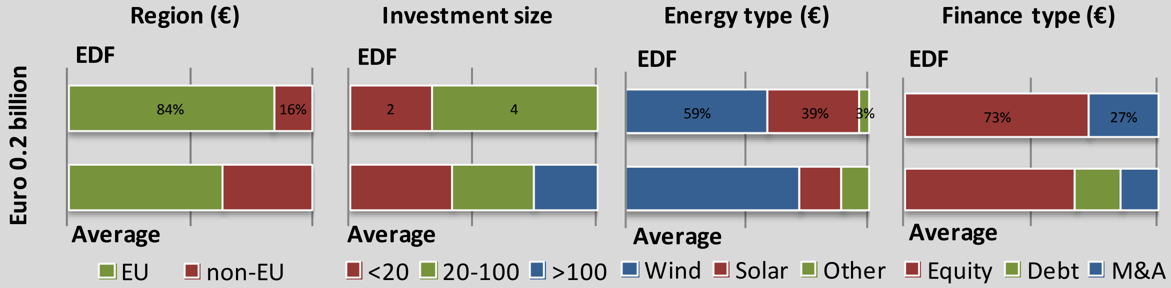
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Edens to F2i ER Srl	2014	N/A	€320m (sale of 70% equity stake, maintaining 30% share)	N/A	Wind	Italy
Lac Alfred and Massif du Sud Wind Projects to Enbridge	2014	N/A	c.€170m (approx. $225m; sale of 30% equity stake, maintaining 20% share))	N/A	Wind	Canada

DESCRIPTION

Specialized in renewable energy, EDF Energies Nouvelles, a subsidiary of EDF Group, is a worldwide leader in green electricity production. As an integrated operator, EDF EN develops, finances, builds renewable installations, and manages operations and maintenance for its own account and for third parties. A major global player in onshore and offshore wind power and in solar photovoltaic power, EDF Energies Nouvelles is also participating in the emergence of new sectors through innovative future technologies' investments: marine energies (floating wind turbines, marine current turbines) and energy storage.

MARKET COMPARISON



3.6 Market Participant Description Sheets for SPECIALISED INVESTORS

Box 3.63 KKR

Overview:

Name	**Kohlberg Kravis Roberts & Co. L.P.**
Type	**Private Equity**
HQ	**New York, USA**
Established	**1989**
Ownership	**Limited partnership**
Parent	**N/A**
Sectors	**General**
SET sector	**Advanced electricity networks; biomass conversion technologies; carbon capture and storage (CCS); solar photovoltaics; wind**
Type	**Private equity; mergers and acquisitions**
Regional interest	**USA; UK; Spain; Netherlands; Australia**
Signatory to	**UN Principles for Reasonable Investment**

Credit http://www.kkr.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Energy Future Holdings	2007	c.€1.25bn ($3.5bn between 2 in $48bn deal)	Equity (LBO)	700MW	Wind	USA
Afvalverwerking Rijnmond (AVR)	2006	c.€450m (€1.4bn between 3)	Equity (LBO)	315.3MW	Biomass conversion technologies	Netherlands
Acciona Energia Internacional SA	2014	€417m	Equity (33% stake)	2.3GW	Wind, solar PV	Spain

FIRST-OF-A-KIND SET

N/A

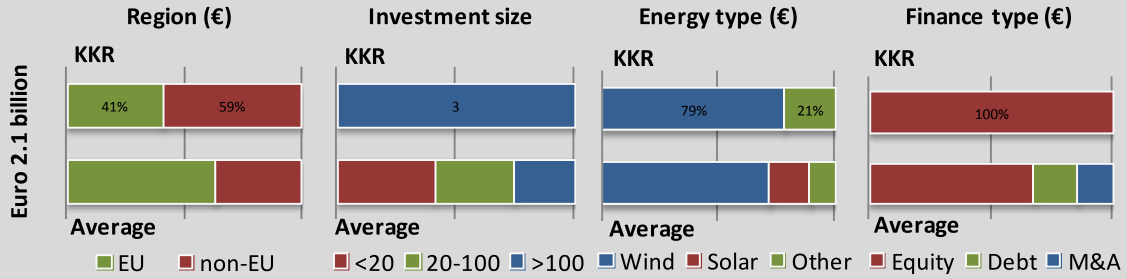
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Landis+Gyr AG	2004	2002	c.€150m (c.AUD 250m)	N/A	Advanced electricity networks	Switzerland
Afvalverwerking Rijnmond (AVR)	2014	2006	€940m	ROI: -5% Multiple: x0.67	Biomass conversion technologies	Netherlands

DESCRIPTION

KKR is a leading global investment firm with more than 74 billion Euros (US$98bn) in assets under management as of May, 2015. KKR has been investing in the energy sector for almost 30 years, across the entire energy supply chain and multiple asset classes.

MARKET COMPARISON



Box 3.64 TPG Capital Management

Overview:

Name	**TPG**
Type	**Private Equity**
HQ	**Fort Worth, Texas**
Established	**1993**
Ownership	**Limited partnership**
Parent	**N/A**
Sectors	**General**
SET sector	**Carbon capture and storage; biomass conversion technologies; solar photovoltaics; wind**
Type	**Private equity; corporate debt**
Regional interest	**USA; UK; Germany; China; Hong Kong**
Signatory to	**UN Principles for Reasonable Investment**

Credit https://tpg.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☑	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Energy Future Holdings	2007	c.€1.25bn ($3.5bn between 2 in $48bn deal)	Equity (LBO)	700MW	Wind	USA
Comtec Solar	2011	c.€110m ($150m)	Convertible bond	N/A	Solar PV	China

FIRST-OF-A-KIND SET

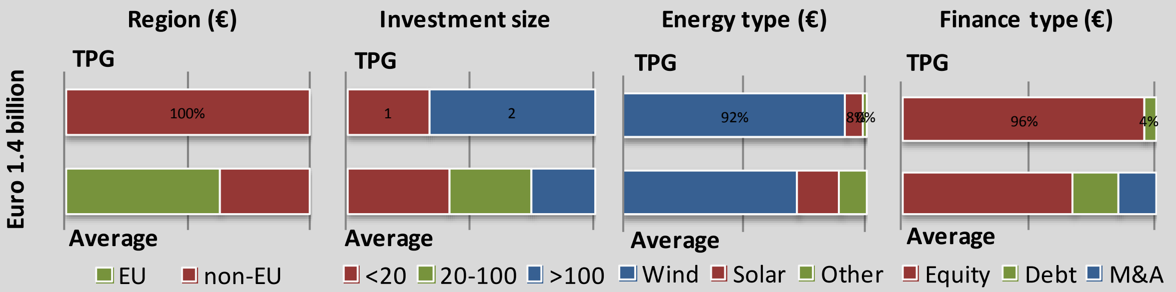
Name	Year	Value	Instrument	Scale	Sector	State
Alphabet Energy	2011	c€3m ($12m between 3)	Equity	N/A	Biomass conversion technologies	USA
2Co Energy Ltd	2010	N/A	Equity	N/A	Carbon capture & storage (CCS)	United Kingdom

EXITS: N/A

DESCRIPTION

TPG is a leading global private investment firm with 50 billion Euros ($67bn) of capital under management. TPG Capital is TPG's principal investment platform in the U.S., Europe, Asia, Australia and Latin America, and generally focuses on established businesses that require equity capital between 7.5 million Euros and 750 million Euros ($10m and $1bn).

MARKET COMPARISON



Box 3.65 Craton Equity Partners

Overview:

Name	**Craton Equity Partners**
Type	**Private equity**
HQ	**Los Angeles, USA**
Established	**1972**
Ownership	**Private limited company**
Parent	**TCW Group Inc**
Sectors	**Green buildings; clean technology**
SET sector	**Advanced electricity networks; biomass conversion technologies; geothermal energy; solar photovoltaics**
Type	**Private equity**
Regional interest	**USA; Canada; UK**
Signatory to	**N/A**

Credit
http://www.cratonep.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Petra Solar Inc	2010	c.€11.5m ($15m)	Equity	N/A	Solar PV & advanced electricity networks	USA
EnLink Geoenergy Services Inc	2008	c.€7m ($10m)	Equity	N/A	Geothermal	USA
Sungevity Inc	2013	c.€6m ($40m between 5)	Equity	N/A	Solar PV	USA

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
GridPoint Inc	2011	c.€1m ($23.6m between 22)	Equity	N/A	Advanced electricity networks	USA

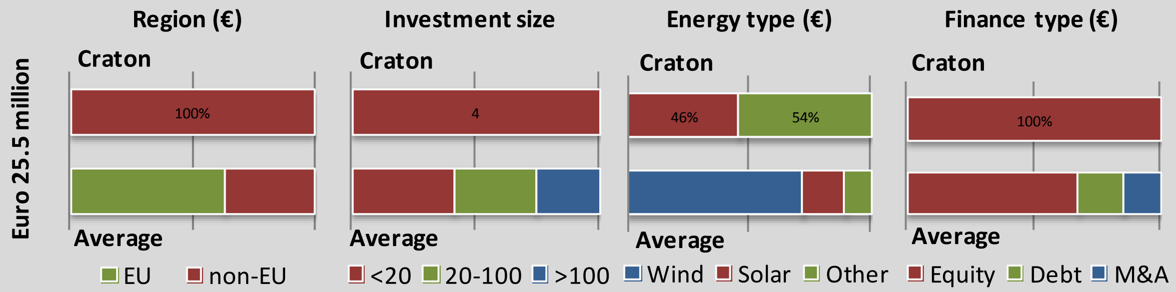
EXITS

N/A

DESCRIPTION

Craton Equity Partners is a nationally known, Los Angeles-based cleantech fund, focused on investing in new technologies that provide profitable solutions to the effects of climate change and environmental degradation. Craton's investments include green building products, earth heat exchange projects, smart grid technologies and next-generation biofuels.

MARKET COMPARISON



Box 3.66 3i

Overview:

Name	**3i**
Type	**Private Equity Fund**
HQ	**London, United Kingdom**
Established	**1945**
Ownership	**Public limited company**
Parent	**N/A**
Sectors	**General**
SET sector	**Advanced electricity networks; biomass conversion technologies; ocean energy; solar photovoltaics; wind**
Type	**Private equity**
Regional interest	**UK; North America; Europe; Hong Kong**
Signatory to	**UN Principles for Reasonable Investment**

Credit www.3i.com

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Electrawinds NV	2006	€30m	Equity	45MW	Wind; biomass conversion technologies	Belgium
Gamesa advanced Servicios S.A. Unipersonal and Siemsa Este S.A. Unipersonal	2006	€170m	Equity (100%)	N/A	Wind	Spain

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
SiGE Semiconductor	2006	c.€2m ($19.5 between 8)	Equity	N/A	Advanced electricity networks	USA
Konarka Technologies Inc	2006	c.€2.5m ($20m between 7)	Equity	N/A	Solar PV	USA
Pelamis Wave Power	2002-2006	c.€5m (£40 between 8)	Equity	2.25MW	Ocean energy	United Kingdom

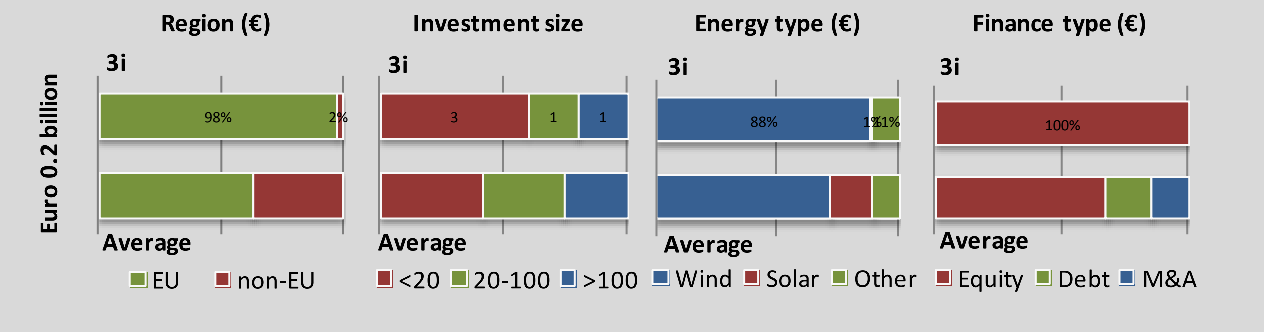
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Electrawinds, NV	2008	2006	c.€60m (double investm't)	ROI: c.41% Multiple: c.2x	Wind	Belgium

DESCRIPTION

3i is a leading international investment manager focused on mid-market Private Equity, Infrastructure and Debt Management. Its Private Equity business invests in mid-market companies with an enterprise value between €100m – €500m. Its Infrastructure business invests principally in core infrastructure in Europe, as well as primary PPP and renewable energy project markets.Its Debt Management business invest in senior and mezzanine corporate debt in large private companies in Europe and North America. 3i's growth capital team, which provides financial and strategic support, invests €10 - €150 million in minority positions in established businesses with the potential for value growth. As of September 2014, it had 16 billion Euros (£12.9bn) of assets under management.

MARKET COMPARISON



Box 3.67 HG Capital

Overview:

Name	**HgCapital**
Type	**Private equity / pensions**
HQ	**London, United Kingdom**
Established	**2000**
Ownership	**Private limited partnership**
Parent	**N/A**
Sectors	**Telecoms, Media and Technology; Services; Industrials; Renewable Energy**
SET sector	**Biomass conversion technologies; solar photovoltaics; wind**
Type	**Private equity; asset finance (equity and debt)**
Regional interest	**Canada, USA, UK, Germany; France; Spain**
Signatory to	**UN Principles for Reasonable Investment**

Credit http://www.hgcapital.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Aufwind Schmack Neue Energien	2007	c.€50m	Equity	N/A	Biomass conversion technologies; Wind	Germany
Picardy wind farms from ENERTRAG	2007	€69m	Equity	47.5MW	Wind	France
Spain PV from AIG	2009	N/A (EV: €300m)	Equity	35.4MW	Solar PV	Spain

FIRST-OF-A-KIND SET

N/A

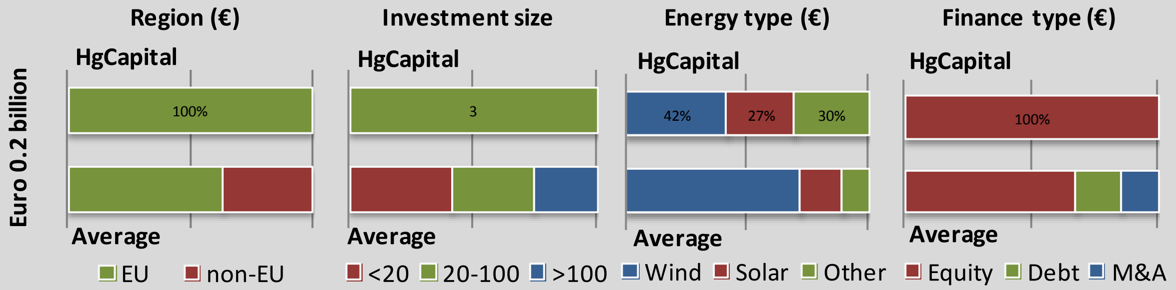
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
RidgeWind to Blue Energy	2013	2007	c.€300 (£250m)	Multiple: 1.5x	Wind	United Kingdom
Picardy wind farms	2013	2007	N/A	N/A	Wind	France
UK Wind Portfolio to Munich Re MAEG	2012	2005, 2008, 2009	N/A	N/A	Wind	United Kingdom

DESCRIPTION

HgCapital is a sector expert private equity investor, supporting management teams to grow industry champions. With 100 employees in two investment offices in the UK and Germany, HgCapital has assets under management of 6.5 billion Euros (£5.2 billion), serving over 100 institutional investors, including private and public pension funds, endowments, insurance companies and fund of funds.

MARKET COMPARISON



Box 3.68 Foresight Group

Overview:

Name	**Foresight Group**
Type	**Private Equity Fund**
HQ	**London, United Kingdom**
Established	**1984**
Ownership	**Private limited company**
Parent	**N/A**
Sectors	**IT; communications; manufacturing; services; environmental**
SET sector	**Advanced electricity networks; biomass conversion technologies; large scale energy storage solutions; solar photovoltaics; wind**
Type	**Private equity; asset finance**
Regional interest	**UK; Spain; Italy**
Signatory to	**UN Principles for Reasonable Investment**

Credit http://www.foresightgroup.eu/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Foresight Puglia PV Portfolio	2009	c.€6.25m	Equity	6MW	Solar PV	Italy
OPDE Piedmont PV Portfolio	2011	€11m (€33m between 3)	Equity	8MW	Solar PV	Italy
Utility Funding Ltd	2013	c.€8.5m (£7.5m)	Equity	N/A	Advanced electricity networks	United Kingdom

FIRST-OF-A-KIND SET

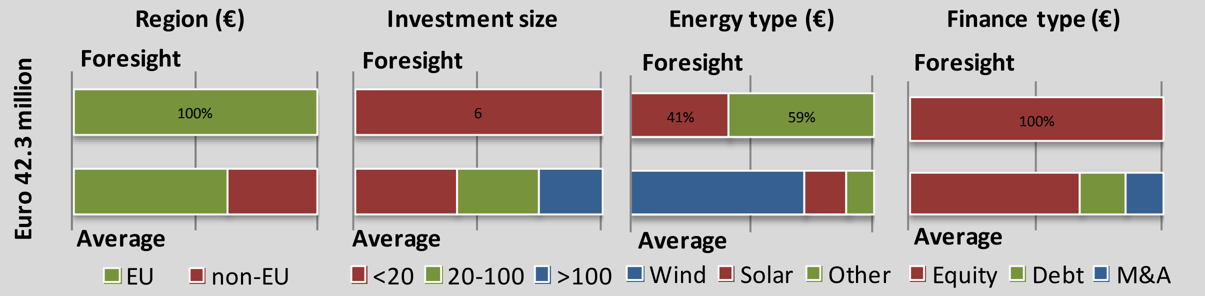
Name	Year	Value	Instrument	Scale	Sector	State
Birmingham Bio Power Ltd	2013	c.€7.5m (£6.2m in £47.8m deal)	Equity	10.3MW	Biomass conversion technologies	United Kingdom
Abandoned - O-Gen	2007 2008	c.€1m (£0.46m+ £0.35m)	Equity	3MW	Biomass conversion technologies	United Kingdom
Enfield anaerobic digestion	2014	c.€8m (£7.5m)	Equity (with GIB)	1.2MW	Biomass conversion technologies	United Kingdom

EXIT N/A

DESCRIPTION

Foresight Group is a leading independent infrastructure and private equity investment manager with over 1.6 billion Euros (£1.3bn) of assets under management, raised from institutional investors, family offices, private and high net-worth individuals.

MARKET COMPARISON



Box 3.69 Braemar Energy Ventures

Overview:

Name	**Braemar Energy Ventures**
Type	**Private Equity Fund**
HQ	**London, United Kingdom**
Established	**2002**
Ownership	**Private limited company**
Parent	**N/A**
Sectors	**Energy technology**
SET sector	**Advanced electricity networks; carbon capture and storage; large scale energy storage; solar photovoltaics**
Type	**Private equity**
Regional interest	**USA; Ireland**
Signatory to	**N/A**

Credit http://www.braemarenergy.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Powervation	2014	c€1m ($5.5m between 5)	Equity	N/A	Advanced electricity networks	Ireland
Ciris Energy	2011	<€5m ($24m between 4)	Equity	N/A	Carbon capture and storage (CCS)	USA
Stion	2007	c.€3m ($15m between 4)	Equity	R&D	Solar PV	USA

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Abandoned - Climos	2008	c€1m ($3.5m between >2)	Equity	N/A	Carbon capture and storage (CCS)	USA
Stion	2011	c.€16m ($130m between 6)	Equity	60kW	Solar PV	USA

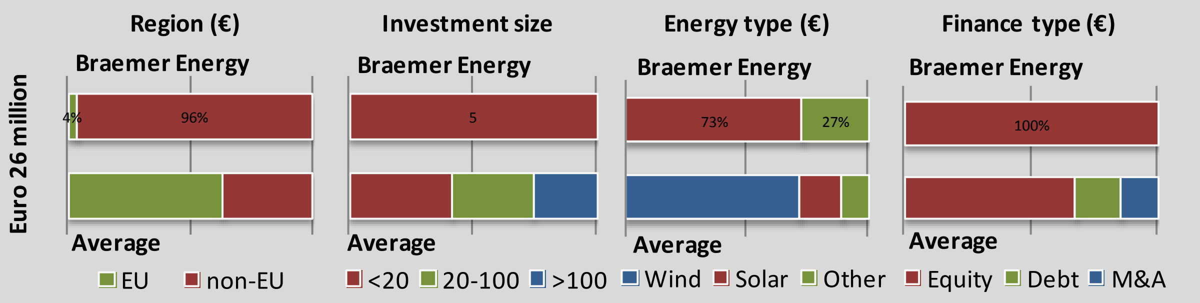
EXIT

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Solazyme	2011	2009	c.€55m ($80.3m)	Series A – 41.3x Series B – 15.8x Series C – 3.2x Series D – 2.4x	Biomass conversion technologies (algae)	USA
EnerNoc	2007	2004 – 2006	c.€8m ($11.1m, $26 times 426.7k)	Average: 107% p.a. ROI 5.84x multiple	Advanced electricity networks	USA

DESCRIPTION

Braemar Energy Ventures is a venture capital fund making early- to mid-stage investments in the energy technology sector. The firm's principals have invested in more than 60 companies in the sector and have more than 100 years of combined technical, operational and financial experience in energy and energy-related industries.

MARKET COMPARISON



Box 3.70 Wellington Partners

Overview:

Name	**Wellington Partners**
Type	**Private Equity Fund**
HQ	**Munich, Germany**
Established	**1998**
Ownership	**Private limited company**
Parent	**N/A**

Credit http://www.wellington-partners.com/

Sectors	**General**
SET sector	**Advanced electricity networks; biomass conversion technologies; ocean energy; solar photovoltaics**

Type	**Private equity**
Regional interest	**Germany, UK**
Signatory to	**UN Principles for Reasonable Investment**

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Enecsys	2009	c.€3.5m($10m between 2)	Equity	N/A	Solar PV	United Kingdom

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
ORECon	2008	c.€4m ($24m between 4)	Equity	1.5 MW	Ocean energy	United Kingdom
Heliatek	2009	c.€3m (€18m between 8)	Equity	N/A	Solar PV	Germany

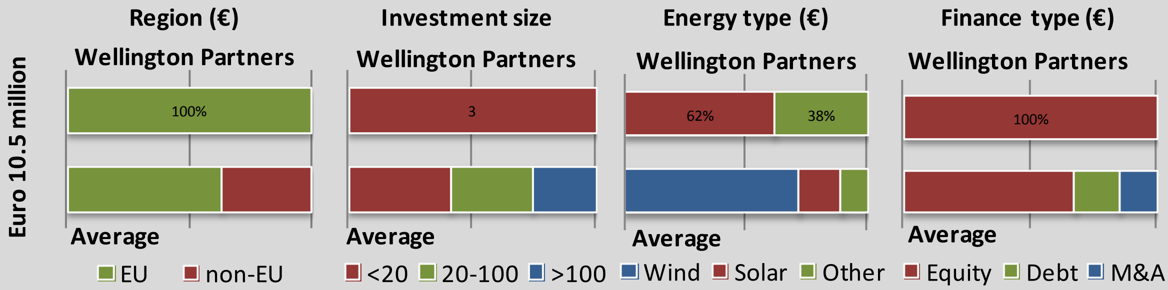
EXITS

N/A

DESCRIPTION

Wellington Partners is a pan-European venture capital firm with €800 million under management and offices in London, Munich and Zurich. The firm invests in young companies throughout Europe, mainly in the areas of technology, life sciences and digital media.

MARKET COMPARISON



Box 3.71 Turquoise

Overview:

Name	**Turquoise**
Type	**Private equity fund / merchant bank**
HQ	**London, United Kingdom**
Established	**2002**
Ownership	**Limited liability partnership**
Parent	**N/A**
Sectors	**Energy and environment**
SET sector	**Advanced electricity networks; biomass conversion technologies; ocean energy; solar photovoltaics**
Type	**Private equity; grants**
Regional interest	**UK; Australia**
Signatory to	**N/A**

Credit
http://www.turquoiseassociates.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
Examples:	☑	☐	☐	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Green Energy Options Ltd	2014	c.€1m (£3m between 3)	Equity	N/A	Advanced electricity networks	United Kingdom
AmiHo Ltd	2013	c.€0.5m ($1.4m for 2)	Equity	N/A	Advanced electricity networks	United Kingdom

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Push Energy Ltd	2013	c.€1m ($1.2m)	Equity	150MW	Solar PV	United Kingdom
Trident Energy PowerPod	2012	c.€0.2m (£0.18m)	Grant	N/A	Ocean energy	United Kingdom

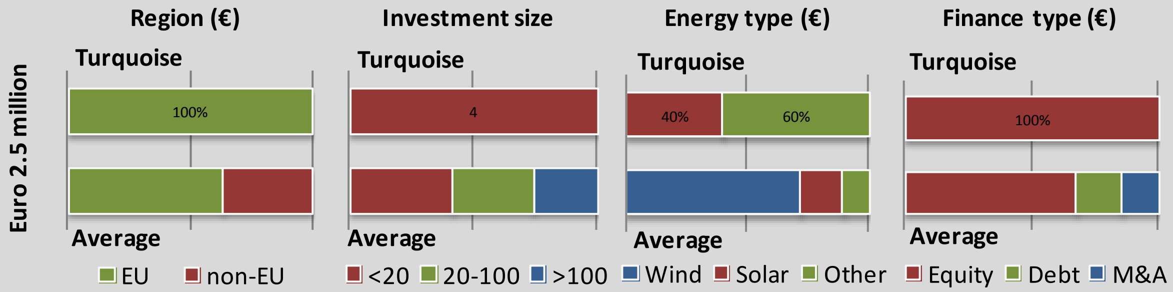
EXITS

N/A

DESCRIPTION

Turquoise Associates is a group of independent companies with a common focus on Corporate Finance for Energy and Environment. Turquoise International is a merchant bank specialising in Energy and Environment. Turquoise Capital LLP invests in selected opportunities in Energy and Environment. The Low Carbon Innovation Fund (LCIF) is a venture capital fund which makes early-stage investments as equity or convertible loan between 0.03 million Euros and 0.9 million Euros (£25k and £750k) alongside co-investors.

MARKET COMPARISON



Box 3.72 DeMeter Partners

Overview:

Name	**DeMeter Partners**
Type	**Venture Capital Fund**
HQ	**Paris, France**
Established	**2005**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Green Energy**
SET sector	**Advanced electricity networks; biomass conversion technologies; concentrated solar power; large scale energy storage; solar photovoltaics; wind**
Type	**Private equity**
Regional interest	**France, Germany, Spain, Belgium, UK, USA**
Signatory to	**UN Principles for Reasonable Investment**

Credit http://www.demeter-partners.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Solairedirect SA	2007	c.€2m (6.1m between 3)	Equity	16MW	Solar PV	France
SCHNELL Motoren AG	2011	c.€5m (€10m between 2)	Equity	N/A	Biomass conversion technologies	Germany
Qualisteo	2014	c.€1m (€2m between 2)	Equity	N/A	Advanced electricity networks	France

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Solairedirect SA	2009	c.€3m (€20m between 7)	Equity	4.2 MW	Solar PV	France

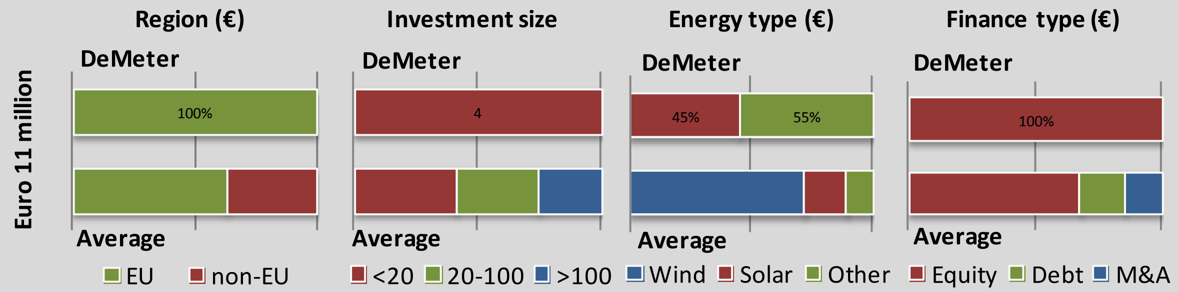
EXITS

N/A

DESCRIPTION

Demeter Partners is a private equity management company specialising in the areas of the environment and renewable energy. It currently manages 350 million Euros dedicated to SMEs in eco-industries and eco-energies located mainly in France, Germany and Spain, from the seed stage to growth capital.

MARKET COMPARISON



Box 3.73 Camco Clean Energy

Overview:

Name	**Camco Clean Energy**
Type	**Venture Capital / Developer**
HQ	**London, United Kingdom/St. Helier, Jersey**
Established	**1989**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Renewable energy and carbon markets**
SET sector	**Biomass conversion technologies; large scale energy storage; solar photovoltaics**
Type	**Asset finance**
Regional interest	**USA, UK, China, Africa**
Signatory to	**N/A**

Credit http://www.camcocleanenergy.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Dallas Landfill Gas Recovery Facility	2007	<€10m (<$12.5m)	Equity	3,850 dTh/day	Biomass conversion technologies	USA
Cargill's biogas plant Hansen	2014	€2m	Equity	2.1MW	Biomass conversion technologies	USA

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Dairy Farm Biogas Project in Idaho	2011	<€20m (<$25m)	Equity	4.5MW	Biomass conversion technologies	USA
Re-Fuel Tech Limited (now RED-T Tech Limited)	2008	€0.49m	Equity (75% increase from 43%)	N/A	Large scale energy storage	UK

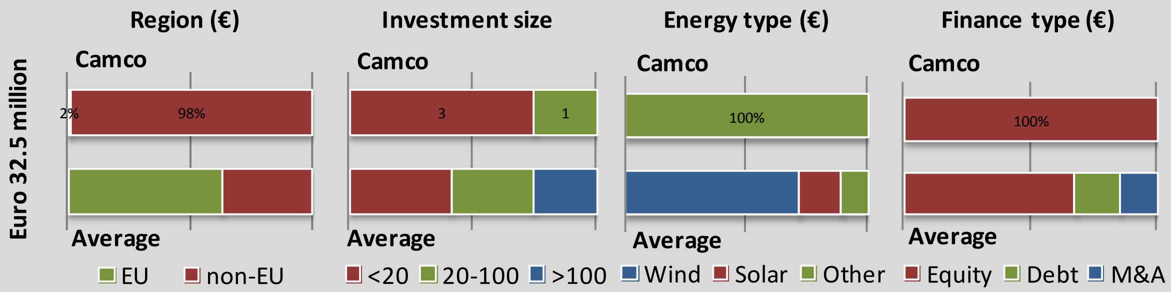
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Dallas Landfill Gas Recovery Facility	2008	2007	c.€12.5m ($19.1m)	ROI: 66% (IRR) Multiple: 1.53x	Biomass conversion technologies	USA
RED-T Tech Limited	2011	2000	Equity (sale 75% to 49%)	N/A	Large scale energy storage	UK

DESCRIPTION

Camco Clean Energy is a clean energy development company which combines technical and commercial expertise to finance, develop, and operate renewable energy projects and storage technology. Camco works with local developers, governments, development banks, and private investors to implement clean energy projects, policies, and technologies and reduce emissions in Asia, North America, Africa and Europe.

MARKET COMPARISON



Box 3.74 Sofiannova Partners

Overview:

Name	**Sofinnova Partners**
Type	**Venture capital**
HQ	**Paris, France**
Established	**1972**
Ownership	**Partnership**
Parent	**N/A**

Credit http://www.sofinnova.fr/

Sectors	**Information technology and life sciences**
SET sector	**Advanced electricity networks; biomass conversion technologies; large scale energy storage**
Type	**Private equity**
Regional interest	**France; Italy; UK**
Signatory to	**N/A**

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Accent SpA	2006	€10.6m	Equity	N/A	Advanced electricity networks	Italy

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Synthace Ltd	2013	c.€1m (£1.3 lead)	Equity	N/A	Biomass conversion technologies	United Kingdom
McPhy Energy	2010	c.€5m (€13.7m between 3)	Equity	N/A	Large scale energy storage	France

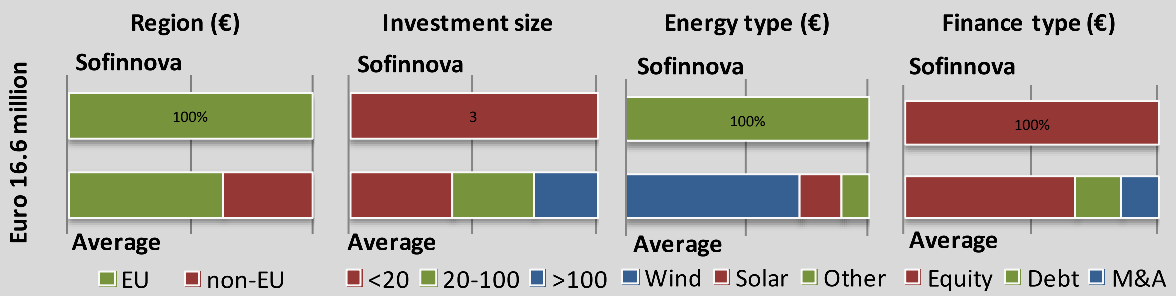
EXITS

N/A

DESCRIPTION

Sofinnova Partners is an independent venture capital firm based in Paris, France. For 40 years, the firm has backed nearly 500 companies at different stages of their development – pure creations, spin-offs, as well as turnaround situations – in the Life Sciences and Clean Energy sectors. With over 1.3 billion Euros of funds under management, Sofinnova Partners applies a hands-on approach in building portfolio companies through to exit.

MARKET COMPARISON



Box 3.75 KPCB

Overview:

Name	**Kleiner Perkins Caufield Byers**
Type	**Venture Capital**
HQ	**Menlo Park, USA**
Established	**1972**
Ownership	**Private limited company**
Parent	**TCW Group Inc**
Sectors	**Information technology and life sciences**
SET sector	**Advanced electricity networks; biomass conversion technologies; carbon capture and storage; concentrated solar power; geothermal energy; solar photovoltaics; wind**
Type	**Private equity; corporate debt (rare)**
Regional interest	**USA**
Signatory to	**N/A**

Credit http://www.kpcb.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☑	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Amonix Inc	2010	c.€15m ($129.4m between 8)	Equity	N/A	Concentrated solar power (CSP)	USA
Enphase Energy	2010	c.€10m ($63m between 7)	Equity	N/A	Solar PV	USA
Miasole	2012	c€10m($55m between 5)	Convertible debt	150MW	Solar PV	USA

FIRST-OF-A-KIND SET

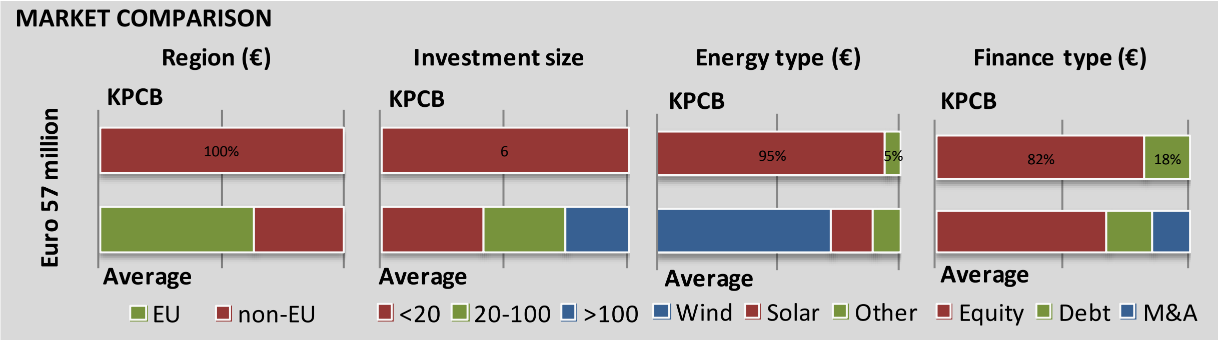
Name	Year	Value	Instrument	Scale	Sector	State
AltaRock Energy	2008	c.€3m ($4m)	Equity (VC / PE)		Geothermal energy	USA
Ausra Areva Solar	2007	c.€15m ($41.8m between 2)	Equity	N/A	Concentrated solar power (CSP)	USA
Solexel Inc	2012	c€4m($25m between 5)	Equity	N/A	Solar PV	USA

EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Ausra Areva Solar	2010	2007	c.€300m	N/A	Concentrated solar power (CSP)	USA
Miasole	2012	2005-2012	c.€5m ($30m total)	Multiple: <0.05x	Solar PV	USA

DESCRIPTION

KPCB invests in all stages from seed and incubation to growth companies and operates from offices in Menlo Park, San Francisco, Shanghai and Beijing. The firm makes seed investments ranging from 75 thousand Euros to 0.75 million Euros ($0.1m to $1m), early-stage investments between 0.75 million Euros and 7.5 million Euros ($1m and $10m), and growth-stage investments between 7.5 million Euros and 56 million Euros ($10m and $75m). KPCB has two industry specific teams: digital growth and green growth.



MARKET COMPARISON
Region (€)
Investment size
Energy type (€)
Finance type (€)
Euro 57 million
KPCB
100%
6
95%
5%
82%
18%
Average
EU
non-EU
<20
20-100
>100
Wind
Solar
Other
Equity
Debt
M&A

Box 3.76 Yellow and Blue

Overview:

Name	**Yellow & Blue**
Type	**Venture Capital**
HQ	**Utrecht, Netherlands**
Established	**2008**
Ownership	**Private limited company**
Parent	**Nuon (majority shareholder)**
Sectors	**Renewable energy and energy efficiency technology**
SET sector	**Advanced electricity networks; biomass conversion technologies; wind**
Type	**Private equity**
Regional interest	**Netherlands; Switzerland; Germany**
Signatory to	**N/A**

Credit http://www.yellowandblue.nl/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Topell Energy BV	2012	c.€2.6 (€13m between 5)	Equity	N/A	Biomass conversion technologies	Netherlands
Romo Wind	2013	c.€1.2m (€4.8m between 4)	Equity	N/A	Wind	Switzerland
Triogen Group	2013	c€1.2m (€6.5m between 4)	Equity	N/A	Biomass conversion technologies	Netherlands

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Locamation	2011	c.€1.7m (€5m between 3)	Equity	N/A	Advanced electricity networks	Netherlands

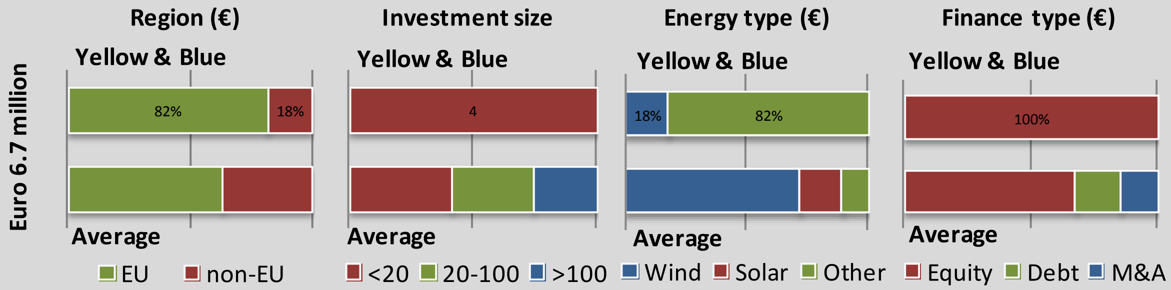
EXITS

N/A

DESCRIPTION

Yellow&Blue Investment Management B.V. is an independent venture capital firm specializing in development stage clean energy investments. Yellow&Blue was founded in 2008 by Nuon, a major energy company (part of the Vattenfall group of companies).

MARKET COMPARISON



Box 3.77 Ambienta

Overview:

Name	**Ambienta SGR**
Type	**Private Equity**
HQ	**Milano, Italy**
Established	**2007**
Ownership	**Public limited company**
Parent	**N/A**
Sectors	**Environment**
SET sector	**Biomass conversion technologies; large scale energy storage; solar photovoltaics; wind**
Type	**Private equity**
Regional interest	**Italy; France; UK**
Signatory to	**UN Principles for Reasonable Investment**

Credit http://www.ambientasgr.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Announced - Foundocean	2012	€10m	Equity (35% stake)	N/A	Wind	United Kingdom
Ravelli Srl	2010	N/A (€10-€30m)	Equity (60% stake)	N/A	Biomass conversion technologies	Italy
ICQ holding SpA	2010	€37.5m	Equity (23.8% stake)	110MW	Biomass conversion technologies; solar PV; large scale energy storage; wind	Italy

FIRST-OF-A-KIND SET

N/A

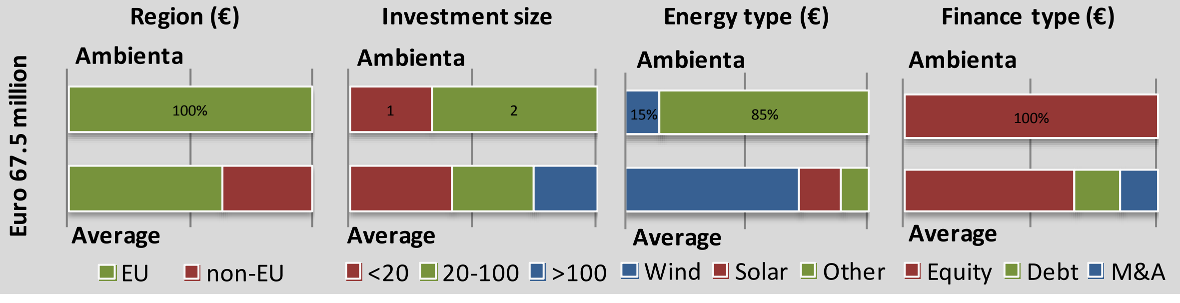
EXITS

Name	Exit	Entry	Value	ROI/Multiple	Sector	State
Italiana Pellets	2013	2008	N/A	N/A	Biomass conversion technologies	Italy
Alpin Pellet	2013	2009	N/A	N/A	Biomass conversion technologies	France

DESCRIPTION

Ambienta SGR is the largest European private equity fund focused on the environmental sector with assets under management of over 450 million Euros, Ambienta has completed ten investments (16 including add-ons) in the areas of energy efficiency, pollution control, recycling, and primary resource management.

MARKET COMPARISON



Box 3.78 NZ:Northzone

Northzone

GROWTH INVESTORS SINCE 1996

Credit northzone.com/

Overview:

Name	**NZ:Northzone**
Type	**Venture capital**
HQ	**Stockholm, Sweden**
Established	**1996**
Ownership	**Public limited company**
Parent	**N/A**
Sectors	**Technology**
SET sector	**Ocean energy; large scale energy storage; solar photovoltaics; concentrating solar power; wind**
Type	**Private equity**
Regional interest	**Norway; Sweden; UK; USA**
Signatory to	**N/A**

Investment focus:	Equity	Loans	Capital market bonds	M&A
	☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Innotech Solar AS	2009	c.€3m (€6m between 2)	Equity	N/A	Solar PV	Norway
ChapDrive AS	2007	c.€0.8 (€2.25 between 3)	Equity	300 kW	Wind	Norway

FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Defunct - Oreco Ltd	2008	c.€3.5m (£12.1m between 4)	Equity	N/A	Ocean energy	United Kingdom
ClimateWell	2008	c.€5m (SEK 100m between 2)	Equity	N/A	Concentrating solar power (CSP)	Sweden
Chapdrive AS	2010	c.€2m (€11m between 5)	Equity	5MW*	Wind	Norway

*Same company, different technology

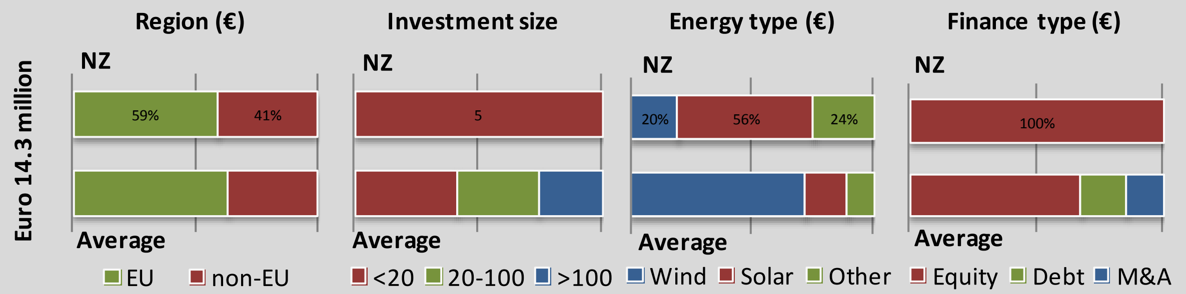
EXITS

N/A

DESCRIPTION

Founded in 1996, Northzone has to date raised seven funds and invested in some 100 technology-enabled companies. Northzone's latest fund, Northzone VII, at 245 million Euros ($325m), made it one of the largest venture funds raised in 2014 globally.The company has offices in London, Stockholm, Oslo, Copenhagen and New York.

MARKET COMPARISON



Box 3.79 Blackstone

Overview:

Name	**Blackstone Group LP/The**
Type	**Asset Manager**
HQ	**New York, USA**
Established	**1985**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**Alternative assets**
SET sector	**Advanced electricity networks; concentrating solar power; large scale energy storage; geothermal; solar photovoltaics; wind**
Type	**Private equity; asset finance**
Regional interest	**USA; Germany; India**
Signatory to	**N/A**

Credit https://www.blackstone.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

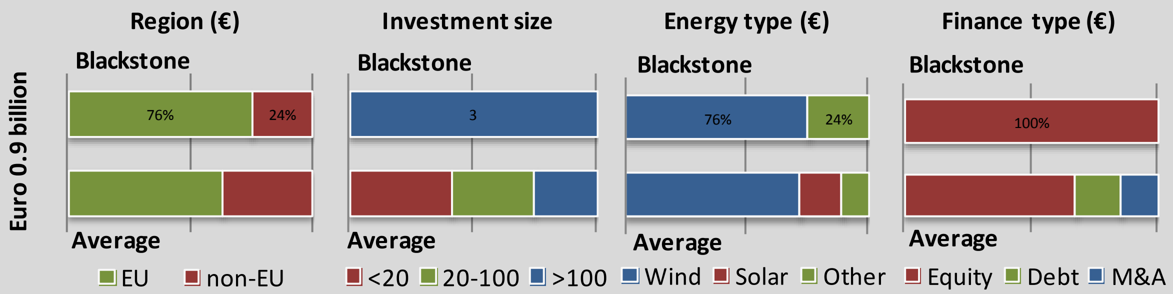
Name	Year	Value	Instrument	Scale	Sector	State
Announced - Nördlicher Grund Offshore Wind Farm	2011	c.€400m (€1.3bn, assumption 30/70 equity/debt)	Equity (100% stake)	320MW	Wind	Germany
Meerwind Sud und Ost Offshore Wind	2010	c.€300m (€1.2bn total, >3x leverage)	Equity (80% stake)	288MW	Wind	Germany
Moser Baer Projects Private Ltd (MBPPL)	2010	c.€225m (INR13.5bn)	Equity	5,000MW	Geothermal (4/5), solar, hydro	India

FIRST-OF-A-KIND SET
N/A

EXITS
N/A

DESCRIPTION
Blackstone is a premier global investment and advisory firm. Blackstone is the world's largest independent alternative asset manager, serving the investment needs of leading public pension funds, academic and charitable institutions and other investors for nearly 30 years. Total Assets Under Management were 233 billion Euros ($310bn) as of March 31, 2015.

MARKET COMPARISON



Box 3.80 Blackrock

Overview:

Name	**BlackRock**
Type	**Asset Management**
HQ	**New York, USA**
Established	**1988**
Ownership	**Public listed company**
Parent	**N/A**
Sectors	**General**
SET sector	**Solar photovoltaics; wind**
Type	**Asset finance**
Regional interest	**USA, UK, Canada, Ireland, France, Sweden**
Signatory to	**UN Principles for Reasonable Investment**

Credit https://www.blackrock.com/

Investment focus:

Equity	Loans	Capital market bonds	M&A
☑	☐	☐	☐

Examples:

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Solairedirect SA France PV Portfolio	2015	c.€50m (€168 between 3+)	Equity	136.8MW	Solar PV	France
Announced - EDF Hereford , Longhorn & Spinning Spur III Wind Farm Acquisition	2015	N/A	50% Equity	594MW	Wind	USA
Sancton Hill and South Sharpley Wind Farms	2013	c.€18m (£15.3 in £31.2m)	Equity	16MW	Wind	UK

FIRST-OF-A-KIND SET

N/A

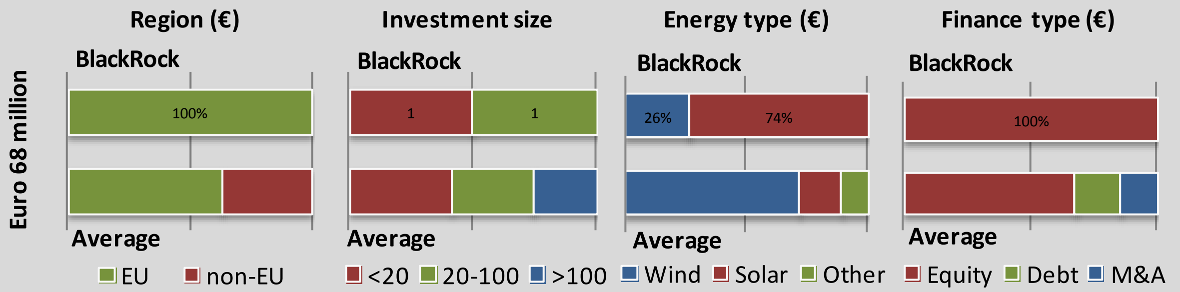
EXITS

N/A

DESCRIPTION

BlackRock is one of the world’s leading asset management firms and a premier provider of investment management, risk management and advisory services to institutional, intermediary and retail clients worldwide. With over 7,700 portfolios managed by over 12,000+ employees in the world with 3.6 trillion Euros ($4.77tn) of assets under management, BlackRock manages more money than any other investment firm.

MARKET COMPARISON



Box 3.81 MEAG

Overview:

Name	**MEAG Munich Re and ERGO Asset Management GmbH**
Type	**Asset management**
HQ	**Munich, Germany**
Established	**1999**
Ownership	**Subsidiary / quoted company**
Parent	**Münchener Rückversicherungs-Gesellschaft AG in München**
Sectors	**Securities, real estate, funds of funds**
SET sector	**Solar photovoltaics; wind**
Type	**Private equity, asset finance, asset acquisition**
Geography	**France; Spain; Germany; Italy; UK**
Signatory to	**UN Principles for Reasonable Investment**

Credit http://www.meag.com/

Investment focus:	Equity	Loans	Capital market bonds	M&A
Examples:	☑	☐	☐	☐

NON-FIRST-OF-A-KIND SET

Name	Year	Value	Instrument	Scale	Sector	State
Iberdrola France Wind Portfolio	2012	€140m (40% €350m)	40% equity	305MW	Wind	France
Scout Moor Wind Farm acquisition	2012	c.€65m (c.£50m)	Equity	65MW	Wind	United Kingdom
Germany wind acquisition	2010	>€100m (low three digit million range)	Equity	73MW	Wind	Germany

FIRST-OF-A-KIND SET

N/A

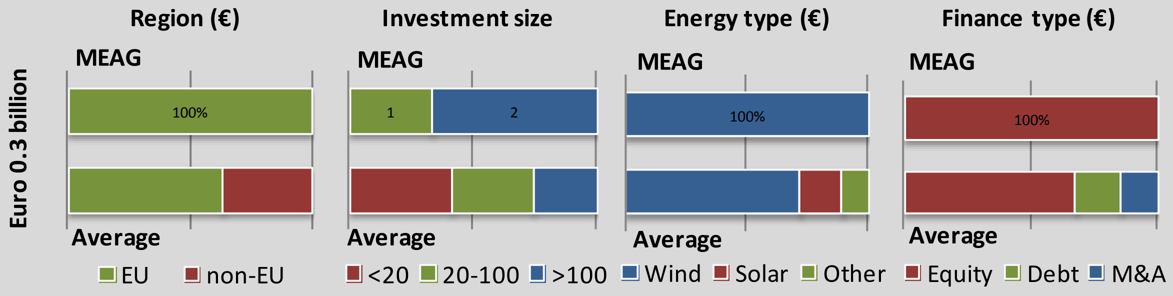
EXIT

N/A

DESCRIPTION

MEAG is one of the major asset managers in the European financial sector. It is responsible for virtually all the investments of Munich Re and ERGO. MEAG also manages the capital of partners from outside the company group. As of March 2015, it had 270 billion Euros of assets under management.

MARKET COMPARISON



3.7 Consolidated List of Market Participants

Table 3.1 overleaf presents a tabular overview of all 80 market participants and indicates the 50 that we have selected for interview on the basis of ensuring a good balance across different types of market participant, their countries of location, and the SET Plan technologies, and for which we have good contacts. It is these 50 that constitute the Consolidated List of Market Participants. An Excel version of Table 3.1 was previously submitted to DG RTD as the Market Participant List and Market Participants' Selection.

Table 3.1 Market Participant List, comprising all 80 market participants in the table, and Consolidated List of Market Participants, consisting of the 50 market participants written in black

Name	Stakeholder Group	City	Country	AEN	BIO	CCS	CSP	GEO	LES	OCN	SPV	WIN	Link
3i	Private Equity	London	UK	✓	✓	-	-	-	-	✓	✓	✓	http://www.3i.com
ABN AMRO Bank NV	Corporate Bank	Amsterdam	Netherlands	-	✓	✓	✓	-	✓	-	✓	✓	https://www.abnamro.com/
AIG	*Insurance*	*New York*	*USA*	-	-	-	-	-	✓	-	✓	-	*http://www.aig.com/*
Allianz	Insurance	Munich	Germany	-	-	-	-	-	-	-	✓	✓	https://www.allianz.com
Ambienta SGR	*Venture Capital*	*Milano*	*Italy*	-	✓	-	-	-	✓	-	-	✓	*http://www.ambientasgr.com/*
Bank of Ireland	Corporate Bank	Dublin	Ireland	-	✓	-	-	-	-	-	✓	✓	https://www.bankofireland.com/
Bank of Sabadell	*Corporate Bank*	*Sabadell*	*Spain*	-	✓	-	✓	-	-	-	✓	✓	*https://www.bancsabadell.com*
Bank of Santander	Corporate Bank	Madrid	Spain	✓	-	-	✓	-	-	-	✓	✓	http://www.santander.co.uk/
BBVA	Corporate Bank	Bilbao	Spain	-	✓	-	✓	-	✓	-	✓	✓	https://www.bbva.es
BlackRock	Asset management	New York	USA	-	-	-	-	-	-	-	✓	✓	https://www.blackrock.com
Blackstone Group	Asset management	New York	USA	✓	-	-	✓	✓	✓	-	✓	✓	https://www.blackstone.com/
BNP Paribas	Corporate Bank	Paris	France	-	✓	-	✓	✓	-	-	✓	✓	http://www.bnpparibas.com/
Braemar Energy Ventures	Private Equity	London	UK	✓	-	✓	-	-	✓	-	✓	-	http://www.braemarenergy.com/
Caisse de dépôt et placement du Québec Pension fund	*Pension fund*	*Québec City*	*Canada*	-	-	-	-	-	✓	-	✓	✓	*www.lacaisse.com*
Caixa Geral de Depositos	*Corporate Bank*	*Lisbon*	*Portugal*	-	✓	✓	✓	-	✓	-	✓	✓	*https://www.cgd.pt/*
Camco Clean Energy	Venture Capital	London	UK	-	✓	-	-	-	✓	-	✓	-	http://www.camcocleanenergy.com/
Cargill Environmental Finance	*Industrial*	*Minneapolis*	*USA*	-	✓	-	-	-	-	-	-	✓	*http://www.cargill.com/*
Centrica	Utility	Windsor	UK	-	✓	✓	-	-	✓	-	✓	✓	http://www.centrica.com/
Commerzbank	Corporate Bank	Frankfurt	Germany	-	✓	-	-	-	-	-	✓	✓	https://www.commerzbank.com/
Craton Equity Partners	*Private Equity*	*Los Angeles*	*USA*	✓	✓	-	-	✓	-	-	✓	-	*http://www.cratonep.com/*
Crédit Agricole	*Corporate Bank*	*Paris*	*France*	-	✓	-	-	-	-	-	✓	-	*http://www.crédit-agricole.fr/*
Credit Suisse	Corporate Bank	Zurich	Switzerland	✓	✓	✓	✓	✓	✓	-	✓	✓	https://www.credit-suisse.com/
Danfoss	*Industrial*	*Nordborg*	*Denmark*	-	-	-	-	✓	-	-	✓	-	*http://www.danfoss.com/*
DeMeter Partners	Venture Capital	Paris	France	✓	✓	-	✓	-	✓	-	✓	✓	http://www.demeter-partners.com/
Deutsche Bank	Corporate Bank	Frankfurt	Germany	-	✓	-	-	-	-	-	✓	✓	https://www.db.com
Dexia N.V./S.A.	*Corporate Bank*	*Brussels*	*Belgium*	-	✓	-	-	-	-	-	✓	✓	*http://www.dexia.com/*
DONG Energy	Utility	Skaerbeak	Denmark	✓	✓	✓	-	-	-	-	-	✓	http://www.dongenergy.com/
Doosan Babcock	Industrial	Crawley	UK	-	-	✓	-	-	✓	-	-	-	http://www.doosanbabcock.com/
E.on	Utility	Dusseldorf	Germany	-	✓	✓	✓	-	✓	-	✓	✓	https://www.eonenergy.com/
EDF Energies Nouvelle	Utility	Paris	France	✓	✓	-	-	-	-	-	✓	✓	http://www.edf-energies-nouvelles.com/
Enercon GmbH	Industrial	Aurich	Germany	-	-	-	-	-	✓	-	-	✓	http://www.enercon.de/
ENGIE (former GDF Suez)	Utility	Paris	France	✓	✓	✓	-	✓	✓	-	✓	✓	http://www.gdfsuez.com/
Euler Hermes	Insurance	Paris	France	-	-	-	✓	-	-	-	-	✓	http://www.eulerhermes.com
Foresight Group	Private Equity	London	UK	✓	✓	-	-	-	✓	-	✓	✓	http://www.foresightgroup.eu/
Gamesa	*Industrial*	*Zamudio*	*Spain*	-	-	-	-	-	-	-	-	✓	*http://www.gamesacorp.com/*
General Electric	*Industrial*	*Fairfield*	*USA*	✓	✓	-	-	-	✓	-	✓	✓	*http://www.ge.com/*
Goldman Sachs Group	Corporate Bank	New York	USA	✓	✓	✓	-	-	✓	-	✓	✓	http://www.goldmansachs.com/
Green Investment Bank	Public Bank	Edinburgh	UK	-	✓	-	-	-	-	-	-	✓	http://www.greeninvestmentbank.com/
HgCapital	Private Equity	London	UK	-	✓	-	-	-	-	-	✓	✓	http://www.hgcapital.com/
Honeywell International Inc.	*Industrial*	*New Jersey*	*USA*	✓	-	-	-	-	-	-	✓	-	*http://honeywell.com/*
HSBC	Corporate Bank	London	UK	-	✓	-	✓	-	-	-	✓	✓	https://www.hsbc.co.uk

Name	Stakeholder Group	City	Country	AEN	BIO	CCS	CSP	GEO	LES	OCN	SPV	WIN	Link
Iberdrola S.A.	Utility	Bilbao	Spain	✓	✓	-	✓	-	✓	✓	✓	✓	http://www.iberdrola.es/
Industriens Pensionsforsikring A/S Pension fund	*Pension fund*	*Copenhagen*	*Denmark*	-	-	-	-	-	-	-	-	✓	*https://www.industrienspension.dk*
Industrifonden	Public Bank	Stockholm	Sweden	✓	-	-	-	-	✓	-	✓	✓	http://www.industrifonden.se/
Intesa SanPaolo	Corporate Bank	Turin	Italy	-	✓	-	✓	-	-	-	✓	✓	http://www.intesasanpaolo.com/
Itochu Corp	*Industrial*	*Osaka*	*Japan*	-	✓	-	✓	-	✓	-	✓	✓	*http://www.itochu.co.jp/*
KfW	Public Bank	Frankfurt	Germany	✓	✓	-	✓	✓	✓	-	✓	✓	https://www.kfw.de
Kleiner Perkins Caufield Byers	*Venture Capital*	*Menlo Park*	*USA*	✓	✓	✓	✓	✓	✓	-	✓	✓	*http://www.kpcb.com/*
Kohlberg Kravis Roberts & Co. L.P.	Private Equity	New York	USA	✓	✓	✓	-	-	✓	-	✓	✓	http://www.kkr.com/
Masdar Abu Dhabi Future Energy Co	Public Bank	Abu Dhabi	UAE	-	✓	✓	✓	-	✓	-	✓	✓	http://www.masdar.ae/
MEAG Munich Re and ERGO Asset Management GmbH	*Insurance*	*Munich*	*Germany*	-	-	-	-	-	-	-	✓	✓	*http://www.meag.com/*
Metso	*Industrial*	*Helsinki*	*Finland*	-	✓	✓	-	-	✓	-	-	-	*http://www.metso.com/*
Mitsubishi Heavy Industries	Industrial	Tokyo	Japan	✓	-	✓	-	-	✓	-	✓	✓	https://www.mhi-global.com/
Natixis	Corporate Bank	Paris	France	-	✓	-	✓	-	✓	-	✓	✓	https://www.natixis.com
Norddeutsche Landesbank Girozentrale	*Corporate Bank*	*Hannover*	*Germany*	-	-	-	-	-	-	-	✓	✓	*https://www.nordlb.com/*
Nordea Bank	Corporate Bank	Stockholm	Sweden	-	-	-	-	-	-	-	✓	✓	http://www.nordea.com
Nordic Investment Bank	Public Bank	Helsinki	Finland	-	✓	-	-	-	✓	-	✓	✓	http://www.nib.int/
NZ:Northzone	Venture Capital	Stockholm	Sweden	-	-	-	-	-	✓	✓	✓	✓	http://northzone.com/
PensionDanmark	*Pension fund*	*Copenhagen*	*Denmark*	-	✓	-	-	-	-	-	-	✓	*https://www.pension.dk/*
PFA Pension	*Pension fund*	*Copenhagen*	*Denmark*	-	-	-	-	-	-	-	-	✓	*http://www.pfa.dk*
PGGM	Pension fund	Zeist	Netherlands	-	✓	-	-	-	-	-	-	✓	https://www.pggm.nl
Rabobank International	*Corporate Bank*	*Utrecht*	*Netherlands*	-	✓	-	-	-	-	-	✓	✓	*https://www.rabobank.com*
Robert Bosch GmbH	*Industrial*	*Stuttgart*	*Germany*	-	-	-	-	-	-	-	✓	-	*https://www.bosch-si.com*
Royal Bank of Scotland	*Corporate Bank*	*Edinburgh*	*UK*	✓	✓	-	-	-	-	-	✓	✓	*http://www.rbs.co.uk*
RWE Innogy GmbH	Utility	Essen	Germany	-	✓	-	-	-	-	-	✓	✓	http://www.rwe.com/web/cms/en/86134/rwe-innogy/
Siemens AG	Industrial	Munich	Germany	✓	-	-	✓	-	-	✓	✓	✓	http://www.siemens.com/
Societe Generale SA	Corporate Bank	Paris	France	-	✓	-	✓	✓	-	-	✓	✓	http://www.societegenerale.com/
Sofinnova Partners	*Venture Capital*	*Paris*	*France*	✓	✓	-	-	-	✓	-	-	-	*http://www.sofinnova.fr/*
Statkraft SF	Utility	Oslo	Norway	✓	-	✓	-	✓	✓	✓	✓	✓	http://www.statkraft.com/
Statoil ASA	Energy	Stavanger	Norway	✓	-	✓	-	✓	✓	-	✓	✓	http://www.statoil.com/
Sumitomo Mitsui Banking Corporation	Corporate Bank	Tokyo	Japan	-	✓	-	✓	✓	✓	-	✓	✓	http://www.smbc.co.jp/global/
Suzlon	*Industrial*	*Pune*	*India*	-	-	-	-	-	-	-	-	✓	*http://www.suzlon.com/*
TPG	*Private Equity*	*Fort Worth*	*USA*	-	✓	✓	-	-	✓	-	✓	✓	*https://tpg.com/*
Triodos Bank Group	Corporate Bank	Zeist	Netherlands	✓	-	-	-	-	✓	✓	✓	✓	https://www.triodos.co.uk
Turquoise	Private Equity	London	UK	✓	✓	-	-	-	-	✓	✓	-	http://www.turquoiseassociates.com/
Unione di Banche Italiane SCpA	Corporate Bank	Bergamo	Italy	-	-	-	✓	-	-	-	✓	✓	http://www.ubibanca.it/
Vestas Wind Systems A/S	Industrial	Aarhus	Denmark	-	-	-	-	-	✓	-	-	✓	http://www.vestas.com/
Viessmann Werke GmbH & Co KG	*Industrial*	*Allendorf*	*Germany*	-	✓	-	✓	-	-	-	-	-	*http://www.viessmann.com/*
Wellington Partners	Private Equity	Munich	Germany	✓	✓	-	-	-	-	✓	✓	-	http://www.wellington-partners.com/
Yellow & Blue	*Venture Capital*	*Utrecht*	*Netherlands*	✓	✓	-	-	-	-	-	-	✓	*http://www.yellowandblue.nl/*
Number of Market Participants in the List of 80 who have invested in each SET technology				**29**	**51**	**18**	**24**	**12**	**38**	**8**	**62**	**66**	
Number of Market Participants in the Consolidated List of 50 who have invested in each SET technology				**22**	**33**	**14**	**18**	**9**	**28**	**8**	**43**	**45**	

4 Market Conditions Descriptions Sheets

4.1 Overview

On the basis of desktop research by the ICF Team, covering applicable literature and data from 2013 onwards and focusing on key developments, this deliverable describes sector-specific market conditions across the 32 European countries studied (the EU 28 plus Iceland, Norway, Switzerland and Ukraine) for each of the nine relevant sectors of the Strategic Energy Technology (SET) Plan in a format that allows further processing.[101]

Within each sector-specific sheet, for each country, the growth trend of installed capacity over the period 2011 to 2014 is presented. This is useful to know since a consistent growth trend may be taken as an indication of a stable policy environment, which is crucial for the investor confidence needed for support by market participants for first-of-a-kind commercial-scale SET demonstration projects. This quantification exercise is supplemented by a simple qualitative scoring system that uses “smileys” to summarise the current attractiveness of the market conditions in the respective countries.

The report concludes with a summary of key findings, including an overview of Member States, which appear to offer favourable or unfavourable developments in their environment for first-of-a-kind commercial-scale SET demonstration projects. Some broad conclusions on financial support mechanisms and state aid are also provided in light of recent analyses and the potential ramifications of changes to European Union state aid guidelines.

4.2 Structure of the market condition description sheets

The first page of the market condition description sheet for a given SET displays key figures on capacity for that sector and recent growth in capacity. In the case of advanced electricity networks, the development and deployment budget is used as proxy for capacity. In the case of carbon capture and storage, values in mega-tonnes per annum stored (Mtpa) for planned capture capacity are given as well as for operational capture capacity.

This page also contains a map that shows the level of capacity (or budget) in each European country and shows the locations of test and demonstration facilities.

The second page consists of a table that, for each European country, shows the:

- Value for installed capacity as at the end of 2014, usually in megawatts (MW);
- Value for the target capacity for 2020 under the relevant National Renewable Energy Action Plan (NREAP);
- Year that the NREAP target was met, if it has been[102];
- Values for additions to capacity during the years 2012, 2013 and 2014.

Section 4.15 provides further details regarding the sourcing and processing of capacity data.

The remainder of each sector-specific sheet consists of tables that summarise recent important developments affecting market conditions by providing key information on the factors influencing deployment of the technology (predominantly the policy and regulatory frameworks) and, where possible, relevant information on factors in recent and planned

[101] Note that a more comprehensive survey of current direct and indirect policy measures, in addition to non-policy market conditions, would be a very extensive exercise that would add little in terms of value. For illustration, please refer to the historic overview (2005-2011) of energy support schemes published by the European Environment Agency, *Energy support measures and their impact on innovation in the renewable energy sector in Europe*, published December 2014. This report also contains a comparison of R&D for 2005-2011 which we considered too historic for this current analysis.

[102] Where ‘not applicable’ is indicated, this means either that the country did not specify a specific target in their NREAP reports for the sector in question or that the country is not an EU member

deployments. (Direct policy mechanisms linked to promotion of biofuels have been identified by country in the policy tables.)

Each table contains different countries, and the order of the tables is as follows:

- The highest ranking countries for installed capacity for the SET – usually the Top 5;
- The highest ranking countries for additions to installed capacity in 2014;
- The highest ranking countries for growth in installed capacity over the period 2011-2014;
- Other countries of interest with respect to the SET.

The final table highlights in a set of bullets the countries of “particular interest” with respect to the SET and hence to first-of-a-kind, commercial-scale, SET demonstration projects. In general, these are countries that have shown growth in 2014 and sustained growth over the period 2011 – 2014. Countries of particular interest were noted from the set of most notable developments (associated nearly ubiquitously with positive smileys) in the policy and the broader market[103]. Countries of particular interest – especially when combined with a positive policy outlook – denote the countries well positioned as catalysts of FOAK developments.

4.2.1 Market outlook

Market outlook is a qualitative scoring system we employ and present through happy, neutral, or frowny faces or “smileys”. Our market outlooks are not a comprehensive assessment of the market situation, instead they reflect developments in the policy and market environments relative to the current market situation. (For example, the decision by the UK government to remove the £1 billion, or approximately €1.4 billion, ring-fenced CCS competition in late November 2015 would score a frowny or negative outlook for CCS in the UK, despite other countries which may never have had such a competition to start with; the change policy determined our market outlook).

Foremost, smileys in our market outlook are derived from (i) supportive public policies, as well as (ii) available natural resources to expand, and (iii) strong current or future supply chains. Policies might take a quantitative approach, as dedicated funds or feed-in-tariffs, or non-quantified measures such as coordination and regulatory support. In either case the market outlook will always depend on information being readily available and identifiable from our structured internet search to provide evidence for the developments in the sector.

4.2.2 Prominent test facilities

Test facilities were selected to show some demonstration scale commercial test capacities, or likely to perform at least some demonstration scale test capacities or equivalents.

The focus on demonstration scale capacities means we make a distinction between test facilities likely for FOAK tests and facilities solely focussed on accreditation of equipment and standards, which we do not include. Likewise, tests facilities solely for the purpose of primary research, early feasibility tests, and/or tangent consultancy studies are not among the selected test facilities. In addition, to qualify as a test centre evidence is required of a broader research facility and a purpose of support to the supply chain (as opposite to an independent demonstration project) and eliminates projects at a more advanced stage. Prominent test facilities have been selected to be relevant in the supply chain support of projects with a FOAK technology readiness level for commercial demonstration purposes.

First, test facilities were identified through a structured internet search (using keywords and phrases, for instance “test site”, “catapult”, “test location”, “demonstration”, and

[103] In a very few instances, the countries of particular interest do not have an outlook, as they do not belong to the high capacity, addition, or growth countries, but do represent countries that are likely to be important for FOAK projects.

"demonstration site") and energy associations if readily available[104]. These were screened to be relevant to first-of-a-kind technology demonstration, as described above.

Second, the prominence of the test centre in each SET was evaluated using the annual research budget and number of full-time researchers as proxies for its prominence (these had to be estimated if not readily available). In some areas this was particularly relevant due to the otherwise large number of test demonstration facilities of minor importance (e.g. farmers associations and universities for Solar PV, CSP, and large scale energy storage), and a cut-off for prominence was set dependent on the industry. (For example, in CCS test facilities were chosen based on the criterion that the budget was sizeable (at least in the tens of millions), the facility had a research focus or objective, the facility has capabilities to perform demonstration tests, and the facility is current (i.e. not long abandoned or planned many years in the future)).

4.3 Sources of information

The five main sources of information used were:

- **European Commission Joint Research Centre (JRC) publications** – the JRC publishes numerous technology reports and science policy papers which the analysis has drawn upon. In addition, early drafts of this paper have benefited from peer review by JRC technology specialists.
- **The IEA/IRENA policy and measures database** - offers access to information on energy-related policies and measures taken or planned to reduce GHG emissions, improve energy efficiency and support renewable energy development and deployment. Covers policies and measures adopted in IEA's 28 member countries, including 17 EU Member States;
- The **Renewable Energy Country Attractiveness Index**, produced by Ernst & Young on a quarterly basis. This ranks 40 countries on the attractiveness of their renewable energy investment and deployment opportunities, based on a number of macro, energy market and technology-specific indicators. Within the EU, the June 2015 Index includes 16 of 28 Member States and is backed by country-specific analysis which helps to shed light on what is enabling or inhibiting investment;
- **REN21 Global Status Report** – the annual renewable energy analysis of market growth, key industry trends including leaders in renewable energy deployment as well as market support mechanisms;
- **EurObserv'ER Barometer** – This measures progress made by renewable energies in each sector and in each EU Member State, using figures less than 12 months old. The site provides insights into market growth, employment, turnover and investment trends.

Other sources of information are listed in Annex 1 and are referenced in the market conditions descriptions sheets, as are relevant websites.

The three main sources were reviewed to find information on factors influencing deployment of the nine SETs. As mentioned above, these consist of the policy and regulatory frameworks, which are set by policymakers, and social if available acceptance, which is not determined by policymakers. Within the frameworks are market support mechanisms (feed-in tariffs, feed-in premiums, capacity mechanisms etc.), permitting and licensing procedures if available, and state aid regimes.

[104] For CCS, the association databases of ECCSEL (available here) and MIT Energy Initiative (available here). For CSP, STAGE-STE - Scientific and Technological Alliance for Guaranteeing the European Excellence in Concentrating Solar Thermal Energy (available here). For all sectors, the EUREC – The Association of European Renewable Energy Centres Network (available here), last accessed 15 December 2015

Market support mechanisms were extensively covered in the four main sources as well as in supplementary sources. Key direct policy mechanisms for each sector were readily identifiable and included in the sector-specific market condition sheets for each country[105].

Regarding planning and permitting procedures, information (where readily available) was obtained and chiefly reflects the overall situation by SET sector for the EU as a whole. In some sectors, particular Member States have been identified, either where the particular situation has been analysed in more detail or if particular procedures have been put in place to tackle planning and permitting challenges. General conclusions regarding planning and permitting have been drawn in section 4.13.2.3 together with a summary matrix of critical issues identified under this category.

Regarding state aid, there is a comprehensive database available for all state aid decisions for EU Member States[106]. However, given the current changes to state aid legislation announced in April 2014, which are currently being implemented, a historical perspective of state-aid decisions was deemed to be of limited interest to this presentation of current (and future) market conditions. An overview of key changes and the potential impact on the policy environment is included in Section 4.13.4, but specific state-aid cases are not discussed in the sector-specific market condition sheets.

Finally, market growth perspectives were determined using data on installed capacity or, as explained in Section 4.2, planned and operational capacity for carbon capture and storage, and development and deployment budget for advanced electricity networks.

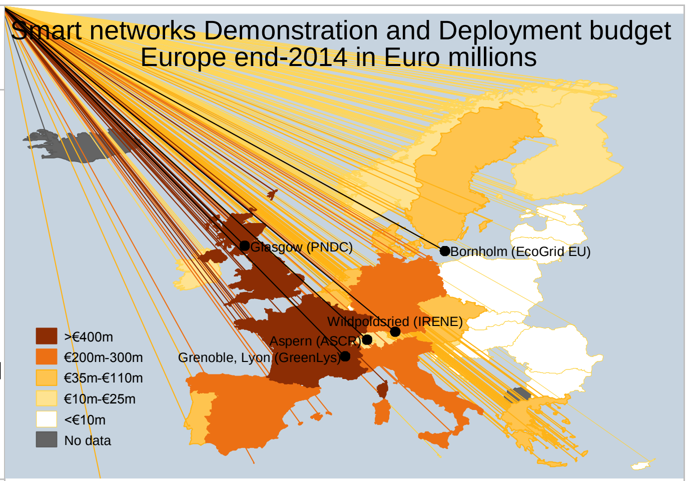
[105] For the purposes of this review we have avoided looking at individual regions within Member States (e.g. England, Wales, Scotland and Northern Ireland for the UK; Brussels, Flanders and Brussels in Belgium)

[106] European Commission Competition site for state aid decisions on electric power generation, transmission and distribution, available here

4.4 Advanced electricity networks

Key facts and figures for European advanced electricity networks

Total Demonstration and Deployment (D&D) budget[107] size for Europe: **€2,309 million**



Top five countries by D&D budget size in 2014 [108]

- United Kingdom (€462 million);
- France (€401 million);
- Germany (€278 million);
- Spain (€261 million);
- Italy (€220 million).

Together these 5 countries represent 70% of total D&D budget size in Europe: €1,622 million

The three countries that had D&D budget growth between 2013 and 2014:

- United Kingdom (growth of €55 million);
- Netherlands (growth of €2 million);
- Cyprus (growth of €1 million).

Name and location of prominent test facilities for Smart Energy Networks in Europe:

- (PNDC) Power Networks Demonstration Centre - University of Strathclyde, Glasgow, UK;
- (GreenLys) Grenoble Institute of Technology, Grenoble and Lyon, France;
- (ASCR) Aspern Smart City Research, Aspern, Switzerland;
- (IRENE) Integration of Regenerative Energy and Electric Mobility, Wildpoldsried, Germany;
- (EcoGrid EU) Bornholm Test Site, Bornholm, Denmark.

Top five countries with strongest D&D budget growth over the period 2011 to 2014:

Growth between 2011 and 2014:

- Norway (242%);
- Finland (216%);
- France (195%);
- United Kingdom (141%);
- Ireland (85%).

D&D budget in 2014:

- Norway (€16.81 million);
- Finland (€17.05 million);
- France (€401.18 million);
- United Kingdom (€461.81 million);
- Ireland (€17.26 million).

Social Acceptance:

Most of social acceptance issue regarding advanced electricity networks stems from concerns regarding security and privacy of data and to a potentially high cost burden.[109]

[107] The budgets for Demonstration and Deployment projects are used as a measure of Advanced Electricity Networks capacity

[108] http://ses.jrc.ec.europa.eu/european-smart-grid-projects-budget

[109] Petrov, K., 2012. Smart Grids and Regulatory Challenges. KEMA Consulting GmbH, Bonn [Presentation]

Planning and Permitting:

Advanced electricity networks and the 'smart grid' are in an embryonic stage of development when compared to other renewable energy technologies, but planning and permitting procedures and regulations already impact on the development of this technology.
As with the rollout of traditional transmission lines, lengthy licensing procedures together with jurisdictional issues are the major bottlenecks for the development of new transmission infrastructure, while the concept of "smart grids" needs to be clarified for all users, in order to ensure a coordinate approach, standardisation and interoperability of the infrastructure.[110]

Streamlined permitting processes, establish business and billing models and tackle regulatory issues are the key enablers to sustain the development of this technology.[111]

As recommended in the European Commission's Smart Grid Communication, "permitting procedures for the construction and renewal of energy grids have to be streamlined and optimised and regional regulatory barriers and resistances must be tackled".[112]

Other regulatory solutions include the promotion of Sustainable Rural Community level planning, so as to streamline zoning, siting and permitting processes, while supporting financing of micro-grids (at the different levels of generation, distribution, metering and smart control systems) and enabling synergies with "multiple service aggregation" (i.e. gas, power, water, telecommunications).[113]

[110] The renewables-Grid-Initiative Constructing the Future Electricity Grid of the EU: 8 Key Issues to Be Included in the Infrastructure Package http://renewables-grid.eu/fileadmin/user_upload/Files_RGI/RGI_Publications/Position_Papers/RGI_Position_on_Infrastructure_Package.pdf

[111] SilverSprings Networks, How the Smart Grid Enables Utilities to Integrate Electric Vehicles, 2013. http://www.silverspringnet.com/wp-content/uploads/SilverSpring-Whitepaper-ElectricVehicles.pdf

[112] Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation"), 18 February 2014, CERR - Council of European Energy Regulators. http://www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Electricity/Tab3/C13-EQS-57-04_Regulatory%20Approaches%20to%20Smart%20Grids_21-Jan-2014-2.pdf

[113] Larisa Dobriansky, Mini-grid Opportunities: Policy and Regulatory Issues, https://cleanenergysolutions.org/sites/default/files/documents/GMI-CEM4-PREP-Minigrids_Larisa.pdf

Table 4.1 Advanced electricity network demonstration & deployment budgets (million Euro)[114]

Country	Cumulative Demonstration and Deployment (D&D) budget as of 2014 (million €)	Total budget (Research & Development and D&D) as of 2014 (million €)	D&D budget as a proportion of total budget (%)	D&D budget increase 2011-12 (million €)	D&D budget increase 2012-13 (million €)	D&D budget increase 2013-14 (million €)
Belgium	91.94	133.28	69%	12.82	3.93	0
Bulgaria	2.2	3.24	68%	0	0.52	0
Czech Republic	35.7	41.18	87%	7.14	3.73	0
Denmark	95.91	222.47	43%	21.97	7.32	0
Germany	278.28	363.29	77%	63.48	12.94	0
Estonia	0	2.03	0%	0	0	0
Ireland	17.29	22.72	76%	4.48	3.45	0
Greece	37.6	56.42	67%	4.05	2.86	0
Spain	260.87	360.14	72%	30.01	19.63	0
France	401.18	507.85	79%	212.84	52.36	0
Croatia	3.27	4.64	70%	-2.38	3.27	0
Italy	220.04	268.09	82%	48.47	19.51	0
Cyprus	1.05	2.45	43%	0	0	1.05
Latvia	2.15	5.41	40%	0	2.15	0
Lithuania	8.92	10.06	89%	8.92	0	0
Luxembourg	0.99	2.78	36%	0	0.99	0
Hungary	9.85	11.18	88%	0.27	1.76	0
Malta	0	0	-	0	0	0
Netherlands	110.8	141.45	78%	12.76	11.42	2.06
Austria	55.06	83.82	66%	5.25	6.19	0
Poland	6.18	13.15	47%	0	0.94	0
Portugal	49.91	66.34	75%	4.37	4.91	0
Romania	2.93	6.41	46%	2.64	0.29	0
Slovenia	24.76	36.32	68%	6.1	0.47	0
Slovakia	3.26	10.72	30%	3.26	0	0
Finland	17.05	69.08	25%	2.89	8.77	0
Sweden	79.35	120.66	66%	21	12.76	0
United Kingdom	461.81	497.2	93%	101	113.86	54.94
Switzerland	13.92	23.84	58%	3.27	1.12	0
Iceland	-	-	-	-	-	-
Norway	16.81	32.53	52%	6.43	5.47	0
Ukraine	-	-	-	--	-	-

We have not generated growth trends for the share of spending in demonstration and deployment since data for 2014 was only partially available.

[114] http://ses.jrc.ec.europa.eu/european-smart-grid-projects-budget

Countries that have the largest D&D budgets for advanced electricity networks

Country	Outlook	Key market condition developments
United Kingdom	☺	■ The UK regulator OFGEM has introduced a Low Carbon Network Fund to provide regulatory funding for especially innovative smart grid projects, unlike other countries which have opted to offer assistance through a tariff. ■ The UK has the highest demonstration and deployment budget in Europe and its DSOs deploy around twice the funds to smart grid projects relative to those of any other country, partly due to their direct access of regulatory funds.[115]
France	☺	■ Very active in setting up cooperation links for multinational projects, with France generally acting as the top contributor.[116]
Germany	☺	■ Has the most implementation sites in Europe (77 sites).[117] ■ Amendment of certain Acts to adhere with the third legislative package on the internal energy market. The Energy Industry Act amendments requires the certification and nomination of transmission operators, extensive unbundling of the network operator function from other functions of integrated energy supplier, consumer protection and other regulatory revisions.[118]
Spain	☺	■ The low voltage code has been changed to a new discriminatory tariff that promotes charging of Electric Vehicles at low demand times.[119] Similarly, on 28 March 2014, a Royal Decree was passed to introduce residential bills based on hourly electricity prices for customers to enable these to take advantage of prices at low demand[120]. ■ Spain fulfilled its 2014 target set by the legislative order[121] which mandates 100% smart meters by 2018, and had over 9 million of its 27.8 million meters replaced by end 2014[122]. The roll-out makes Spain the source of a multi-billion Euro demand pull for smart grid manufacturers and broader supply chain[123].
Italy	☺	■ The Italian regulator (*Autorità per l'Energia Elettrica e il Gas*) has awarded eight tariff-based funded projects on active medium voltage distribution systems, to demonstrate at-scale advanced network management and automation solutions necessary to integrate distributed generation. ■ The Ministry of Economic Development has also granted over EUR 200 million for demonstration of smart grids features and network modernisation in Southern Italian regions.[124]

[115] JRC (2014) Smart Grid Projects Outlook 2014, Available here, pp.42, 61.

[116] Ibid., p13

[117] Ibid., p9

[118] The German Roadmap E-Energy / Smart Grids 2.0, Smart Grid Standardisation Status, Trends and Prospects, VDE, DKE, (2013), p12

[119] CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation"), Council for European Energy Regulators, (2014), p14, Available here.

[120] Real Decreto 216/2014, available here

[121] Orden IET/290/2012, available here

[122] International Smart Grid Action Network (ISGAN): Case 10. Spain, available here

[123] Iberdrola (press release 2 June 2015) Iberdrola installs over five million Smart Meters in Spain. Available here.

[124] Technology Roadmap Smart Grids, OECD/IEA, (2011), p21. Available here.

Countries whose advanced electricity network D&D budgets grew in 2014 (if not included above)

Country	Outlook	Key points
Netherlands	😐	■ High electricity prices and limited network development funds.[125]
Cyprus	😐	■ Planned introduction of net metering. ■ Demonstration projects are principally funded through the DSOs' budget.[126]

Countries that have the strongest growth rates in advanced electricity network D&D budget over the period 2011 to 2014 (if not included above)

Country	Outlook	Key points
Ireland	🙂	■ Successful deployment of smart grid makes Ireland an example to the rest of Europe. Ireland's transmission system operator, EirGrid, is deploying smart grid technologies to manage the high proportion of wind energy on its system and maximise infrastructure effectiveness. System flexibility and smart grid approaches are estimated to facilitate real-time penetrations of wind up to 75% by 2020.[127]
Finland	🙂	■ DSOs and research institutions are jointly responsible for decisions on granting funding. ■ Cost Benefit Analysis is carried out regularly to determine the net benefit of smart grids compared with carrying out business as usual. ■ Present regulations do not allow a significant participation in the competitive market for the DSOs. DSOs are thus required to unbundle their market related activities at a very early stage. ■ New, incentivising tariffs are being introduced with the advent of smart grids.[128]
Norway	😐	■ Network charges apply; however, there is access to national government funding.[129]

Countries of particular interest

The short term outlook for advanced electricity network demonstration and deployment is very positive for a number of countries within Europe. However, it is the **United Kingdom**, **France**, and **Germany** that have provided the largest investments into demonstration and deployment in recent years, with private funding being particularly significant in the **United Kingdom** and **France**.[130]

[125] CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation"), Council for European Energy Regulators, (2014), p13

[126] Ibid, pp.13, 44

[127] Technology Roadmap Smart Grids, OECD/IEA, (2011), pp. 11-12

[128] CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation"), Council for European Energy Regulators, (2014), pp.20, 24, 37, 39

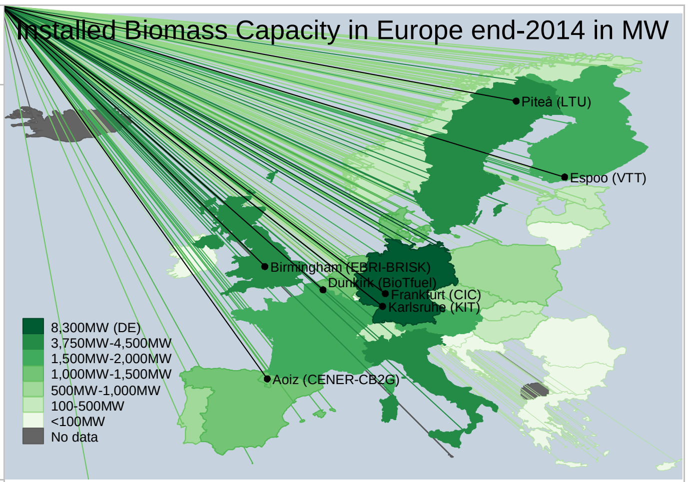
[129] Ibid, p21

[130] Smart Grid Projects Outlook 2014, JRC Science and Policy Reports, (2014), pp. 82-83 Available here.

4.5 Bioenergy

Key facts and figures for European Bioenergy

Total installed capacity for Europe: **35,088 MW**



Top five countries by installed capacity as at the end of 2014 [131]

- Germany (8,331 MW);
- United Kingdom (4,431 MW);
- Sweden (3,862 MW);
- Italy (3,762 MW);
- Austria (1,971 MW).

Together these countries represent 64% of total capacity in Europe: 22,357 MW

Top five countries by additions to installed capacity made in 2014 only:

- United Kingdom (467 MW added);
- France (156 MW added);
- Czech Republic (82MW added);
- Germany (64MW added);
- Sweden (57 MW added).

Name and location of test facilities for bioenergy in Europe:

- (CENER-CB2G) National Renewable Energy Centre - Centro de Biocombustibles de Segunda Generación, Aoiz, Spain;
- (EBRI-BRISK) Aston University - European Bioenergy Research Institute and BRISK, Birmingham, UK;
- (BioTfuel) BioTfuel - The BioTfuel BtL demonstration project, Dunkirk, France;
- (KIT) bioliq® pilot plant at Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany;
- (CIC) Clariant Innovation Centre, sunliquid® demonstration of cellulosic ethanol from agricultural residues, Frankfurt, Germany;
- (LTU) Luleå University of Technology's Chemrec gassification, Piteå, Sweden;
- (VTT) Technical Research Centre, Espoo, Finland.

Top five countries by highest consistent[132] growth rate over the period 2011 – 2014:

Growth between 2011 and 2014:

- Ukraine (1,125%);
- Bulgaria (382%);
- Latvia (303%);
- Romania (203%);
- Lithuania (179%).

Installed capacity as at end-2014:

- Ukraine (49 MW);
- Bulgaria (53 MW);
- Latvia (121 MW);
- Romania (91 MW);
- Lithuania (92 MW).

[131] IRENA dashboard. Available here.

[132] "Consistent growth" means that the pace of growth did not slow down year on year, as is the case in Poland which actually grew more than Lithuania over the period: 182% from 277MW to 782MW. (Poland is nonetheless a country of interest as there is growth, the policy outlook is good and the NREAP target has still to be met, see overleaf.)

Social Acceptance:

Social concerns with bioenergy are twofold: social and environmental. On the social side, concerns encompass competition with food crops, food price volatility, labour conditions of farm workers, land rights and land grabbing. Regarding environmental issues, concerns encompass net GHG emissions from crops, impacts on biodiversity, high water demand, indirect land use change (ILUC) and land use impacts (e.g. habitat loss for wildlife). [133,134]

Planning and Permitting:

The report "Benchmark of bioenergy permitting procedures in the European Union"[135] provides information about main statistics and major bottlenecks of the permitting procedures for Bioenergy power plants in Europe. The report's conclusions depict a landscape where:

- A permitting procedure on average comprises of at least three procedural steps;

- Average lead times for the total bio-energy permit procedure is around 2 years (23 months) with a deviation of close to 2 years (21 months). These values are homogeneous across regions in the EU;

- For procedures which include an Environmental Impact Assessment (EIA), average lead times move up to almost 34 months. Where an EIA and legal case apply, this timescale can extend to almost 5 years (59 months).

- Over 30% of applications fail (i.e. their characteristics exceed their application's boundary conditions);

- The major steps leading to delay include the spatial planning procedure, the EIA, the integrated environmental permit, grid access and any legal disputes (if these apply).

- Of all technologies, biofuel technologies require on average the longest timescale while biomass to energy (i.e. boiler plant) require the shortest timescales.

The report identified principal bottlenecks in the permitting process, which include:

- Land use approval;
- Bureaucratic inefficiencies, in particular cross-authorisation or lack of mandatory deadlines for authorities;
- Multitude of permits and licenses used by different authorities;
- Lack of bio-energy specific legislation;
- Lack of well-defined administrative structures and procedures;
- Procedural errors which result in an incorrect issuance of the permit;
- Official authorities lacking the knowledge, capacity and expertise to properly evaluate and adjudicate innovative bio-energy power plants;
- Public resistance; and,
- No clear and transparent procedures for grid access.

Recommended actions to improve the efficiency in the permitting process include:

- Define an independent authority and create an accessible communication tool;

- Streamline the permitting procedure by implementing a one-stop-shop approach and by stimulating a higher level of standardisation; and,

- Improve the efficiency of the communication process among the various authorities and stakeholders to prevent ineffective higher appeals and double work.

[133] Ecologic Institute, 2012. The Social Dimension of EU Biofuel Policy. -. Available at: http://www.ecologic.eu/files/publications/1358406689/kaphengst_12_Ecologic_Brief_Biofuel.pdf [Accessed 11 December 2015]

[134] IRENA & DNV KEMA, 2013. Study on environmental impact from large-scale deployment of renewable energy technologies. [Presentation]. Available at: http://www.irena.org/DocumentDownloads/events/2013/october/Workshop/16_Namavira.pdf

[135] Ecofys and Golder Associates, Benchmark of bioenergy permitting procedures in the European Union, DG TREN, 2009

Table 4.2 Biomass installed capacity, developments in European countries 2011 - 2014

Country	Installed capacity as at end 2014 (MW)	NREAP target specified for 2020 (MW)[136]	NREAP target reached	Additions to capacity in 2012 (MW)	Additions to capacity in 2013 (MW)	Additions to capacity in 2014 (MW)
Belgium	1,088	2,452	not yet	-54	-9	0
Bulgaria	53	158	not yet	3	30	9
Czech Republic	794	4,520	not applicable	149	37	82
Denmark	1,354	2,779	not yet	225	-176	13
Germany	8,331	8,825	not yet	409	710	64
Estonia	366	-	not applicable	18	199	0
Ireland	67	400	not yet	21	1	6
Greece	47	250	not yet	0	1	1
Spain	1,126	1,587	not yet	86	19	25
France	1,579	3,007	not yet	85	-28	156
Croatia	25	125	not yet	4	6	1
Italy	3,762	3,820	not yet	924	207	0
Cyprus	10	17	not yet	0	1	0
Latvia	121	200	not yet	36	42	13
Lithuania	92	224	not yet	20	18	21
Luxembourg	29	59	not yet	0	0	0
Hungary	346	600	not yet	-228	55	0
Malta	0	23	not yet	0	0	0
Netherlands	1,383	2,892	not yet	-66	-130	0
Austria	1,971	1,281	in 2006	-18	-515	0
Poland	782	2,530	not yet	306	152	47
Portugal	551	952	not yet	8	-17	0
Romania	91	600	not yet	5	11	45
Slovenia	59	95	not yet	5	0	0
Slovakia	216	280	not yet	18	1	0
Finland	1,860	2,920	not yet	-32	23	48
Sweden	3,862	2,914	in 2006	140	-307	57
United Kingdom	4,431	4,240	in 2014	142	702	467
Switzerland	431	-	not applicable	50	0	0
Iceland	-	-	-	-	-	-
Norway	173	236	not yet	0	0	0
Ukraine	49	-	not applicable	2	18	25

Not applicable, either because the country did not specify a specific biomass target in its NREAP report, or because the country is not an EU Member State.

[136] Mapping Renewable Energy Pathways towards 2020, European Renewable Energy Council (2011). Available here. Croatia Ref. Ares(2014)443294 - 21/02/2014 Available here p110; Norway Ref. Ares(2013)117932 - 30/01/2013 Available here p135; Iceland Ref. Ares(2014)806315 - 19/03/2014 p58 Available here, N.B. Czech Republic has a target of 364MW solid biomass and 4,156MW in bioliquids in its revised 'National Renewable Energy Action Plan of the Czech Republic' of August 2012, p82, Available here

Countries that have the greatest installed biomass capacity

Country	Outlook	Key market condition developments
Germany	☺	■ Renewable Energy Heat Act (EEWärmeG) and the Combined Heat and Power Act include obligations such as the requirement to use renewable-generated heat in the new buildings sector, which has incentivised the use of biomass.[137] ■ First Member State to transpose the EU sustainability criteria into national law through its Biomass-Electricity-Sustainability Ordinance. Requirements included GHG savings and direct land use changes.[138] ■ Germany uses a non-tax levy (an electricity surcharge paid by some or all users via their electricity bills) to finance RES electricity support schemes, EE-Umlage, which is set annually by the transmission system operator.[139] ■ Had a high biofuels blending target in place. However, since 1.1.2015, the government decided to shift from a blending quota system to a GHG reduction quota. Fuel suppliers are no longer required to achieve a certain minimum level of biofuels but rather a minimum level of GHG savings, compared to conventional fossil petrol and diesel. Required GHG savings are 3.5% GHG in 2015 and 2016, 4% from 2017 onwards and 7% GHG from 2020[140]. ■ Largest no of biodiesel production sites (9) in the EC (Eurobserv'er 2015).
United Kingdom	😐	■ Biomass is not a government priority sector of the Green Investment Bank (GIB). Funding for biomass projects by the GIB has faced criticism, and a response to campaigns against this was requested by the Department for Business, Innovation and Skills (BIS).[141] ■ RES electricity support schemes are funded through channels which include 'possible pass down' of scheme costs to end users, rather than through general taxes or non-tax levies.[142] ■ In the first wave of the UK's new Contracts for Difference (CfD) scheme, two biomass CHP industrial plants totalling 94MW capacity were supported out of the 27 contracts awarded across all SET. The CfD design has been criticised by the Association for Decentralised Energy who said it *"makes biomass CHP near-uninvestable, preventing many potential projects from participating in today's auction, limiting the options for industry to invest in their future competitiveness."*[143] ■ In December 2014, the UK Department for Transport launched the Advanced Biofuel Demonstration Competition, providing up to £25 million in funding through grants for demonstration projects offering innovative and major solutions.[144] On 3 Sep 2015, three projects were awarded: "Celtic Renewables Limited £10,925,000; Advanced Plasma Power Limited £10,958,194; and Nova Pangaea Limited £ 3,000,000."[145]

[137] National Biomass Action Plan for Germany: Biomass and Sustainable Energy Supply, Federal Ministry of Food, Agriculture and Consumer Protection (2009), pp. 12. Available here

[138] Country policy assessment report on Bioenergy – Germany, (2012), Bioenergy Promotion, p19, Available here .

[139] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, January 2015. Available here

[140] Zwölftes Gesetz zur Änderung des Bundes-Immissionsschutzgesetzes, November 2014. Available here.

[141] UK government response to the campaign against green investment bank funding for big biomass. Available here.

[142] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, January 2015. Available here

[143] EDIE, CfD auction: What it really means for renewables, February 2015. Available here.

[144] Department for Transport (statement 10 December 2014) Advanced biofuel demonstration competition, available here

[145] Department for Transport, Advanced Biofuels Demonstration Competition: grant award, statement to parliament, 7 September 2015. Available here

Sweden	😐	■ High biofuels blending target in place. ■ The Swedish Act on Sustainability criteria for bio-fuels and bio-liquids constituted requirements to decrease greenhouse gas emissions, increased restrictions on certain land area utilisation and made it a necessity to have a physical traceability for the fuel. ■ As of 2012, tax exemptions for bio-fuels and bio-liquids are conditional upon the holding of a valid sustainability notification.[146] ■ RES electricity support schemes are funded through channels which include 'possible pass down' of scheme costs to end users, rather than through general taxes or non-tax levies.[147]
Italy	🙂	■ Introduction of incentives for bio-methane, including a special rate offered to producers feeding into the grid, which is twice the 2012 market rate, less the monthly cost of the gas, if selling to the market directly. Also, plants using by-products are entitled to a 50% increase in the incentive.[148] ■ The 'Conto Termico' support scheme launched in 2013 provides financial incentives on capital costs, with a disbursement allocation of €200 million.[149] ■ RES support schemes are funded through non-tax levies, typically set by the national regulatory authority.[150] ■ 3rd largest no of biodiesel production sites (5) in the EC (Eurobserv'er 2015) ■ Europe's first commercial scale (80 million litres), 2nd generation (cellulosic ethanol) plant commissioned at Crescentino in 2013 by Beta Renewables[151]. ■ Italy is the first Member State to introduce a sub-target for advanced biofuels and 3 more advanced biofuels production plants were envisaged to be operational in 2015[152]. ■ In November 2014, Italy became the first EU MS to mandate the use of advanced biofuels in fuels. Starting from January 2018, gasoline and diesel is required to contain at least 1.2 % advanced biofuel, rising to 1.6 % by 2020, and 2 % by 2022.[153]
Austria	😐	■ Green electricity act of 2012 provides a 15 year feed-in tariff (FiT) guarantee for biomass and biogas, with fixed rates that decreases on the size of the plant (as well as co-combustion, co-fermentation and solid waste components.) ■ RES support schemes are funded through non-tax levies which are set by the government, introduced on 1 July 2012.[154]

[146] IRENA policy database, Sweden, Biomass, Available here

[147] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, January 2015. Available here

[148] IRENA policy database, Italy, Biomass. Available here

[149] IRENA policy database, Italy, Biomass. Available here

[150] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, January 2015. Available here

[151] Beta Renewables World's First Refinery Turning Farm Waste to Bioethanol Opens, press 14 October 2013. Available here

[152] GU Serie Generale n.250 del 27-10-2014, October 2014. Available here

[153] European Biofuels Technology Platform: Advanced biofuels demonstrations and R&D Projects in Italy, July 2015, Available here

[154] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, (January 2015). Available here

Countries with the greatest additions to installed biomass capacity in 2014 (if not included above)

Country	Outlook	Key points
France	☺	■ Approximately €1 billion was allocated from 2009 to 2013 as part of 'The Heat Fund' focusing chiefly upon biomass, as well as other forms of renewable energy including geothermal energy, heat pumps, and solar thermal. [155] ■ 2009 Finance Law initiated to increase support for renewable energy included measures such as 0% interest loan programmes for multiple energy saving incentives including the installation of heating or hot water systems which use renewable energy. [156] ■ RES support schemes are financed through non-tax levies which are set by the national regulatory authority.[157] ■ High biofuels blending target in place. ■ A 'loi de transition energetique' is being drafted. The draft includes a commitment to increasing the share of renewable in transport fuels to 15% by 2015. As part of this commitment, legislation is proposed supporting the development of advanced biofuels from wastes.[158] ■ Largest no of bioethanol production sites (12) and 2nd largest no of biodiesel production sites (7) in the EC (Eurobserv'er 2015)
Czech Republic	☺	■ Income tax exemption through an Income Tax Act amendment in 2005. Owners of devices producing renewable energy for own consumption, through biomass, biogas and other renewable energy generating equipment, are exempt from income tax payments for five years.[159] ■ RES support schemes are funded through a combination of general taxes and non-tax levies, the latter set by the national regulatory authority.[160] ■ Biofuels and the biofuel content of mixed fuels are exempt from consumption tax.[161] ■ There is a mandatory minimum biofuel share for petrol and diesel fuel.[162]

[155] IRENA policy database, France, Bio-energy, Available here,

[156] IRENA policy database, France, Bio-energy, Available here,

[157] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, (January 2015). Available here

[158] Ministère de l'Écologie, du Développement Durable et de L'Énergie: La transition énergétique pour la croissance verte. Available here

[159] IRENA policy database, Czech Republic, Bio-energy, Available here,

[160] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, (January 2015). Available here

[161] Act No. 353/2003 on Consumption Taxes. Available here

[162] Regulation No. 133/2010 Coll. on the Quality and the Registering of Fuels. Available here

Countries with highest consistent rate biomass capacity growth rate from 2011 to 2014 (if different from above)

Country	Outlook	Key points
Latvia	☺	■ Reduction in the excise duty to be paid on selected types of bio-fuel.[163]
Lithuania	😐	■ In 2011, Lithuanian Law on Energy from Renewable Sources outlined the aspired capacity of a number of renewable energy sources (including bio-fuels), and set targets for plants running on bio-fuels to be at least 355 MW by 2020. However, after this capacity the FiT will no longer be valid.[164] ■ RES support schemes are financed through channels which include 'possible pass down' of scheme costs to end users, rather than through general taxes or non-tax levies.[165]
Ukraine	😐	■ Law of Promotion of Biological Fuels Production and Use introduces a registry and certification of biofuels. No financial support is attached.[166]
Bulgaria	☺	■ In an attempt to meet the 2020 target, Bulgaria has initiated a zero rate of excise duty for pure bio-fuels and has rendered the blending of bio-fuels compulsory.[167]
Romania	☹	■ Bio-fuel blending has been revised down from its expected rise to 7%, to a flat rate of 5% until 2016.[168] ■ RES support schemes are funded through channels which include 'possible pass down' of scheme costs to end users, rather than through general taxes or non-tax levies.[169]

Selected countries which have not yet met their NREAP biomass capacity targets (if not included above)[170]

Country	Outlook	Key points
Slovak Republic	☺	■ The Slovak Republic New Energy Policy outlined development objectives for biomass, including combined combustion of coal and wood chip, gasification of wood in thermal power plants, use of biogas in smaller power plants, and use of agricultural and forestry biomass for energy purposes.[171]
Luxembourg	☺	■ Luxembourg funds its RES schemes using a combination of general taxes and non-tax levies, the latter of which is set by the national regulatory authority.[172] ■ Luxembourg has a biofuels quota in place, requiring oil companies releasing petrol and diesel for consumption to fulfil a quota of biofuels per annum.[173]

[163] IRENA policy database, Latvia, Bio-energy, Available here,

[164] IRENA policy database, Lithuania, Bio-energy, Available here,

[165] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, (January 2015). Available here

[166] IRENA policy database, Ukraine, Bio-energy, Available here,

[167] IRENA policy database, Bulgaria, Bio-energy, Available here,

[168] Romania revises down the biofuels mandates, USDA, (2014), p1 Available here

[169] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, (January 2015). Available here

[170] Selected countries with a mix of support for biofuels and biomass combustion

[171] IRENA policy database, Slovakia, Bio-energy, Available here,

[172] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, (January 2015). Available here

[173] Loi du 17 décembre 2010 (Loi du 17 décembre 2010 fixant les droits d'accise et les taxes assimilées sur les produits énergétiques, l'électricité, les produits de tabacs manufacturés, l'alcool et les boissons alcooliques - Law of 17 December 2010 defining excise duties and rates on energy products, electricity, tobacco and alcohol)

Poland	☺	■ High biofuels blending target in place for 2014. The Ministry of Economy launched The Regulation on National Indicative targets setting targets for bio-fuel energy content for transportation fuels, increasing annually from 2013 to 2018, when it will reach 8.5%. [174] ■ In 2013, the Polish Ministry of Economy provided a c. €100 million programme for research, education, promotion and support of bio-fuels[175].
Denmark	☺	■ Danish Energy Agreement encouraged green heating measures whereby converting from coal to biomass at large scale combined heat and power plants is encouraged; smaller gas-fuelled combined heat and power plants struggling against high heating prices are offered cheap heating based on biomass; DKK 30 million is dedicated per annum to support CHP in industry and greenhouses until 2020. For biogas the capital installation subsidies are increased from 20% to 30%.[176] ■ Denmark finances its RES schemes through non-tax levies, which are set by the transmission system operator (owned by the State).[177]
Belgium	☹	■ While in Belgium Biomass is currently an important source of renewable energy, looking forward it has restricted production potential due to having limited domestic biomass sources for energy and other uses. ■ Transport biofuels are incentivised through a tax reduction allocated on a quota system. Lack of sufficient incentives and delays in the quota system have meant Belgium lags behind other nations in biofuel blends.[178]
Cyprus	😐	■ Cyprus has a 20 year fixed feed-in tariff for biomass, for which the rate in 2013 was set to increase (in contrast to lower FITs for several other sources).[179] ■ Due to its limited water and agricultural land, biomass energy in Cyprus is mainly limited to the energy generation from agricultural residue and municipal waste.[180]
Greece	☺	■ Electricity generation from biomass is a major renewable energy source and continues to receive major political support from the government and the industrial-agricultural sectors. Existing biomass tariffs are amongst the highest of the EU countries. Scope is foreseen to increase output with a combination of new technologies and larger scale applications.[181] ■ Legislation has also been put in place to institute a mandatory quota, revised annually, for distributors of petrol and diesel to blend their fuels with biofuels. In 2014, this quota was at 133,000 kilolitres of biodiesel.[182]

Loi du 29 avril 2014 (Loi du 29 avril 2014 concernant le budget des recettes et des dépenses de l'Etat pour l'exercice 2014 - Law of 29 April 2014 regarding the budget of the State´s receipts and expenses for the tax year 2014)

[174] IRENA policy database, Poland, Bio-energy, Available here,

[175] IRENA policy database, Poland, Bio-energy, Available here

[176] IRENA policy database, Denmark, Bio-energy, Available here,

[177] Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, (January 2015). Available here

[178] Bioenergy in Belgium, IEA, (2010), Available here

[179] Feed-in Tariff specifications, features, amendments, and current and future challenges in Cyprus, IRENA Workshop, (2013), p9, Available here

[180] Evaluation of Cyprus' Electricity Generation Planning Using Mean-Variance Portfolio Theory, Cyprus Economic Policy Review, (2010), p25, Available here

[181] Outlook on Market Segments for Biomass Uptake by 2020 in Greece, Intelligent Energy Europe, (2011), p22. Available here

[182] FEK B 937/2014 (Call for Participation to the Distribution of 133,000 kiloliters of biodiesel in accordance with Art.15A Par.7 Law No.3054/2002 for 2014)

Spain	😐	▪ In 2012, financial support for electricity from renewable energy, waste, or combined heat and power was abolished (without a retroactive effect)[183]. ▪ More recently, biomass has been given priority in several minor grants and subsidy schemes, namely: in 2013 a €125 million scheme with subsidies to replace conventional heating with biomass; and in 2014, a €123 million scheme including support of biomass energy for energy and other enterprises[184]. ▪ A quota for biofuels is in operation, obliging fuel operators (wholesale and retail), as well as fuel consumers who are not supplied by wholesale or retail operators of fuels, to sell / consume a minimal quota of biofuels. This minimum amount is set at both a general level (all biofuels) and a specific level (e.g. for diesel and gasoline). Operators/consumers have to submit a number of certificates (each of value 1 toe) to the National Energy Commission (CNE) to prove compliance. A penalty is applied in cases of non-compliance with the goals. Where operators or consumers sell or consume more than they are obliged to, they receive the proceeds from the penalty fees in proportion to the amount by which they exceeded their quota.[185]
Croatia	😐	▪ In Croatia, a myriad of administrative hurdles are present at all stages of developments (environmental permits, to impact assessment, to construction permits, to finance, to access to networks) which has led to most biomass, pellets, etc. being exported[186]. ▪ Biofuels producers receive subsidies, paid for by a share of the excise duty paid by producers of fuel and diesel. The excise duty for biofuels is set to 0%.[187]
Hungary	😐	▪ In 2013, Hungary had a larger feed-in tariff instated (METÁR, previously KÁT) with biomass receiving a special brown tariff provision to help cover operating costs.[188] ▪ Despite an improvement, the new feed-in tariff still does not support biogas.[189] Biogas has further technical, legal and commercial barriers to grid injection.[190] ▪ The biomass NREAP targets are not ambitious (apart from CHP electricity)[191].

[183] IRENA policy database, Spain, bio-energy, (2011), Available here

[184] IRENA policy database, Spain, bio-energy, (2013), Available here, Ibid. (2014), Available here

[185] Legal sources in renewable energy, Spain biofuel quota. Available here

[186] Biomass in Croatia, (2012), cluster Inteligentna Energija, pp. 8, 12. Available here

[187] Incentive Measures Rulebook (Pravilnik o uvjetima i postupku za ostvarivanje poticaja za proizvodnju biogoriva za prijevoz – Rulebook on the Conditions and Procedure for Incentives for the Production of Biofuels for Transport)Subsidy Decision 2014 (Odluka o visini udjela iz prihoda od trošarina koji se izdvaja za proizvodnju biogoriva u 2014. godini - Decision on the Amount of Excise Tax Revenues that are set aside for the Biofuel Production in the Year 2014)

Incentive Fee Decision 2014 (Odluka o jediničnom iznosu novčanog poticaja za proizvodnju biogoriva u 2014. godini - Decision on the Amount of the Incentive Fee for the promotion of Biofuel Production in the year 2014)

[188] Renewable Energy in Hungary, (2012), Hungarian Investment and Trade Agency, p8, Available here

[189] EU Handbook Biogas markets, (2012), Cross Border Bioenergy, p91. Available here

[190] The potential for the production and use of biomass-based energy sources in Hungary, (2012), Garay et al, p8 Available here

[191] CrossBorderBioEnergy.eu, Hungary Accessible here

Ireland	😐	■ In the Republic of Ireland, the biomass energy tariff was raised to between 10 and 16€c/kW_eh[192] and landfill levies were raised from €20/t to €75/t in 2012. However, commercialisation will remain uncompetitive with FiT rates at 25€c/kW_eh far better across the border in Northern Ireland.[193] ■ Ireland has little feedstock for biomass, does not have ambitious NREAP targets and lacks economic policy instruments (The European Biomass Association ranks Ireland 80 out of 81 in terms of general attractiveness).[194]
Malta	😐	■ Biofuels in Malta lack support beyond the minimum NREAP requirements, due to lack of domestic capacity and fiscal costs of subsidies.[195] ■ Early stage research is supported by the Malta Intelligent Energy Management Agency in the generation of bio-fuels from micro-algae[196].
Norway	😐	■ Norway lists bio-energy among its major renewable energy sources in its national strategy for research, development, demonstration and commercialisation (Energi21), however it is not one of the six focus areas[197]. ■ However, the Norwegian Research Council's ENERGIX programme has bioenergy and heating as one of its priority areas, as is "developing sustainable value chains for the development, efficient conversion and use of biofuels". The programme spent 332 million NOK in 2013.[198]
Portugal	🙂	■ Since 2015, production quotas and maximum reference prices for biofuel blends have been phased out, previously restricting supply and demand respectively. Portugal has one of the highest blending mandates in the EU[199]. ■ Biodiesel represents over 80% of total renewable energy blends in Portugal and is among Europe's highest.[200] As a consequence the planned further increases in biofuels will require additional blends and development[201]. ■ Portugal has sufficient quantities to sustainably feed its current and planned biomass conversion plants from its forest residues.[202]
Slovenia	🙂	■ Biomass received close to 50% of the ERDF, ESF, and Cohesion Fund allocation to renewable energy. Moreover, large FiTs are provided for production of biomass energy below 10MW.[203] ■ In Slovenia, biomass is seen to have many prospects for heating, with initiatives to replace the large central heating districts in Slovenia with biomass boilers.[204] ■ High biofuels blending target in place.

[192] IRENA policy database, Ireland, (2012), Available here

[193] Task 37 Biogas Country Report Overview (Country Reports), IEA Bio-energy, (2015), p29 Available here

[194] CrossBorderBioEnergy.eu, Ireland Accessible here

[195] Report on the present state of biofuels in Malta and measures for their promotion (and update), (2014), Malta Resource Authority, Available here

[196] A report on bio-fuels in Malta in the light of 2020 targets, (2010), Malta Intelligent Energy Management Agency, p13 Available here

[197] Strategy 2014: Priority focus areas and implementation measures for the strategy Part 1, (2014) Energi21, p21. Available here

[198] IEA Bioenergy Task 40 – Country report 2013 for Norway, Norwegian University of Life Sciences 2015. Available here.

[199] Portugal Biofuels Standing Report, USDA FAS, (2015), Available here

[200] Options to increase EU biofuels volumes beyond the current blending limits, TNO Delft, (2013), Available here p38

[201] Portugal Biofuels Standing Report, USDA FAS, (2015), p3. Available here

[202] Forest biomass resources for industrial energy conversion in Portugal, (2011), Monteiro et al. Available here

[203] Task 1: Policy Paper On Renewable Energy And Energy Efficiency Of Residential Housing, Slovenia, (2011), Institute For Economic Research, Ljubljana pp. 12, 16 Available here

[204] Promotion Of Residual Forestry Biomass In The Mediterranean Basin, Proforbiomed, (2012), p117 Available here

Additional Countries

Country	Outlook	Key points
Estonia	☺	■ One of a few Member States which maintains the 7% conventional bio-fuels cap as the lowest acceptable level that would ensure investment stability.[205] ■ Steady receipt of funding from the European Bank for Reconstruction and Development (EBRD) over recent years, with €595 million offered for 79 projects.[206]
Finland	😐	■ The Energy Market Authority of Finland is supporting new biogas plants, which produce more than 100 kVA with a feed-in tariff. A minimum price of €83.50/MWh is guaranteed, however, when combined capacity of generators exceed 19 MVA, no subsidy is paid.[207] ■ Investment grants are paid by the Ministry of Employment and Economy to biogas plants producing energy, which do not meet the requirements of feed-in tariffs, excluding residential buildings, farms, or such affiliated plants.[208] ■ High biofuels blending target in place.
Netherlands	☺	■ Blending is permitted with all types of ethanol, contrary to other member states whereby blending is only permitted with denatured ethanol.[209] ■ Green funds and lower taxes offered by the government assist with the cost of investment. The additional cost of production for green electricity and green gas was alleviated through a feed-in tariff, and circa €5 billion was made available in 2009 to guarantee the payment for the next 15 years for the production of green electricity and green gas.[210]

Countries of particular interest

Biomass is the most mature baseload technology for renewables within Europe and is also the most accessible option for reducing carbon emissions from transport.

- **France** and **Germany** have high targets for biofuels coupled with large domestic production capacities for bioethanol and biodiesel.
- **Italy** is the first Member State to introduce a sub-target for advanced biofuels and already has the first commercial-scale cellulosic ethanol production plant in the European Union.
- **Poland**, **Bulgaria** and the **Czech Republic** combine strong recent growth in biomass capacity with a positive policy outlook.

[205] EU Biofuels policy: Dealing with indirect land use change, (2015), EPRS, p8 Available here
[206] EBRD, Estonia, Available here
[207] Task 37 Biogas Country Report Overview (Country Reports), IEA Bio-energy, (2015), p18 Available here
[208] Ibid, p18
[209] Sustainable Biomass and Bio-energy in the Netherlands: Report 2013, (2013) Copernicus Institute, Utrecht University, p12. Available here
[210] Bio-energy in the Netherlands, IEA (Guest Editorial), (2013), Available here

EC biofuels policy and implications for Member States

The binding targets of both the **Renewable Energy Directive (RED)**[211] and the **Fuel Quality Directive (FQD)**[212] for 2020 are currently the main driver for biofuels in the EU, as they will mainly be met by an increase in biofuel consumption.

The RED sets a binding target of 10% for the share of renewable energy in transport in 2020 (of which crop-derived biofuels could represent no more than 7% of final consumption of energy in transport, necessitating an emphasis on 2nd and 3rd generation biofuels to make up the balance.[213] The FQD sets a reduction target for the GHG intensity of transport fuels in 2020.

Both Directives define sustainability criteria for the biofuels that count towards these targets. Neither the RED nor FQD, however, prescribe the policy measures that Member States should implement to comply with these Directives. Member States have therefore implemented both Directives in different ways, resulting in a range of different policy measures that all aim to increase the shares of biofuels on their market, in order to assure the realisation (or, in some cases, overachievement) of these targets by 2020. In terms of an overview of developments across the EU28:

- Most Member States have decided to oblige fuel suppliers to put a share of total fuel sales as biofuels on the market. These quotas will help to ensure the increase of the consumption of biofuel volumes required to meet the 10% target in 2020 of the RED, as well as the 6% reduction target for the GHG intensity of transport fuels of the FQD.
- Almost all Member States (25 to be specific), with the exception of Latvia, Cyprus and Estonia, had binding targets in place for the consumption of biofuels in 2014. Table 4.3 presents these targets in energy content in order to facilitate comparison, although 11 countries have actually set volumetric targets (denoted with a V). Some observations include:
  - France, Poland, Slovenia and Sweden have the highest targets, which could present problems in meeting within the current blending limits set by the FQD.
  - Twelve Member States have also put in place subtargets for diesel and petrol. On average, lower subtargets are in place for petrol compared to diesel. The targets mentioned do include double-counting of biofuels from waste and residues (in line with Art. 21(2) of the RED), so the actual share in the fuel volume can be lower.
- Biofuel blending mandates typically increase over time. However, most countries to date have only defined the targets until 2014 or 2015. To what extent the blending limits will pose an issue for more Member States to meet their 2020 targets will become clear over the next few years.

Table 4.3 Overview biofuel blending binding targets (quotas) in place across 25 Member States in 2014 (in energy content)

[211] Renewable energy directive, European Parliament. Available here.

[212] Directive 2009/30/EC of the European Parliament and of the council. Available here.

[213] Renewable energy directive, European Parliament. Available here.

Member State	Overall Target	Target for petrol	Target for diesel	Member State	Overall target	Target for petrol	Target for diesel
France	7.57%	7.00%	7.70%	**Bulgaria (v)**	4.94%	3.34%	5.53%
Poland	7.10%			**Hungary**	4.90%	4.90%	4.90%
Slovenia	7.00%			**Romania (v)**	4.79%	3.00%	5.53%
Sweden (v)	6.41%	3.20%	8.78%	**Luxembourg**	4.75%		
Germany	6.25%	2.80%	4.40%	**Czech Republic (v)**	4.57%	2.73%	5.53%
Finland	6.00%			**Slovakia (v)**	4.50%	2.73%	6.27%
Lithuania (v)	5.80%	3.34%	6.45%	**Italy**	4.50%		
Austria	5.75%	3.40%	6.30%	**Malta**	4.50%		
Denmark	5.57%			**Spain**	4.10%	3.90%	4.10%
Portugal	5.50%			**United Kingdom (v)**	3.90%		
Netherlands	5.50%	3.50%	3.50%	**Greece (v)**	2.64%		
Belgium (v)	5.09%	2.66%	5.53%	**Croatia (v)**	2.06%		
Ireland (v)	4.94%			**Mean target**	5.15%	3.58%	5.81%

Source: Biofuel Barometer, 2015. (v) = obligations originally set in % volume/volume (v/v)

'Advanced' biofuels are defined as "conversion technologies which are still in the research and development (R&D), pilot or demonstration phase, commonly referred to as second- or third- generation. This category includes biofuels based on lignocellulosic biomass, such as cellulosic-ethanol, biomass-to-liquids (BtL)-diesel and bio-synthetic gas (bio-SG). The category also includes novel technologies that are mainly in the R&D and pilot stage, such as algae-based biofuels and the conversion of sugar into diesel-type biofuels using biological or chemical catalysts" (IEA, 2015).[214] According to Biofuels Digest (2013), planned production capacity of advanced biofuels across European Member States (plus Norway) was set to rise from approximately 634 million gallons per year in 2013 to approximately 793 million gallons per year in 2015.[215]

The **Indirect land use Change (ILUC) Directive**[216], voted into EC legislation in 2015, prescribes revisions in both the RED and FQD in order to limit the risk of ILUC. The proposed new rules, which will help to stimulate advanced biofuels, aim to ensure that "biofuels from new installations emit at least 60% less greenhouse gases than fossil fuels": an increase from the present requirement of 35%. Emissions reports supplied by fuel providers and EU Member States must detail the mean provisional estimates of emissions that might be caused by indirect land use change. Biofuels "made from feedstocks that do not lead to additional demand for land, such as those from waste feedstocks, should be assigned a zero emissions factor"[217]. Advanced biofuels, with an indicative 0.5% sub-target, are considered to contribute twice that of other biofuels[218 219]. Another key development of ILUC is that, after 2020, governments can provide financial support only to 2nd and 3rd

[214] Bioenergy, IEA. Available here. , accessed 02 Dec 2015.

[215] http://www.biofuelstp.eu/fuelproduction.html, accessed 3rd Dec 2015.

[216] Land use change, European Commission. Available here.

[217] Renewable energy directive, European Parliament. Available here.

[218] EREC (2011) Mapping Renewable Energy Pathways towards 2020: EU Roadmap, p10, available here

[219] http://biofuelstp.eu/biofuels-legislation.html

generation biofuels plants.[220] Member States are obliged to transpose the law into national legislation by 2017, and indicate how they will meet the targets for advanced biofuels.

In order to incentivise research into advanced biofuels, a number of EC financing mechanisms are available: [221]

- Horizon 2020: supports bio-based industries Joint Technological Initiatives (JTI), with €1 billion contributed by the EC and Member States over the next seven years, and a little under €3 billion from industry;
- NER 300[222]: helps stimulate the construction and operation of commercial-scale demonstration projects with more than 10 bioenergy / biofuels projects awarded;
- Intelligent Energy Europe – has supported projects relating to feedstocks[223] and clean and sustainable transport.[224]
- INTERREG IVC, supporting interregional cooperation across Europe, has supported good practice sharing relating to advanced biofuels in sustainable transport[225] and the "promotion of the biodiesel chain".[226]

---

[220] ibid

[221] http://www.biofuelstp.eu/funding.html#projects

[222] NER 300-2, European Commission. Available here, accessed 4th Dec 2015.

[223] Feedstocks projects, European Commission. Available here.

[224] Sustainable projects, European Commission, Available here.

[225] Sustainable Transport overview, INTERREG IVC. Available here.

[226] Integrated promotion of biodiesel chain, INTERREG IVC. Available here.

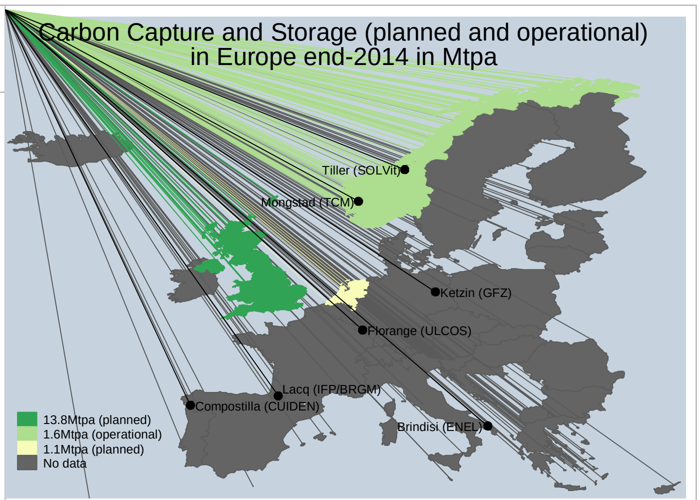
4.6 Carbon Capture and Storage

Key facts and figures for European Carbon Capture and Storage (CCS)

Total capacity (planned and operational):
16.5 Mtpa (mega-tonnes per annum)

The only three countries in which installed capacity is planned or operational [227]

- United Kingdom: 10.1 Mtpa (planned)
- Norway: 1.6 Mtpa (**operational**)
- Netherlands: 1.1 Mtpa (planned)



Top countries by capacity added in 2014 only:

- Not applicable: no capacity has been added since 2008[228]

Name and location of prominent test facilities for CCS in Europe:

- (CIUDEN) Fundación Ciudad de la Energía, Compostilla, Spain;
- (Lacq) Lacq demonstration (by various incl. IFP and BRGM), Lacq, France;
- (ULCOS) Ultra-Low-CO2-Steel, Florange, France;
- (TCM) The European CO2 Test Centre, Mongstad, Norway;
- (SOLVit) Aker Clean Carbon , SINTEF and NTNU, Tiller, Norway;
- (GFZ) GFZ German Research Centre for Geosciences - PilotStandortKetzin, Ketzin, Germany;
- (ENEL) Post-combustion coal based pilot plant at Brindisi, (ENEL, Italy), Brindisi, Italy.

Countries with highest consistent growth rates over the period 2011 to 2014:

Growth between 2011 and 2014:

- Not applicable: no capacity has been installed since 2008

CCS capacity in 2014:

- Not applicable: no capacity has been installed since 2008

Social Acceptance:

Due to the small number of CCS projects in place, there is not much concrete evidence on this technology's social acceptance. Most hypothetical surveys, however, point to a "NIMBY effect" relating to transportation (e.g. pipelines) and storage (defined as "NUMBY" or "not under my backyard"), as well as to some concerns over the source of carbon. Overall, people tend to be more welcoming of CCS projects if they are capturing carbon from a biomass power plant than from a coal power plant. Some concerns regarding decreases in local property values have also been raised. [229]

---

[227] http://www.globalccsinstitute.com/projects/large-scale-ccs-projects

[228] Since 2009 four major CCS demonstration projects under the European Energy Programme for Recovery (EEPR) have been terminated due to a lack of financial support or agreement of CCS in national frameworks. These include: Belchatow (Poland), Porto Tolle (Italy), Janschwalde (Germany), Compostilla (Spain).

[229] Duetschkea, E., Schumannb D., Pietznerc, K., Wohlfartha, K., Höllerc, S., 2014. Does it make a difference to the public where CO2 comes from and where it is stored? Energy Procedia 63 (2014) 6999 – 7010[PDF]

Planning and Permitting:

In the EU, CCS is regulated both at national and European level, with Member States required to put in place measures that reflect the European **CCS Directive**. The Directive deals with environmental and permitting regulation on the geological storage of CO_2 and had to be transposed into national law by 2011. By end 2013, seven Member States had not yet notified their transposition (Austria, Cyprus, Hungary, Ireland, Sweden & Slovenia), of which all but Cyprus have not allowed geological storage of CO_2, while others have severely restricted it (Germany, Czech Republic)[230]. Other countries have faced strong public opposition of geological storage onshore (Denmark, Germany, and Netherlands).[231] Overall, the review of the CCS Directive in 2015 found that the CCS Directive was relevant and fit for purpose as a uniform framework, and coherent. The disappearance of the commercial case for CCS has meant that the CCS Directive has not been tried and tested as much as expected. The CCS Directive could allow for new technologies such as Industrial CCS and Bio-CCS, however stakeholders tend to agree that the policy uncertainty which would arise from amending the directive would outweigh the benefits from including these technologies. [232]

CCS projects face complex and burdensome permitting processes linked to the implementation of the CCS Directive and due to the wide range of permitting authorities developers have to deal with.

Permitting requirements for CCS projects can be subdivided either according to the 3 main temporal phases (planning and construction; operation; and closure and decommissioning) or into functional areas:

- CO_2 capture plant;
- CO_2 transport;
- CO_2 injection and storage to point of well closures; and,
- Long term stewardship of storage reservoir

The study “Permitting issues for CO_2 capture and geological storage”[233] identifies that the main issues requiring consideration occur for the injection/storage phase and the long term stewardship phase; capture and transport operations however show no significant issues for permitting.

The most prominent and largest integrated CCS demonstration project to be planned in the world is the Dutch ROAD (Rotterdam Capture and Storage Demonstration) project. Because it was the first of its kind in the Netherlands, applying for all the necessary permits was one of the most challenging parts of the projects.[234] The long-term commitment imposed by the storage facility created significant challenges in terms of understanding and addressing at the outset the potential technical issues that might require a specific consent. Furthermore, the ROAD project highlighted the importance of information exchange between all parties and authorities involved in the design, construction and permitting processes. The array of permits, consents and licensees, shown below, illustrate the challenge facing developers of such FOAK projects:

- General permits: general Environmental Impact Assessment; Emission permit
- Permits for the capture facility: All-in-one permit for physical aspects; Building Permission and Environmental Permission; Natural Protection Act Permit
- Permits for the transport facility: State zoning plant; Environmental Impact Assessment; Water permit; Railway permit
- Permits for the storage facility: All-in-one permit for physical aspects; Storage permit

Other permits may be needed for the establishment of responsibility for decommissioning and long term liabilities associated with storage facilities.

---

[230] With a further three regions, Finland, Luxembourg and Brussels Capital Region of Belgium notified that they will not allow CO_2 storage due to the lack of geological suitability.

Report from the Commission to the European Parliament and the Council on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide. EC COM(2014)99 final, Report from the Commission to the European Parliament and the Council on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide, p3, available here

[231] Shogenova et al (2014) Implementation of the EU CCS Directive in Europe: results and development in 2013, Energy Procedia, 63: 6662 – 6670

[232] Support to the review of Directive 2009/31/EC on the geological storage of carbon dioxide (CCS Directive)”, report from Triple E, Ricardo-AEA and TNO to the European Commission, December 2014, available here

[233] IEA Greenhouse Gas R&D Programme, “Permitting issues for co2 capture and geological storage”, 2006.

[234] Tom Jonker, “The permitting process – Special report on getting a CCS project permitted, January 2013.

Countries with CCS capacity (planned or operational)

Country	Outlook	Key market condition developments
United Kingdom	☹	■ The United Kingdom has four planned projects. The source of carbon is power generation and industrial zone activities, the transport is via pipelines to dedicated geological sources.[235] ■ On 25th of November 2015, the UK government scrapped the £1 billion CCS competition in its autumn statement, introduced only in 2012 by the previous coalition government to commercialise CCS technology;[236] ■ Citing the autumn statement, both preferred bidders in the competition – namely Peterhead (Shell and SSE) and White Rose (PowerCapture) – announced the abandonment and likely abandonment of their respective projects[237] [238]; ■ The budget for the Department of Energy and Climate Change (DECC) has been cut by 22% over the next four years[239] – cuts in non-nuclear programmes are estimated to be 46% in 2017/2018 before the budget will rise again[240].
Netherlands	☺	■ The Netherlands has one planned project. The source of carbon is power generation. The transport is via a pipeline to a dedicated geological source.[241] ■ The ROAD project is the first of its kind in the Netherlands and has therefore required a plethora of permits to allow it to proceed, creating one of the most challenging parts of the project *(see Planning & Permitting section above)*.
Norway	😐	■ Norway has two operational projects. The source of carbon for both the gasification process. One project applies direct injection, while the other uses pipeline transport. Both use dedicated geological sources.[242] ■ Although the Pollution and Waste Act has no CCS specific references, there have been instances of its application on CCS-related projects. Under this Act, the storage of CO2, whether onshore or offshore, will require a permit.[243]

[235] http://www.globalccsinstitute.com/projects/large-scale-ccs-projects

[236] Dept of Energy & Climate Change (25 November 2015) "HM Government Statement to Markets Regarding Carbon Capture and Storage Competition", available here

[237] Shell, Peterhead CCS Project announcement, available here

[238] Power Capture (press release 25 November 2015) Government withdraws CCS Commercialisation Programme, available here

[239] HM Treasury (updated 27 November 2015) Spending review and autumn statement 2015, available here

[240] BBC (24 November 2015) Spending Review: Department-by-department cuts guide. available here

[241] http://www.globalccsinstitute.com/projects/large-scale-ccs-projects

[242] http://www.globalccsinstitute.com/projects/large-scale-ccs-projects

[243] Global CCS Institute: Norwegian CCS legislation, available here

Other countries of interest[244]

Country	Outlook	Key market condition developments
Germany	😐	■ Public opposition to CCS, competitive alternative green energy technologies and limited storage potential in Germany[245] has shifted the focus from CCS to CCSU (Carbon Capture, Use and Storage). The Ministry of Education and Research (BMBF) has made €100 million available 2010-2016 for basic research on CCUS and expects an additional €50 million to come from industry[246]. ■ Following CCUS research, several projects are either planning or completing their pilot demonstration phases in CCUS with a wide variety of successful applications (production of polymers, liquid fuels, algae, etc)[247] and reflect early optimism in the area.
France	😐	■ On the 22nd July 2015, France passed a new energy bill which raises the country's domestic carbon tax to €100/tonne by 2030 (currently €14.5/tonne), and commits France to a 30% reduction in fossil fuel consumption, alongside a reduction in the reliance on nuclear power.[248]
Switzerland	😐	■ In the May 2013 Roadmap, Switzerland planned an indicative gross budget of 30 million CHF for CCS research and 90 million CHF for demonstration.[249] ■ A concern is the availability of sufficient adequate geological storage reservoirs for commercial applications of CCS.[250] ■ Switzerland boasts a highly developed supply-chain in the area, with leading companies in CCS inspection, verification, testing, and certification as well as development and demonstration of Carbon Capture Use and Storage.[251]
Italy	😐	■ In Italy, CCS continues to face public opposition and not-in-my-backyard (NIMBY) objections.[252] ■ Italy faces high transportation costs from the current locations of CO_2 emission and potential geological storage reservoirs. More broadly, anticipated techno-logical advances and cost reductions in CCS have not materialised so far[253]. ■ In August 2013, the Italian Ministry of Economic Development (MISE) awarded Technology Centre Sulcis in Sardinia €30 million to help realise CCS in 2017 for five main projects including a demonstration of CCS.[254] Italy already contains multiple pilot and advanced stage CCS demonstration facilities.[255]

[244] Other countries of interest are selected as the top five countries (in addition to the three countries already mentioned above) with the highest Public and Corporate R&D spending on CCS in 2011, based on JRC (2015) Capacity Mapping: R&D investment in SET-Plan technologies, available here p37

[245] Viebahn, Vallentin, Höller, Fischedick (2012). Integrated assessment of CCS in the German power plant sector with special emphasis on the competition with renewable energy technologies. Mitigation and Adaptation Strategies for Global Change, 17(6), 707-730, available here

[246] BMBF presentation (21 October 2014) "The German R&D Program for CO2 Utilization – innovations for a green economy" available here

[247] Ibid.

[248] Carbon Pulse (July 22, 2015) France passes sweeping energy bill, to raise CO2 tax to €100/t by 2030, available here

[249] Bundesamt für Energie BFE (presentation 31 May 2013) Roadmap for a Carbon Dioxide Capture and Storage pilot project in Switzerland, available here

[250] Ibid.

[251] BusinessGreen (26 Oct 2015) "Climeworks says world's 'first' commercial-scale atmospheric carbon capture plant on track for 2016 launch", available here; SGS: Overview carbon capture and storage, available here

[252] Virdis, M.R. et al. (2015). Pathways to deep decarbonization in Italy, SDSN – IDDRI, available here

[253] Ibid.

[254] ENEA and SOTACARBO (presentation conference 20-22 May 2014) 9th CO2GeoNet Open Forum: Building a full CCS value chain towards an Italian demonstration project in the Sulcis area , available here

[255] Carbon Sequestration Leadership Forum: Italy. available here

Denmark	☹	■ In Denmark, investment in CCS R&D is dependent on the private sector[256], with opposition from environmental NGOs active to move the country to a carbon free future without the use CCS.[257] ■ After public opposition, Denmark banned all onshore CCS until at least 2020[258]. ■ In May 2014, Vattenfall, a major private investor in CCS and one of the largest fossil fuel utility companies in the country, discontinued its long standing research regarding coal power with CCS[259]. In June 2015, Vattenfall sold the last of its fossil assets in Denmark, marking its transition from carbon to wind technologies[260].
Spain	☺	■ EU co-funded COMET project had objectives of defining integrated transport and storage infrastructure in Portugal, Spain and Morocco. [261] ■ Pilot 'FLEXYBURN CFB' project initiated in Spain, aimed to develop and demonstrate a power plant concept based on the Circulating Fluidized Bed technology combined with CCS and including a 30MW pilot plant in Spain.[262]

Countries of particular interest

CCS development would benefit from the proposed inclusion into the EC 2030 climate and energy policy framework as significant progress is needed for it to have a role in meeting the 2030 climate targets[263]. (The SCCS research partnership has developed a "cluster plan", wherein existing studies of North Sea CCS clusters are developed further, that could be of interest in that respect.[264]) However, for the time being, the only possible countries of particular interest are those with operational or planned capacity: **Norway**, the **UK** and the **Netherlands**.

Carbon Capture, Use, and Storage (CCUS) has emerged in several EU Member States, most notably Germany, as an area which has attracted a substantial amount of public and private support.

EC support schemes for CCS and CCUS projects

For CCS, the EC has multiple programmes and special initiatives in place to aid its development. At the same time, the EC programmes require CCS demonstrations to attract significant additional funds from private and other public domestic sources.

- **New Entrants' Reserve 300 (NER 300)**[265] is a €2.1 billion grant mechanism instrument that started in 2009 with the aim to stimulate the construction and operation of environmentally safe CCS and renewable energy demonstration projects. Despite an intention to support several CCs plants (a key condition being that no more than 15% of the total fund would go to a single project), only one CCS project is still active.[266] Leading CCS projects in the two NER 300 calls were:

[256] JRC (2015) Capacity Mapping: R&D investment in SET-Plan technologies, available here

[257] Greenpeace (27 October 2014) Denmark's commitment to 100% renewable energy, available here

[258] Shogenova et al. (2014) Implementation of the EU CCS Directive in Europe: Results and Development in 2013, presentation available here

[259] The Local SE (7 May 2014) Vattenfall abandons research on CO2 storage, available here

[260] Vattenfall (press release 24 June 2014) Vattenfall divests Danish power plant, available here

[261] Global CCS Institute (May 2015) Carbon Capture and Storage in the Community of Portuguese Language Countries, Opportunities and Challenges, p5, available here

[262] Ibid, p5

[263] EC Climate Action: Carbon Capture and Geological Storage, available here

[264] Scottish Carbon Capture and Storage (2015) Recommendations and Conference 2014 report, available here

[265] EC Climate Action: NER 300 programme, available here

[266] EC Climate Action (press release 18 December 2012) "23 innovative renewable energy demonstration projects receive €1.2 billion EU funding", available here

– Don Valley Power Project (UK) - first call, July 2012. The project failed to qualify however for the UK's CCS Competition. This meant its bid had to be abandoned[267] (see under EEPR below for more information).

– White Rose Project (UK) – sole applicant, second call, July 2013. Earlier that year, the project was named as one of two preferred bidders in the UK's CCS Competition. In August 2014, it was awarded up to €300 million in NER 300 funds[268]. However, in late November 2015 the UK CCS Competition was cancelled by the newly elected government leading to the cancellation of the project, with management stating it had become "difficult to imagine its continuation in the absence of crucial Government support".[269]

- **European Energy Programme for Recovery (EEPR)**, launched in 2009 and dedicated €1 billion grant funding to CCS. Conditions of the programme stated a maximum of €180 million be awarded with only one project funded per Member State[270]. By the end of 2009, six CCS projects had been awarded funding of which two are still 'live':
  – Don Valley Power Project in the UK - secured €180 million but having failed to receive funding from NER 300, it restructured to enable it to proceed outside the DECC competition.[271] In late 2014, the project was sold to Norwegian Sargas and as of mid-2015 still had plans for its gas phase CCS to be operational by 2020. However, a second coal phase which was originally part of the plan will no longer be pursued.[272]

  – Maasvlakte CCS Project (ROAD) in the Netherlands secured €180 million in 2009. In 2011, the EC approved a further €150 million in state aid.[273] Project sponsors, E.On and GDF Suez, were also to contribute a further €100 million.[274] In 2014, it was put on hold having failed to find investors for its operational phase. Its plan to sell carbon credits under the EU Emission Trading Scheme was no longer viable with the collapse in price of carbon. By the end November 2015, the outlook for the project had become more optimistic with possible investment from Germany and Norway in 2016 and plans to be operational by 2019.[275]

- **Seventh Framework Programme (FP7) / Horizon 2020** - FP7 awarded €204 million in total to 48 CCS projects (including for clean coal research), making it an important source of funds for earlier stage projects as well as some demonstration projects, albeit at average funding levels per project far lower than the hundreds of millions required for full-scale, full chain CCS demonstration projects.[276]

- **Fast Track to Innovation Pilot** - a €200 million innovation pilot fund over two years to tackle projects in later stages of development (about €70 million for energy innovation, including CCS[277]) aimed at SMEs[278].

<u>Move from CCS to CCUS</u>

The EC SET communication (September 2015)[279] called for a "step up [of] research and innovation activities on the

[267] DECC (20 March 2013) Preferred bidders announced in UK's £1bn CCS Competition, available here

[268] Capture Power (press release 1 August 2014) White Rose CCS Project secures award decision on European NER300 funding, available here.

[269] Power Capture (press release 25 November 2015) Government withdraws CCS Commercialisation Programme, available here

[270] Support to the review of Directive 2009/31/EC on the geological storage of carbon dioxide (CCS Directive)", report from Triple E, Ricardo-AEA and TNO to the European Commission, December 2014, available here

[271] National Grid: Don Valley, available here

[272] 2CO 7 July 2014 Press release, available here, followed by The Star 26 June 2015 'Doncaster carbon capture power plan still on track, says new boss', available here

[273] ROAD CCS: State Aid, available here

[274] Energie actueel (article 26 November 2015) Finally progress in offshore CO2 storage project (original: "Eindelijk schot in project voor CO2-opslag onder zeebodem), available here (Dutch)

[275] Carbon Capture Journal (18 November 2015) Special report from the 8th Dutch CCS: Symposium, available here

[276] N.B. the figure includes research money for Clean Coal Technology (CCT). Technopolis Group, Hinicio, LBST, FEEM (19 June 2014) Evaluation of the impact of projects funded under the 6th and 7th EU Framework Programme for RD&D in the area of non-nuclear energy, pp vi, 17, available here

[277] European Commission Decision C (2015)2453 of 17 April 2015, Revised Horizon 2020 Work Programme 2014 – 2015: 10. Secure, clean and efficient energy, p93, available here

[278] EC Horizon 2020: Leadership in Enabling and Industrial Technologies, available here

application of CCS and the commercial viability of carbon capture and use (CCU)" (p13), with EC support through:

- **European Fund for Strategic Investments (EFSI) -** a fund that aims to deliver at least €315 billion in strategic infrastructure investments (including transport and energy technology) and to small business[280], facilitated by a €16 billion EC guarantee and €5 billion from the European Investment Bank (EIB). DG GROW Deputy Director General Mr. Peltomäki advocated a CO_2 utilisation project be included in EFSI to 'use CO_2 as a source of carbon for fuels or chemicals feedstock and to provide new business opportunities for the European industry'.[281]
- **InnovFin Energy Demonstration Projects (EDP) -** launched in June 2015 by EIB with support under Horizon 2020 to provide loans of €7.5 million to (initially) €25 million for first-of-a-kind, commercial-scale industrial demonstration projects in renewables.[282]
- **European Structural and Investment Funds (ESI Funds) -** has over €64 billion available from 2014 to 2020 to support a transition to a "Low-Carbon Economy".[283]

In addition, two additional sources of potential support for CCS/CCU/CCUS include:

- **Connecting Europe Facility** - a €33 billion fund to boost infrastructure for energy, transport, and digital between 2014 and 2020[284], and may potentially support transport of CO_2 through international pipelines for carbon use (storage has potential legislative barriers framework for cross border storage). As of end 2013, there were no carbon transport projects active (the next update is scheduled end 2015)[285].

- **Important Project of Common European Interest (IPCEI**) are classified as large transnational projects of strategic importance where a market failure exists, thus allowing support from member states under state aid rules[286]. DG GROW flagged major projects of carbon capture as potential IPCEI[287].

With the limited commercial success of CCS, efforts have shifted slightly to CCU, with an added benefit that captured carbon can be used for biofuels and other industrial purposes. Public support and policy climate seem to be agreeable to these developments and there is high level talk of CCU as a Key Enabling Technology (KET)[288], with potential for large job creation and economic growth. However, this enthusiasm is not shared by all: the Association of European Renewable Energy Centres (EUREC) has communicated that it believes CCU/CCS is "given an easy ride": it argues the technology is unlikely to be commercially feasible, not proven to be able to be used at a large scale and does not warrant the amount of public attention it has received so far[289].

---

[279] COM(2015) 6317 Communication from the Commission - Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation, p8, available here.

[280] European Commission: The European Fund for Strategic Investments (EFSI), available here.

[281] European Commission (2015) Proceedings of the scoping workshop Transforming CO2 into value for a rejuvenated European economy, p13, available here

[282] European Investment Bank: InnovFin Energy Demo Projects, flyer available here. CCS out of scope at this stage.

[283] EC European Structural And Investment Funds, Data: Low-Carbon Economy, Theme 4, available here

[284] EC Energy: Funding, available here

[285] EC Energy: Projects of common interest - Overview of projects by country, available here

[286] IP/14/673, European Commission (press release 13 June 2014) State aid: Commission adopts new rules to support important projects of common European interest , available here

[287] European Commission (2015) Proceedings of the scoping workshop Transforming CO2 into value for a rejuvenated European economy, p13, available here

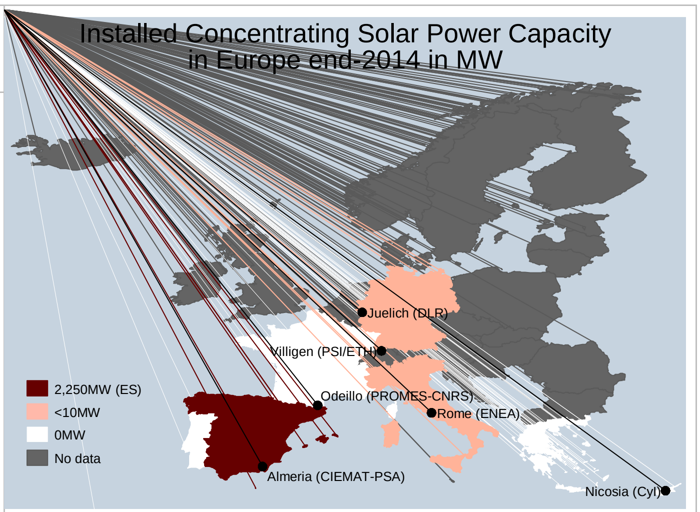
[288] Ibid.

[289] The European Renewable Energy Centres (EUREC): Commission adopts new SET Plan communication, available here

4.7 Concentrated Solar Power (CSP)

Key facts and figures for Concentrated Solar Power (CSP)

Total installed capacity for Europe: **2,258 MW**



The only three countries with installed capacity as at the end of 2014 [290]

- Spain (2,250MW);
- Italy (6MW);
- Germany (2MW).

The only country to add to capacity in 2014:

- Italy (1MW added)

Name and location of selected test facilities for CSP in Europe:

- (CIEMAT-PSA) Plataforma Solar de Almeria - CIEMAT, Almeria, Spain;
- (PROMES-CNRS) Processes, Materials and Solar Energy Laboratory, Font-Romeu-Odeillo-Via, France;
- (PSI/ETH) Paul Scherrer Institute/ETH - Professorship in Renewable Energy Carriers, Villigen, Switzerland;
- (DLR) German Aerospace Center - Solar Energy Research, Juelich, Germany;
- (ENEA) Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Rome, Italy;
- (CyI) Cyprus Institute - Cyprus Solar Thermal Energy for the Mediterranean, Nicosia, Cyprus.

The only two countries to show any capacity growth over the period 2011-2014:

Growth between 2011 and 2014 :

- Spain (96%);
- Italy (20%).

Installed CSP capacity as at end-2014:

- Spain (2,250 MW);
- Italy (6 MW).

Social Acceptance:

Social acceptance of CSP projects is mostly related to the technology's net environmental impact. Environmental issues encompass impacts on birds (fatalities due to high temperature), high water demand and land use impacts. On the social side, concerns are also raised that a boom-bust cycle might result from CSP plant construction and that permanent jobs are minimal. Other issues regarding the intermittency of solar power are expressed, although clearly the move at many new plants towards the use of thermal storage which can help shift production to peak power demand will help [IRENA & DNV KEMA, 2013].

[290] IRENA dashboard. Available here.

Planning and Permitting

For concentrated solar power technology, consenting and permitting processes can be particularly burdensome: the enormous towers, solar arrays and parabolic racks used in CSP projects can take years to get permitted and approved by local and national authorities and stakeholders. The grid connection is also a crucial element to be considered in the development phase given the fact that CSP plants require large tracts of land with homogenous solar resources, usually away from dense populated centres and often in desert regions. The fact that the technology is still young and most projects are first-of-a-kind does not alleviate the burden to developers and permitting authorities. For instance, the Ivanpah solar electric generating system developed in the USA took 7 years from first pre-qualification application to the US Department of Energy until the final entry into service in December 2013.

Developers may encounter several non-economic barriers to establishing CSP plants. These include:

- Difficulties in obtaining permits for land use and grid access;

- Difficulties in securing access to water and gas networks in some locations;

- Environmental impacts evaluation process, including assessment of loss of animal habitat, water use, visual impact and effects on endangered species;

Similarly to other large-scale innovative technologies, the main recommendations provided by experts focus on two main points:

- Removing or alleviating non-economic barriers, such as costly, lengthy and heavy permitting and connection procedures;

- Creation of a policy framework for market deployment, including tailoring incentive schemes, targets for deployment at country level and updating the regulatory framework to meet CSP specific technological requirements. [291]

- Streamline procedures and permits for CSP plants and transmission lines.

[291] International Energy Agency, Technology Roadmap, 2014.

Table 4.4 CSP installed capacity, developments in European countries 2011 – 2014

Country	Installed capacity as at end 2014 (MW)	Specified NREAP targets for 2020 (MW)[292]	NREAP target reached	Additions to capacity in 2012 (MW)	Additions to capacity in 2013 (MW)	Additions to capacity in 2014 (MW)
Belgium	-	-	-	-	-	-
Bulgaria	-	-	-	-	-	-
Czech Republic	-	-	-	-	-	-
Denmark	-	-	-	-	-	-
Germany	2	0	in 2008	0	0	0
Estonia	-	-	-	-	-	-
Ireland	-	-	-	-	-	-
Greece	0	250	not yet	0	0	0
Spain	2,250	5,079	not yet	851	250	0
France	-	-	-	-	-	-
Croatia	-	-	-	-	-	-
Italy	6	600	not yet	0	0	1
Cyprus	0	75	not yet	0	0	0
Latvia	-	-	-	-	-	-
Lithuania	-	-	-	-	-	-
Luxembourg	-	-	-	-	-	-
Hungary	-	-	-	-	-	-
Malta	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-
Austria	-	-	-	-	-	-
Poland	-	-	-	-	-	-
Portugal	0	500	not yet	0	0	0
Romania	-	-	-	-	-	-
Slovenia	-	-	-	-	-	-
Slovakia	-	-	-	-	-	-
Finland	-	-	-	-	-	-
Sweden	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-
Switzerland	-	-	-	-	-	-
Iceland	-	-	-	-	-	-
Norway	-	-	-	-	-	-
Ukraine	-	-	-	-	-	-

[292] Mapping Renewable Energy Pathways towards 2020, European Renewable Energy Council (2011). Available here.

Countries that have the greatest installed CSP capacity

Country	Outlook	Key market condition developments
Spain	☹	■ Termination of FiT system in 2013, and potential replacement with a ‘reasonable return’ or ‘profitability’ revenue scheme.[293] Also, a regulatory limit of a sub-optimal 50 MW of power output per plant.[294]
Italy	😐	■ Specific FiT set by the Ministry of Economic Development. Extensive use of oil in trough plants is forbidden by environmental legislation; however, this has the effect of encouraging more innovative designs, e.g., direct steam generation (DSG) or molten salts.[295]
Germany	😐	■ Operation of small pilot schemes.[296] ■ Market premiums are offered above the market price for electricity.[297]

Countries which have not yet met their NREAP CSP capacity targets (if not included above)

Country	Outlook	Key points
Cyprus	😐	■ Expressed interest in joining SolarPACES, the main international forum on CSP R&D.[298]
Portugal	☹	■ The most important means of promotion is a feed-in tariff for existing installations. New provisions for new small-scale installations are expected to come into force in 2015, but there is no information on support for larger schemes.[299]
France	☺	■ Support in France is provided through a mix of feed-in tariffs, tenders for new renewable build and/or tax regulation mechanisms.[300]
Greece	☺	■ One of nine countries participating in EU-SOLARIS with the aim of enhancing R&D promotion and coordination.[301] ■ Two CSP projects to be developed by Greece were awarded €86.7 million under the EU NER300 programme. [302]

Countries of particular interest

- **Italy** has continued support for CSP despite significant changes to financial support for solar PV, with approximately 115 MW of CSP projects in the pipeline.[303]

---

[293] Study on the Competitiveness of the EU Renewable Energy Industry, (2014), ICF International, p12, Available here.
[294] Technology Roadmap, Solar Thermal Electricity (2014), International Energy Agency, p16 Available here.
[295] Ibid, p18
[296] Concentrating Solar Thermal Power (CSP), CLEANLEAP. Available here.
[297] European Commission, (July 2014), State aid: Commission approves German renewable energy law EEG 2014, Available here
[298] Thematic Research Summary, Concentrating Solar Power, European Commission (2014), p51 Available here.
[299] Legal sources on renewable energy, Promotion in Portugal, Res-Legal, 2014. Available here.
[300] Legal sources on renewable energy, Promotion in France, Res-Legal, 2014. Available here.
[301] Thematic Research Summary, Concentrating Solar Power, European Commission, p42
[302] Greece country information, SolarPACES. Available here.
[303] Technology Roadmap, Solar Thermal Electricity (2014), International Energy Agency, p18

4.8 Geothermal energy

The data on installed capacity relate to geothermal power production. The country comments relate to power, the developments related to geothermal for heat are included where policy affects both heat and power.

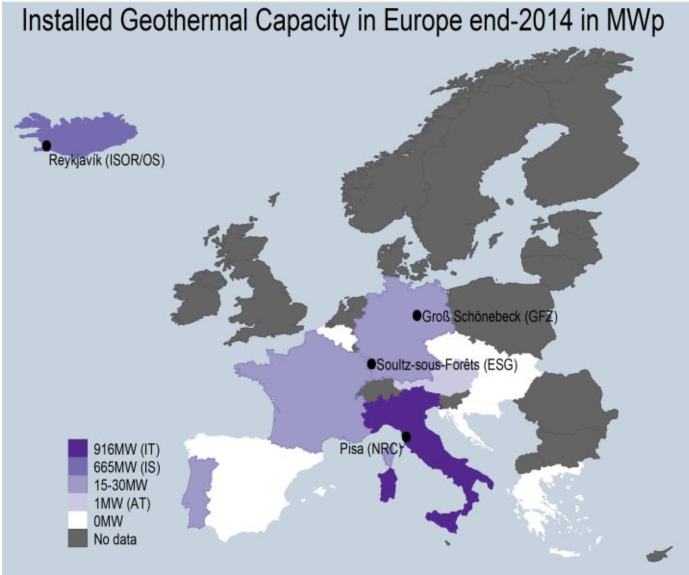
Key facts and figures for European geothermal energy:

Total installed power capacity for Europe: **1654.3 MWe**

Top five countries by installed capacity as at end-2015)[304]

- Italy (916 MWe);
- Iceland (665 MWe);
- Portugal (29 MWe);
- Germany (27 MWe);
- France (16 MWe).

(Taken together, these countries represent 99.9% of total capacity in Europe: 1653 MWe. The only other installed capacity is 1.2 MWe in Austria and 0.1 MWe in Romania)



The countries adding capacity since 2010:

- Iceland (90 MWe);
- Italy (74 MWe);
- Germany (20 MWe);

Name and location of selected test facilities for Geothermal Energy in Europe:

- (ISOR/OS) Íslenskar Orkurannsóknir/Iceland National Energy Authority (Orkustofnun), Reykjavík, Iceland;
- (ESG) Enhanced Geothermal System by EEIG "Heat Mining" , Soultz-sous-Forêts, France;
- (NRC) Pisa Institute for Geothermal Research of the National Research Council , Pisa, Italy;
- (GFZ) Geothermal research platform, Groß Schönebeck, Germany.

The countries showing capacity growth over the period 2010-2015:

Growth between 2010 and 2015[305]:

- Germany (280%);
- Iceland (16%);
- Italy (9%);

Installed geothermal capacity as at end-2015 :

- Germany (27 MWe);
- Iceland (665 MWe);
- Italy (916 MWe).

---

[304] Bertani, R. (2015) 'Geothermal Power Generation in the World 2010-2014 Update Report', *Proceedings World Geothermal Congress*. Available (here)

[305] Ibid.

Social Acceptance:

Some of the impacts of geothermal power which raise social acceptance concerns include induced seismicity, noise impacts during construction and operation, visual impacts of power structures, as well as competition with recreational purposes. [IRENA & DNV KEMA, 2013]

Planning and Permitting:

Regulatory barriers can hinder the development of large scale geothermal power plants. According to the GEOELEC's "Report on geothermal regulations"[306] principal planning and permitting barriers against geothermal power plants, besides potential public acceptance issues, result from:

- Difficult procedures for obtaining exploitation rights: in order to obtain the legal authorisation, project developers must go through several steps and deal with a number of authorities.

- Environmental regulations: permits, licenses and consents requirements for the development and operation of a geothermal plant may include an Environmental Permit, a water abstraction licence and discharge consent, and a conservation area consent.[307]

Additionally, grid infrastructure development and secured grid access is key for geothermal power systems, together with a legally binding contract with the grid owner.

Key conditions highlighted by GEOELEC to reach effective geothermal licensing rules include, inter alia:

- The implementation of a legal database for geothermal licensing at European level, with national guides to geothermal licensing.

- The application of non-redundant requirements and procedures where information is required at appropriate stage.

- One-stop-shop licensing process: the establishment of a unique geothermal licensing authority with a thorough expertise in geothermal energy a unique authority shall be in charge of the licensing process, able to coordinate competent administrative bodies and with expertise in geothermal electricity generation.

- Transparency and adequacy of criteria: the regulation should provide a clear and relevant set of criteria against which the application for a licence will be assessed.

- Reasonable timeframes of licensing procedures: lead time can add an additional layer of risk to power plant development. It is therefore useful to impose time limits on the administrative process, in order to guarantee that exploration and development licenses will be examined within a 6-months period.

- Transparency and security of rights: guarantee of exploration and development rights need to be clearly specified in the licensing process.

- Flexible and reasonable management of licenses over time: the legislation shall allow for renewal, extension and transfer of the exploration and development licences.

[306] GEOELEC, "Report on geothermal regulations", September 2013 http://www.geoelec.eu/wp-content/uploads/2011/09/D4.1-Report-on-Geothermal-Regulations.pdf

[307] Geothermal power plants planning and environmental regulation - November 2010 http://www.nortonrosefulbright.com/knowledge/publications/32416/geothermal-power-plants-planning-and-environmental-regulation

Table 4.5 Geothermal installed capacity, developments in European countries 2011 – 2014

Country	Installed capacity as at end 2015 (MWe) [308]	Specified NREAP targets for 2020 (MW)	NREAP target reached	Capacity installed in 2012 (MW)	Capacity installed in 2013 (MW)	Capacity installed in 2014 (MW)
Belgium	0	3.5	not yet	0	0	0
Bulgaria	-	-	-	-	-	-
Czech Republic	0	4.4	not yet	0	0	0
Denmark	-	-	-	-	-	-
Germany	27	298	not yet	13	6	0
Estonia	-	-	-	-	-	-
Ireland	-	-	-	-	-	-
Greece	0	120	not yet	0	0	0
Spain	0	50	not yet	0	0	0
France	16	80	not yet	0	0	0
Croatia	0	10	not yet	0	0	0
Italy	916	920	not yet	0	1	40
Cyprus	-	-	-	-	-	-
Latvia	-	-	-	-	-	-
Lithuania	-	-	-	-	-	-
Luxembourg	-	-	-	-	-	-
Hungary	0	57	not yet	0	0	0
Malta	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-
Austria	1	1	in 2002	0	0	0
Poland	-	-	-	-	-	-
Portugal	29	75	not yet	0	0	0
Romania	0	-	-	-	-	-
Slovenia	-	-	-	-	-	-
Slovakia	0	4	not yet	0	0	0
Finland	-	-	-	-	-	-
Sweden	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-
Switzerland	-	-	-	-	-	-
Iceland	665	715	not yet	0	0	0
Norway	-	-	-	-	-	-
Ukraine	-	-	-	-	-	-

[308] Installed capacity as at end 2015 is drawn from Bertani (2015), whereas NREAP targets and installed capacity in 2012, 2013, and 2014 is drawn from IRENA (http://resourceirena.irena.org/gateway/dashboard/)

Countries that have the greatest installed geothermal capacity

Country	Outlook	Key market condition developments
Italy	☺	■ Operation of a FIP payment per kWh beyond the electricity wholesale-market price, encouraging geothermal production.
Iceland	😐	■ Risk insurance funds for geological risk in existence, although the amounts available in this fund are very small and cannot have an impact on the market as a whole, though on an individual basis they can lead to increased direct use on farms for example.[309]
Portugal	☺	■ Investment planned by the Portuguese government to expand geothermal production on the Azores, supported by EEA grants.[310]
Germany	☺	■ Risk insurance funds for the geological risk; geothermal developers have access to either a post-damage guarantee or guaranteed loans.[311] ■ The German government offers soft loans with low interest rates coupled with redemption grants to companies and municipalities investing in geothermal energy.[312] ■ Dedicated feed-in tariff for geothermal electricity.[313]
France	☺	■ Implementation of an ambitious policy in 2005 envisaging new development of every type of geothermal energy in France, with the geothermal heat thus expected to increase by a factor of five until 2020.[314] ■ A new €50 million risk insurance fund, GEODEEP was set up in 2015 to protect project operators against the geological risk faced during exploration and exploitation. Ten new deep geothermal plants are likely to be opened with this fund.[315] ■ Dedicated feed-in tariff for geothermal electricity.[316]

Countries which have not yet met their NREAP geothermal energy power capacity targets (if not included above)

Country	Outlook	Key points
Belgium	😐	■ One of the eight countries to operate tradable green certificates, offering investors a source of income which compensates for revenue fluctuations and encourages a share of electricity generation in renewables (in Flanders).[317]
Czech Republic	☹	■ Few technically feasible sites for geothermal power production.[318] ■ Lack of sufficient regulatory framework, including dedicated licensing framework.[319]

[309] Financing Geothermal Energy, EGEC, (2013), p17, Available here

[310] EEA Grants (10 April 2014) Iceland and Portugal Expand Geothermal Cooperation, Available here

[311] Financing Geothermal Energy, EGEC, (2013), p17, Available here

[312] Deep Geothermal Energy Production in Germany, Energies, (2014), p4407, Available here.

[313] German feed-in tariffs 2014, German energy blog, 10 May 2015, Available here

[314] IEA geothermal, Members' Activities, France, Available here

[315] Ministre de l'Écologie, du Développement durable et de l'Énergie (30 March 2015) Ségolène Royal annonce la création de GEODEEP, un fonds de garantie pour accompagner le développement de la géothermie, Available here

[316] France Country Update: Proceedings, World Geothermal Congress 2015, (2015), p2 Available here.

[317] 2014 JRC Geothermal Energy Status Report, European Commission, (2015), p33

[318] The potential of the usage of renewable energy in the Czech Republic, International Journal of Social Sciences, p47. Available here.

[319] Developing geothermal district heating in Europe (2014), p34, Available here.

Greece	☹	■ No existing plants for geothermal power production.[320] ■ A liberalisation of the existing regulation on geothermal (for heating) is necessary, in addition to providing incentives to install and operate geothermal energy for power generation.[321]
Spain	😐	■ Geothermal for power has stalled due to a moratorium on new renewable energy developments. Projects are expected to be developed in 2017.[322]
Croatia	☺	■ Receipt of significant funding, circa €14.7 million, for geothermal project through the European Commission NER 300 programme.[323]
Hungary	😐	■ The Environment and Energy Operative Program (2007-2013) was the main supporting scheme for geothermal projects in Hungary. Lack of evidence on natural resources, lack of guarantees and long licensing procedures were key barriers to the further development of geothermal energy in this time period.[324] ■ Constrained access to financing is key; however, 24 deep geothermal projects received financing between 2010 and 2014.[325]
Slovakia	☹	■ Plans for building geothermal power stations have not yet materialised. Some companies have expressed interest in building plants, but there is considerable uncertainty over economic returns and protection of the investments which is preventing material progress. The FiT has been reduced, and the government is changing support for RES so that support is provided via grants from EU funds rather than FiTs. A change to legislation has also affected the protection available to investments – geothermal resources were removed from mining legislation and placed under water law.[326]

Countries of particular interest

The market for heat production from geothermal sources (including heat pumps) is more developed than the market for power production, and it is clear that almost all countries with the intent to source power production from geothermal sources are constrained by lack of access to finance, lack of technology maturity and lack of a supportive regulatory environment (particularly in terms of licensing rights). That said:

- **Iceland** has the most mature market for power production from geothermal energy within Europe. However, further expansion of capacity is limited given existing high rates of utilisation, although there is scope for some addition given that they have not yet reached their NREAP targets. Cross-country collaboration potential is very high, with Iceland keen to offer expertise in this area.

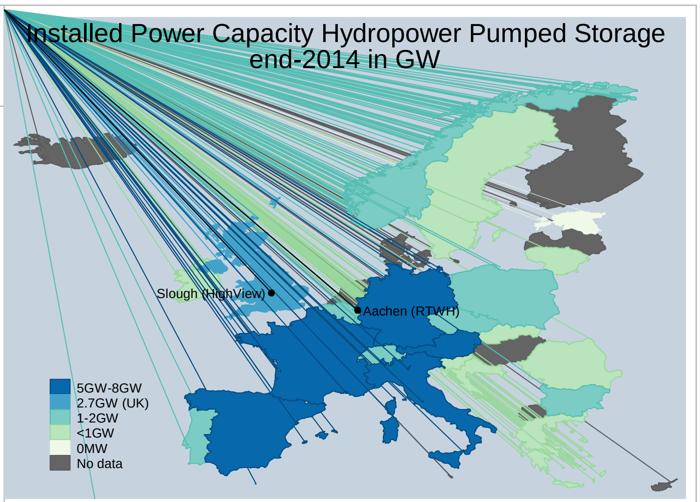
- Several countries have well-developed risk insurance for geothermal projects in place, including **France** and **Germany**. Lack of well-developed regulations such as licensing agreements are highlighted as a key constraint to market development, so countries with risk insurance frameworks in place are likely to have more supportive regulatory environments.
- The **Netherlands** has very substantially increased its use of geothermal heat, with production more than doubling between 2009 and 2014 through the use of heat pumps and direct use of geothermal heat resources. Direct use of geothermal heat from wells drilled into hot water reservoirs has increased by a factor of 10. The government has introduced the 'Guarantee Scheme Geothermal Heat' to encourage geothermal energy use and reduce risks for those engaged in this technology.[327]

[320] World Energy Resources: Geothermal, World Energy Council 2013, p11, Available here.
[321] Greece Country Update: Proceedings, World Geothermal Congress 2015, p7, Available here.
[322] Spain Country Update: Proceedings, World Geothermal Congress 2015, p1 Available here.
[323] Climate action: Commission uses polluters' revenues to fund clean energy projects across Europe, European Commission Press Release 2014. Available here.
[324] Report on support schemes for geoDH (2014) p15-16, Available here.
[325] Hungary Country Update: Proceedings, World Geothermal Congress 2015, pp. 2,4-5 Available here.
[326] Looking to tap geothermal potential, The Slovak spectator, 2014. Available here.
[327] Press release, 2015, Statistics Netherlands. Available here.

4.9 Large-scale storage solutions

Key facts and figures for European large scale storage solutions:

Total installed capacity for Europe (hydropower and non-hydropower):
51,910 MW[328]



Top five countries by installed capacity as at end-2014 [329]

- Italy (7,555 MW);
- France (7,245 MW);
- Germany (6,806 MW);
- Spain (5,328 MW);
- Austria (5,111 MW).

(Together these countries represent 62% of total capacity in Europe: 32,045 MW)

The only two countries to add installed capacity in 2014:

- Ukraine (648 MW added);
- Luxembourg (200 MW added).

Name and location of selected test facilities for large scale storage solutions in Europe (both non-hydropower storage):

- (Highview) Power Storage Demonstration plant (Liquid Air Energy Storage), Slough, UK;
- (RTWH) E.On M5BAT Energy Research Centre - RTWH Aachen University, Aachen, Germany.

The four countries with significant capacity growth over the period 2011 – 2014:

Growth between 2011 and 2014:

- Romania (262%);
- Ukraine (87%);
- Portugal (19%);
- Luxembourg (18%).

Installed capacity as at end-2014:

- Romania (361 MW);
- Ukraine (1,397 MW);
- Portugal (1,298 MW);
- Luxembourg (1,300 MW).

Social Acceptance:

Although the main challenge for energy storage is economic, social acceptance could impair the potential of storage technologies at the three levels at which storage applies, i.e. transmission grid (i.e. national/European; distribution (localised); and end-user storage (i.e. household). Citizens may reject the expansion of renewable energy sources which indirectly results in less need for energy storage and may reject large-scale storage systems (e.g. reservoirs) due to environmental impacts or may refuse remote control of small storage in households.[330] Siting of plants varies widely with some much more easily integrated into existing infrastructure (e.g. banks of batteries at electricity primary substation compared to new build of pumped storage reservoirs). UK Power Networks' plans for a 6MW battery park found that the two largest concerns in responses to its community consultation were potential safety concerns and aesthetic considerations for the proposed facility.[331] Ultimately the project went ahead.

Planning and Permitting:

[328] All figures on installed capacity reference pumped hydro storage. Data on other forms of large-scale storage was not readily available.

[329] IRENA dashboard. Available here.

[330] Directorate-General for Internal Policies; Study for the ITRE Committee; "Energy Storage: Which Market Designs and Regulatory Incentives Are Needed?", 2015. Available here

[331] UK Power Networks, Smarter Network Storage - Design and planning considerations for large-scale distribution-connected energy storage (SNS1.2), Available here

Planning and permitting vary depending on the type of storage project, especially given the very different scale of potential projects (i.e. a few megawatts/tens of megawatts of capacity through to hundreds of megawatts). The majority of planned large-capacity for wind integration globally for example, is materials-based storage, such as new pumped storage and Compressed Air Energy Storage (CAES), "which is more challenging to permit and build than advanced battery or power-to-gas plants"[332].

The main barriers to new pumped storage hydro facilities are environmental, permitting issues and water laws. Environmental issues comprise of:
- Water-resource impacts: stream flows, reservoir surface area, groundwater recharge, water temperature, turbidity, and oxygen content;
- Biological impacts: displacement of terrestrial habitat, alteration of fish migration patterns, and other impacts due to changes in water quality and quantity;
- Potential damage to archaeological, cultural, or historic sites; and
- Visual-quality changes.[333]

In Western Europe much of the planned energy storage is for traditional pumped storage which "is a long and costly process"[334]. Larger sites will require Environmental Impact Assessments and may need lengthy public consultations, especially if sites are located in protected areas (e.g. mountains, national parks).

At the site level, it may also be far easier to incorporate energy storage on to existing sites. For example, in the UK, substation sites are typically classified as 'operational land' and therefore already provide for some permitted activities. However, in the case of the UK Power Networks' 6MW battery storage site, a full planning permission was required on land adjacent to the substation. This provided an opportunity to "generate additional learning around the preparation and completion of the planning process which may be valuable to increasing deployments of storage" either by Distribution Network Operators (DNOs) or third-parties.[335]

Storage types and roles: the rationale and application of large-scale energy storage in Western Europe

Finding the right business model and deployment strategy for different types of energy storage technology is vital to achieving a financially viable solution. The following represent the main types of economic rationale for energy storage capacity being implemented at different levels of the energy system[336]:

- Generation level: balancing energy (supply and demand);
- Generation level: price arbitrage;
- Transmission level: higher utilization and greater integration of renewable energy;
- Generation level / transmission level: Ancillary services including regulation, spinning reserve & MVAR (reactive power) generation;
- Generation level: stabilizing conventional generation (improving operating efficiency);
- Generation level: provision of 'black-start' services (to help bring generation back on line after following power cuts);
- Distribution level: voltage control, capacity support;
- Customer level: peak shaving, time of use cost management

Since revenue streams will vary widely for each type of service – not least, the speed at which energy can be delivered which can range from minutes to milliseconds - this will greatly impact on market demand. The majority of energy storage capacity has to date been provided by building hydroelectric pump storage. Much of the recent

[332] Navigant Consulting, Energy Storage for the Grid and Ancillary Services, 2014

[333] Pumped Storage Hydroelectricity (Energy Engineering). Available here

[334] Ibid

[335] UK Power Networks, Smarter Network Storage - Design and planning considerations for large-scale distribution-connected energy storage (SNS1.2), Available here

[336] Elaborated from various sources including DG ENER working paper: The Future Role and Challenges of Energy Storage. Available here

storage capacity globally has been added for solar PV and wind energy to aid grid integration – the former helping to improve power quality; the latter to help shift energy from low to high demand periods. While arbitrage and reserve provision (frequency control) have been major reasons for investment into energy storage across Europe in the past 10 years, according to the JRC[337] *"these revenue streams have deteriorated in all Member States but to a different degree thus some revenue streams (frequency control) are still attractive enough to trigger investments in some Member States (e.g. Germany) while others (arbitrage) fail to trigger investments and lead to delayed or abandoned projects"*.

While it is debatable whether multi-megawatt batteries (e.g. 2-10MW) can be considered as "large scale" storage, especially if they are being used to provide ancillary services (frequency control) rather than time shifting energy production, there is certainly an appetite for bringing on-stream new innovations due to differing market conditions across the EU-28. Navigant Consulting[338] has assessed the most common storage technologies and capacities in Western Europe. Besides traditional pumped storage, the overall capacity of ten innovative technologies that have been deployed to date (by 2015) is 550 MW. Most of this capacity is molten salt, deployed with concentrating solar power plants such as the Gemasolar plant in Spain (see Member State reference below), although the German Huntorf CAES plant represents a significant amount of this overall capacity (see Member State reference below). Overall Navigant find that, in comparison to North America, *"Europe's demonstration programs are much smaller in scale and emphasize testing pre-commercial technologies instead of commercializing nascent technology. These programs are also focused on a few key applications that are relevant to Europe's grid system"* which they claim *"limits the number of technologies that will be developed and installed in the region"*. Examples of recent innovations in the European market include the Sicilian Terna battery park and the UK Power Network's Smarter Network Storage (SNS) 6MW battery park in Leighton Buzzard, both of which help to deliver frequency regulation and renewables firming. In the UK, Highview Power Storage's standard Liquid Air Energy Storage (LAES) system captures and stores heat produced during the liquefaction process and integrates this heat to the power recovery process to provide short term operating reserve capacity.[339]

The drive toward achieving Energy Union, and the need to ensure a more interconnected energy market, led to the EC publishing its communication in July 2015, launching a consultation on a new energy market design[340]. Greater cross-border participation is envisaged in which capacity mechanisms are implemented (whereby generators, demand response providers and consumers and transmission system operators are involved) and whereby a framework to calculate and allocate cross-border capacity is established. The Commission is currently researching options to address capacity mechanisms including efforts to minimise distortions to the market. Large-scale energy storage could play a major role in a new European energy market, assuming state aid policies are available and regulatory consent is agreed. This could unlock investment in much higher levels of energy storage, including innovative approaches, to fulfil capacity market demand which hitherto would not have been possible.

[337] Pers Comm. JRC, Peten

[338] Navigant Consulting, Energy Storage for the Grid and Ancillary Services, 2014

[339] Highview claim to be able to supply plants of 5MW/15MWh to >50MW/200MWh, offering applications including ancillary services, delivering security of supply for large industrial users as well as helping intermittent renewables. See here

[340] EC new energy market design consultation (2015). Available here

Table 4.6 Large-scale energy storage capacity developments in European countries

Country	Installed capacity as at end-2014 (MW)	Specified NREAP target for 2020 (MW)[341]	NREAP target reached	Additions to capacity in 2012 (MW)	Addition to capacity in 2013 (MW)	Additions to capacity in 2014 (MW)
Belgium	1,310	-	not applicable	0	3	0
Bulgaria	1,013	864	in 2000	0	0	0
Czech Republic	1,172	-	not applicable	0	25	0
Denmark	-	-	-	-	-	-
Germany	6,806	7,900	not yet	-161	0	0
Estonia	0	300	not yet	0	0	0
Ireland	292	50	in 2000	0	0	0
Greece	699	1,580	not yet	0	0	0
Spain	5,328	5,700	not yet	0	71	0
France	7,245	6,800	in 2000	0	0	0
Croatia	293	-	not applicable	0	0	0
Italy	7,555	2,600	in 2000	11	0	0
Cyprus	-	-	-	-	-	-
Latvia	-	-	-	-	-	-
Lithuania	760	-	not applicable	0	0	0
Luxembourg	1,300	1,300	in 2014	0	0	200
Hungary	-	-	-	-	-	-
Malta	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-
Austria	5,111	4,285	in 2008	75	3	0
Poland	1,782	-	not applicable	0	0	0
Portugal	1,298	4,302	not yet	254	-45	0
Romania	361	-	not applicable	0	269	0
Slovenia	180	-	not applicable	0	0	0
Slovakia	916	916	in 2001	0	0	0
Finland	-	-	-	-	-	-
Sweden	99	43	in 2001	0	0	0
United Kingdom	2,744	-	not applicable	0	0	0
Switzerland	1,864	-	not applicable	0	47	0
Iceland	-	-	-	-	-	-
Norway	1,351	1,344	in 2008	0	0	0
Ukraine	1,397	-	not applicable	0	0	648

Not applicable means either that the country did not specify a storage target in its NREAP report or it is not an EU member.

[341] Mapping Renewable Energy Pathways towards 2020, European Renewable Energy Council (2011). Available here
National action plans, Available here, Bulgaria p212, Germany p114, Estonia p58, Greece p104, Croatia 16.3GWh p110, Norway p134, Portugal p119, Slovakia p73

Countries that have the greatest large-scale energy storage installed capacity

Country	Outlook	Key market condition developments
Italy	🙂	■ Italy has set up an innovative metering scheme (SSP) to reward the use of energy storage to regulate the amount of electricity fed into the grid or consumed. The scheme provides economic compensation based on differentiated prices depending on when the electricity is consumed or fed into the grid. For users the scheme provides a clear framework for working out the economic credit from network feed-in.[342] ■ Solar PV in Italy meets 8% of electricity demand in Italy, which has prompted the national TSO, Terna, to procure battery storage for balancing purposes.[343] ■ Italy is currently home to 57 energy storage projects, of which 19 are pumped hydropower projects.[344]
France	😐	■ In 2015 the Ministry of Ecology, Sustainable Development and Energy launched a tender for 50MW of projects combining solar power with energy storage systems on Corsica and its overseas islands territories, with the aim of maximising self-consumption of solar and reducing the burden of demand on grid networks. The call for tenders has a capacity of 50MW for solar installations, with the volume divided equally between installations on buildings (25MW) and the facilities on parking shade structures or floor (25MW).[345] ■ However a major pilot project to integrate power from rooftop solar panels into the grid in Carros, France has shown that battery storage of renewable energy is not yet commercially viable in Europe. The €30m 'Nice Grid' pilot is one of the biggest in an EU-backed Grid4EU scheme which involves France's EDF as part of a wider group of European providers.[346] ■ France is currently home to 26 energy storage projects, of which 11 are pumped hydropower projects.[347] ■ Increased access to finance recommended to encourage investment in guaranteed capacity. Regulation changes would increase flexibility in bidding for reserve capacity.[348]
Germany	😐	■ Significant RD&D initiative channelled in energy storage, addressing basic research, demonstration, fabrication processes, integration and management.[349] ■ Huntorf was the first compressed air energy storage (CAES) projects in the world which was commissioned in a salt formation in 1978. A gas turbine can run at full load within six minutes as the compressed air is combusted with natural gas.[350]

[342] Battery Storage for Renewables: Market Status and Technology Outlook (2015), Irena, pp 18, 38. Available here.

[343] Ibid.

[344] U.S. DOE Global Energy Storage Database: http://www.energystorageexchange.org/ .
Note that the total capacity indicated by this site does not correspond with the values from the IRENA database.

[345] France announces tenders for PV and battery storage systems, PV Magazine 2015. Available here.

[346] French renewables power grid pilot shows limits of batteries in Europe, Reuters, 2015. Available here.

[347] Ibid.

[348] Study of energy storage installation potential: executive summary, Artelys, ENEA Consulting & G2Elab (2015), pp. 14, 18, Available here.

[349] The German Energy Storage RD&D Initiative, Federal Ministry for Economic Affairs and Energy, (2014), Available here.

[350] https://www.eon.com/en/about-us/structure/asset-finder/huntorf.html

		■ Germany provides subsidies for small-scale storage solutions and low interest loans to finance the initial capital costs of such systems.[351] ■ In 2014 a 5 MW/5MWh battery storage facility (Europe's largest) went into operation in Schwerin.[352] ■ However a study commissioned by the German Federal Ministry for Economic Affairs and Energy in 2014 and its Austrian and Swiss counterparts found that investment conditions had deteriorated such that new pumped-storage hydroelectricity plants were difficult to justify, due to extremely low profit margins due to the market situation and the volatility of electricity prices. This was in spite of German plants being exempted from grid pursuant fees (Section 118 para 6 of the German Energy Act)[353] if certain requirements are fulfilled, as well as exemptions from the renewables surcharge and electricity tax.[354]
Spain	😐	■ Mandated increases in storage capacity through new pumped-hydro sites and financial support of R&D to develop and integrate new storage technologies with renewable energy sources.[355] ■ Government ambitions to increase energy storage, in particular using pumped-hydro storage, subsequently having six large scale projects under planning.[356] ■ However a controversial government proposal to impose a tax on solar-plus-storage systems of € 8.9 per kilowatt of capacity (up to €36 for medium sized businesses) would significantly diminish the economic viability of such systems, increasing the payback time from 16 years to 31 years.[357] ■ The world's first commercial-scale solar thermal plant with molten salt as its heat transfer fluid and energy storage medium, the Gemasolar plant in Spain (formerly named Solar Tres following pioneering CSP plants, Solar One and Solar Two), has been operational since 2011.
Austria	😐	■ Austria has significant pumped hydro storage already in place; enough to help balance neighbouring countries' intermittent power supply.[358] [359] ■ As stated in the section on Germany, the German Federal Ministry for Economic Affairs and Energy in 2014 and its Austrian and Swiss counterparts found that investment conditions had deteriorated such that new pumped-storage hydroelectricity plants were difficult to justify, due to extremely low profit margins due to the market situation and the volatility of electricity prices.[360]

[351] Renewable energy country attractiveness index, Issue 44, (2015), p23, Available here.

[352] Renewable Energy World (11 February 2015) Energy Storage Market Outlook 2015 , Available here, and; Younicos: Schwerin Battery Park, Available here

[353] Bundesministerium der Justiz und für Verbraucherschutz (7 July 2015) Gesetz über die Elektrizitäts- und Gasversorgung (Energiewirtschaftsgesetz - EnWG) , Available here

[354] Bundesministerium für Wirtschaft und Energie, Trilaterale Studien zu Pumpspeicherkraftwerken in Deutschland, Österreich und der Schweiz, (August 2014), Avaialble here

[355] Spain's national renewable energy action plan 2011-2020, Ministry of Industry, Tourism and Commerce, (2010), pp. 48, 50 Available here.

[356] Pumped storage in Spain, Waterpower magazine 2013. Available here.

[357] Draft Real Decreto 900/2015 (June 2015), Modalidades de Suministro de Energía Eléctrica con Autoconsumo y de Producción con Autoconsumo, Available here

[358] Executive Summary and Key Recommendations: Austria, OECD/IEA (2014), p11, Available here.

[359] Current situation in Austria, Store-project. Available here.

[360] Bundesministerium für Wirtschaft und Energie, Trilaterale Studien zu Pumpspeicherkraftwerken in Deutschland, Österreich und der Schweiz, (August 2014), Avaialble here

Countries with the greatest additions to installed large-scale energy storage capacity in 2014 (if not included above)

Country	Outlook	Key points
Ukraine	😐	■ Ukraine is currently home to three large scale energy storage projects (one under construction).[361] ■ The conflict in the region has illustrated the need for a significant rebalancing of the energy mix over the long term, but also of the value in having large scale storage of energy in the face of geopolitical risks.
Luxembourg	😐	■ The price coupling of Central Western Europe and North Western Europe market areas in 2014 enabled better integration into the wider market area. ■ Limited storage capacity requires resorting to overseas holdings. ■ Pumped-storage hydro plant in Vianden is directly connected to the German and Belgium grid, with no physical energy supply to Luxembourg.[362]

Selected countries which have not yet met their NREAP large scale energy storage capacity targets (if different from above)

Country	Outlook	Key points
Estonia	😐	■ Very small hydropower generation currently.[363] ■ However, a 500 MW hydro-pumped storage project is in planning, with expected construction in 2022-24.[364]
Greece	😐	■ Electricity pricing policy is not yet developed for stored energy. Significant amendments anticipated in the upcoming years to better align with the European energy policy commitments, offering security and lower energy cost to the consumer. By 2050, aimed achievements include the development of decentralised production units and smart grids.[365]
Portugal	🙂	■ Has developed less than half of its development potential, with a significant technically feasible potential remaining, and an increasing requirement for energy storage, this elicits positive future prospects.[366] ■ The world's first MW-scale renewable energy plus storage system is currently being built on Graciosa island. It uses a fully automated and intelligently managed 2.8MW battery. By stabilising the grid without fossil-fuel-fired backup generators, the system will enable the grid to be fully powered by wind and solar energy.[367]

[361] U.S. DOE Global Energy Storage Database: Energy Storage Exchange, Available here,
Note that the total capacity indicated by this site does not correspond with the values from the IRENA database.

[362] Executive Summary and Key Recommendations: Luxembourg, OECD/IEA (2014), pp. 7,10, Available here

[363] Hydro In Europe: Powering Renewables, Eurelectric, (2011) pp. 14-15, Available here

[364] Baltic energy market interconnection plan, 6th progress report (2014) p32, Available here

[365] Facilitating Energy Storage to allow high penetration of intermittent renewable energy – Greece (2013), D5.1, pp.16, 31, 32, Available here.

[366] Hydro In Europe: Powering Renewables , Eurelectric, (2011), p14, Available here.

[367] Younicos (press release May 2015) Younicos and Leclanché partner on Graciosa project, Available here

Additional Countries

Country	Outlook	Key points
United Kingdom	☺	■ Public organisations including the Engineering and Physical Sciences Research Council, Energy Technologies Institute, Ofgem, Department of Energy and Climate Change and Innovate UK have programmes funding electricity and heat storage development, with multi-year budgets of tens of millions of pounds.[368]

Countries of particular interest

Due to a lack of data enabling the calculation of growth trends, the countries of interest must be chosen more qualitatively than in other sectors:

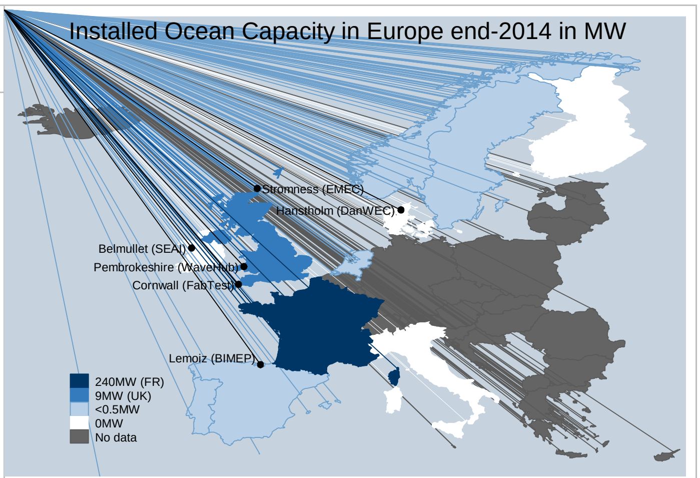
- The **United Kingdom**, while not highlighted in the above tables due to no new capacity added and no specified NREAP targets for large scale storage, do allocate capacity payments for energy storage. For example, in the capacity auctions held in 2014, an existing pumped storage hydro plant was allocated capacity payments.[369]
- Hydro pumped storage dominates the energy storage market in Europe currently, although there are an increasing number of alternate storage technologies emerging. Countries with higher proportions of intermittent electricity supply, such as **Germany** and **Spain**, are particularly interested in developing energy storage capacity.

[368] Energy Storage, Houses of Parliament Parliamentary Office of Science and Technology, April 2015, p4, Available here.
[369] Renewable energy country attractiveness index, Issue 44, June 2015, p23, available here

4.10 Ocean Energy

Key facts and figures for European ocean energy

Total installed capacity for Europe: **249.9MW**



Countries by installed capacity at end-2014 [370] :

- France (240MW[371]);
- United Kingdom (8.7 MW);
- Portugal and Spain (0.3 MW each);
- Netherlands, Norway and Sweden (0.2 MW each)

Together these countries represent 100% of total capacity in Europe: 249.9 GW

The only two countries to add to installed capacity in 2014:

- United Kingdom (1.5 MW added);
- Netherlands (0.2 MW added).

Name and location of selected test facilities for ocean energy in Europe:

- (SEAI) Belmullet Test Site - The Sustainable Energy Authority of Ireland, Belmullet, Ireland;
- (FaBTest) Falmouth Wave Energy Test Site, Cornwall, UK;
- (Wave Hub) Wave Hub - Pembrokeshire Wave Energy Test Site, Pembrokeshire, UK;
- (BIMEP) Biscay Marine Energy Platform, Lemoiz, Spain;
- (EMEC) European Marine Energy Centre Ltd, Stromness, UK;
- (DanWEC) Danish Wave Energy Centre, Hanstholm, Denmark.

The only country to show significant growth over the period 2011 – 2014:

Growth between 2011 and 2014:

- United Kingdom (181%)

Installed ocean energy capacity as at end-2014:

- United Kingdom (8.7 MW)

Social Acceptance:

Impacts on sea and aerial wildlife are among the main issues impacting social acceptance of ocean energy. Concerns include: underwater noise and vibration of machinery; harm to fish through 'blade strikes'; entanglement of diving birds and marine mammals; and the creation of electromagnetic fields, disturbing sea wildlife, as well as increased birds' collision risk with equipment [IRENA & DNV KEMA, 2013]. Interference with shipping and naval activities (e.g. submarine) may also arise which could lead to plans for tidal arrays being scrutinised heavily.

Planning and Permitting:

---

[370] IRENA dashboard. Available here.

[371] Represented by the 240MWe La Rance tidal barrage in Brittany.

Administrative and regulatory issues concerning permitting of ocean energy projects in the sea are likely to be the largest non-technical barrier to overcome to enable large-scale ocean energy deployment.[372] As a result of wave and tidal energy's first-of-a-kind nature, and the high degree of uncertainty surrounding the potential impact of ocean energy technologies on the environment, planning and consenting processes can be considerably expensive and burdensome, adding further risk to wave and tidal energy projects development. The application of environmental legislation[373], which is generally risk averse, can prolong the consenting procedures and increase the administrative burden on developers.[374]

From a developer's point of view, issues revolve around the time taken to obtain consents, the number of authorities involved in the decision-making process, the lack of clarity and consistency in the Environmental Impact assessment (EIA) obligations and application, and the costs associated with the abovementioned requirements.[375]

Scotland and the UK – principal EU markets for wave and tidal energy – have proactively adopted a series of pragmatic actions, simplifying procedures for Marine Planning, establishing a Strategic Environmental Assessment (SEA) and developing a "one-stop-shop" for consenting processes. At the same time, agencies in Ireland, France, Portugal or Spain can apply best practices in terms of simplifying consenting and environmental monitoring processes, taking advantage of developments carried out in the UK.[376]

Inadequate grid and port infrastructure also represent significant barriers to the deployment of wave and tidal energy sources. Policy makers can tackle this issue by incorporating ocean energy projects into future grid development plans, as well as sharing the offshore grid infrastructure with offshore wind projects in order to alleviate the costs of major sub-sea interconnections in areas where both resources are abundant.[377]

Recommendations provided by stakeholders in the ocean energy industry[378] also include:

- Integrated planning: the implementation of strategic plans like the Maritime Spatial Planning (MPS) and the Strategic Environment Assessment (SEA) in order to better manage the different marine areas and users.

- Administrative procedures: streamline procedures and provide guidance to developers, and implement – where possible – a "one-stop-shop" approach for marine energy consenting in order to reduce administrative problems.

- Consistency of EIA: the application of EIA is not consistent across countries and there is a lack of knowledge on real environmental impacts of ocean energy. It is therefore crucial to have more information about environmental aspects and regulation, creating a public database on monitoring results that could foster knowledge transfer and increase awareness.

- Consultation: significant issues could arise from public acceptance of wave and tidal projects. Early stakeholder engagement and informal consultation with local stakeholders are vital to prevent and avoid potential problems.

[372] WavEC – "Consenting processes for ocean energy on OES (Ocean Energy Systems) countries", Feb 2015. Available here

[373] Particularly the Habitats Directive 92/43/EEC and the Birds Directive 2009/147/EC

[374] COM (2014) 8 final, Impact Assessment Accompanying the document: The action needed to deliver on the potential of ocean energy by 2020 and beyond

[375] Ocean Energy Forum – "Strategic Roadmap: Collated "Three-Pagers", July 2015. Available here

[376] SI OCEAN, "Wave and tidal energy market deployment strategy for Europe", June 2014

[377] Idem

[378] Ocean Energy Forum – "Strategic Roadmap: Collated "Three-Pagers", July 2015. Available here

Table 4.7 Ocean energy installed capacity, developments in European countries 2011 – 2014

Country	Installed capacity at end 2014 (MW)	Specified NREAP targets for 2020 (MW)[379]	NREAP target reached	Additions to capacity in 2012 (MW)	Additions to capacity in 2013 (MW)	Additions to capacity in 2014 (MW)
Belgium	-	-	-	-	-	-
Bulgaria	-	-	-	-	-	-
Czech Republic	-	-	-	-	-	-
Denmark	0	-	not applicable	0	-	-
Germany	-	-	-	-	-	-
Estonia	-	-	-	-	-	-
Ireland	0	75	not yet	0	0	0
Greece	-	-	-	-	-	-
Spain	0.3	100	not yet	0	0	0
France	240	380	not yet	0	0	0
Croatia	-	-	-	-	-	-
Italy	0	3	not yet	0	0.2	-
Cyprus	-	-	-	-	-	-
Latvia	-	-	-	-	-	-
Lithuania	-	-	-	-	-	-
Luxembourg	-	-	-	-	-	-
Hungary	-	-	-	-	-	-
Malta	-	-	-	-	-	-
Netherlands	0.2	-	not applicable	0.1	-0.1	0.2
Austria	-	-	-	-	-	-
Poland	-	-	-	-	-	-
Portugal	0.3	250	not yet	0.3	0	0
Romania	-	-	-	-	-	-
Slovenia	-	-	-	-	-	-
Slovakia	-	-	-	-	-	-
Finland	0	10	not yet	0	0	0
Sweden	0.2	-	not applicable	0	0	0
United Kingdom	8.7	1300	not yet	3.6	0.5	1.5
Switzerland	-	-	-	-	-	-
Iceland	-	-	-	-	-	-
Norway	0.2	-	not applicable	0	-1.3	0
Ukraine	-	-	-	-	-	-

Not applicable means either that the country did not specify an ocean energy target in its NREAP report or it is not an EU member.

[379] Mapping Renewable Energy Pathways towards 2020, European Renewable Energy Council (2011). Available here. .

Countries with the greatest installed ocean energy capacity

Country	Outlook	Key market condition developments
France	☺	■ Improved funding, both from the European Commission, primarily through the NER300, and national funds, such as the ADEME funds, for the development of tidal parks, comes in tandem with more stringent conditions, for instance, stipulations such as the operational start date and the amount of electricity to be produced, often resulting in further finance having to be sought.[380] ■ Construction of five full- or part-scale demonstration sites underway, with complete operation expected in 2016.[381] ■ Maritime Spatial Plan is under development although 'one-stop-shop' for consenting currently does not exist.[382]
United Kingdom	☺	■ Funding sources include the Energy Technology Institute, The Crown Estate, Marine Renewables Proving Fund and Demonstration Fund, amongst others.[383] ■ Multiple wave and tidal demonstration test sites including in Scotland (Orkneys, Pentland Firth) and South West England for wave power (Wave Hub). ■ The UK government has established the Offshore Renewables Energy Catapult to help industry to focus on technology innovation to drive down the cost of ocean energy (and offshore wind). It has a team of over 120 people with extensive technical and research capabilities, industry experience and a track record in offshore engineering and commercialisation. ■ Strategic Environmental Assessment in place for wave and tidal energy in all four UK countries.[384] ■ Maritime Spatial Plan is nearing completion in Scotland and is under development in England, Wales and Northern Ireland.[385] ■ A 'one-stop-shop' for consenting currently exists in England and Scotland and is under development in Northern Ireland.[386] ■ Multiple rejections to a tidal barrage project proposal (the Severn barrage), owing to fears over environmental repercussions on nearby ecosystems. Therefore, regardless of the readily available and reliable technology, the prospect of future tidal barrages in the UK is weak.[387] ■ Current negotiations underway on the proposed strike price[388] for the world's first tidal lagoon at Swansea Bay in Wales which was given planning consent in June 2015.[389]

[380] 2014 JRC Ocean Energy Status Report, European Commission, (2015), pp. 26-27, Available here
[381] Ibid
[382] Strategic Initiative for Ocean Energy, Wave and Tidal Energy Market Deployment Strategy for Europe, June 2014, Available here.
[383] Ibid, pp. 15, 58
[384] Strategic Initiative for Ocean Energy, Wave and Tidal Energy Market Deployment Strategy for Europe, June 2014
[385] Strategic Initiative for Ocean Energy, Wave and Tidal Energy Market Deployment Strategy for Europe, June 2014
[386] Strategic Initiative for Ocean Energy, Wave and Tidal Energy Market Deployment Strategy for Europe, June 2014
[387] Ibid, pp. 15, 58
[388] News article from South Wales Evening Post, 24 September 2015 http://www.southwales-eveningpost.co.uk/Government-dragging-feet-tidal-lagoon-funding/story-27856849-detail/story.html
[389] DECC press release, Swansea Bay Tidal Lagoon project gets green light on planning, June 2015 Available here.

Portugal	■ Has a maritime spatial plan in place.[390] ■ A sum of €76 million secured from Fundo de Apoio à Inovação (FAI), channelled towards renewable energy, including ocean energy.[391] ■ Has a dedicated consenting process covering four separate authorities which is in the process of being streamlined into a 'one-stop-shop' for consenting.[392]
Spain	■ FiT scheme is halted for all forms of renewable energy, and has been replaced by a fixed annual investment bonus for incumbent installations. ■ A €3 million scientific programme backed by EVE for ocean energy demonstration is anticipated to encourage production, research and development.[393] ■ Has a maritime spatial plan in place which was adopted under the Marine Strategy Framework Directive.[394] ■ Consenting is not yet streamlined.
Netherlands	■ Ocean energy projects are eligible for the national grant scheme.[395] ■ Has a maritime spatial plan in place.[396] ■ Advantage of grid infrastructure available within close vicinity to ocean energy resources along the coast offers a comparative advantage to other countries. ■ Small size arrays announced for construction on dikes, further increasing the installed capacity.[397]
Norway	■ Offering of capital grants by the Norwegian Energy Agency, Enova, for full scale demonstration projects. ■ Ocean Energy Bill enforces a requirement to obtain governmental certification of suitable geographical areas prior to the receipt of a licence to build such renewable devices. Thus far, merely 15 sites have been identified as suitable.[398]
Sweden	■ Has a maritime spatial plan in place.[399] ■ Swedish Water Law is being reviewed, with suggestions of water related activities being subject merely to notification and not a complete permit process.[400] ■ Tradable green certificate system encourages the expansion of renewable energy production. In 2011, Sweden and Norway entered into an agreement to form a joint electricity certificate market, broadening the scope of energy generation incentives.

[390] 2014 JRC Ocean Energy Status Report, European Commission, (2015), p60

[391] 2014 JRC Ocean Energy Status Report, European Commission, (2015), p58

[392] Strategic Initiative for Ocean Energy, Wave and Tidal Energy Market Deployment Strategy for Europe, June 2014

[393] Ibid, p58

[394] Strategic Initiative for Ocean Energy, Wave and Tidal Energy Market Deployment Strategy for Europe, June 2014

[395] OES Country Report: Netherlands. Available here.

[396] COM (2014) 8 final, Impact Assessment Accompanying the document: The action needed to deliver on the potential of ocean energy by 2020 and beyond, Available here.

[397] Ocean Energy Development in Europe: Current Status and future perspectives, European Commission, DG JRC, Institute for Energy and Transport, (2015), pp. 91,93, Available here

[398] OES Country Report: Norway. Available here.

[399] COM (2014) 8 final, Impact Assessment Accompanying the document: The action needed to deliver on the potential of ocean energy by 2020 and beyond.

[400] OES Country Report: Sweden, Available here.

Countries which have not yet met their NREAP ocean energy capacity targets (if different from above)

Country	Outlook	Key points
Finland		■ Focus upon the encouragement of renewable energy through the provision of grants covering costs such as preparation, administrative planning costs, and other expenses to be incurred.[401]
Ireland		■ An increase in the Ocean Energy Development Budget from €16.8 million to €26.3 million, chiefly for the purpose of test centres. ■ A sustainable RD&D programme to be initiated by SEAI with an investment total of €3.5 million, along with a Prototype Development Fund offered €26 million.[402] ■ A Strategic Environmental Assessment already in place for wave energy and nearing completion for tidal energy, but neither a Maritime Spatial Plan nor 'one-stop-shop' for consenting in place.[403]
Italy		■ Focus upon research through a combination of research initiatives made by multiple institutes, also bearing a degree of entrepreneurship.[404]

Additional Countries

Country	Outlook	Key points
Denmark		■ Has neither a NREAP target for ocean energy nor a Strategic Environmental Assessment for wave energy. ■ Does have two wave power test/demonstration centres. ■ Maritime Spatial Plan is under development and it has a 'one-stop-shop' process for consenting.[405]

Countries of particular interest

The most powerful tidal stream resources are in Ireland, Norway, **France** and the **United Kingdom**[406]. However, only the latter two show the combination of positive policy outlook and good prospects for growth to make them countries of particular interest.

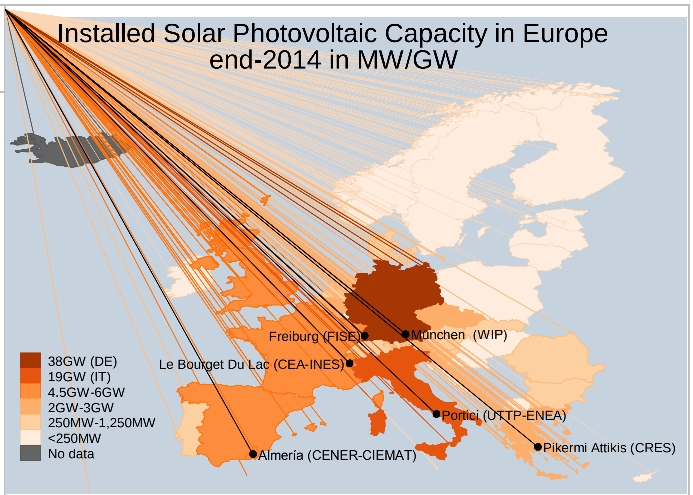
- The **United Kingdom** has in recent years provided a particularly supportive environment for development of ocean energy generation. The delay in agreeing a strike price for the proposed Swansea Bay Tidal Lagoon is causing uncertainty, although this matter is separate from the overall effort by the UK to stimulate the supply chain for ocean energy, especially in funding for tidal arrays.
- In **France**, the construction of five full- or part-scale demonstration sites is underway.[407]

[401] Legal sources on renewable energy, Finland RD&D policies, Res-Legal 2014, Available here.
[402] 2014 JRC Ocean Energy Status Report, European Commission, (2015), p58
[403] Strategic Initiative for Ocean Energy, Wave and Tidal Energy Market Deployment Strategy for Europe, June 2014
[404] Overview of European innovation activities in Marine Energy Technology, European Commission and Joint Research Centre, (2013), p18
[405] Strategic Initiative for Ocean Energy, Wave and Tidal Energy Market Deployment Strategy for Europe, June 2014
[406] 2014 JRC Ocean Energy Status Report, European Commission, (2015), p. 15, Available here.
[407] Ibid, pp. 26-27

4.11 Solar photovoltaic

Key facts and figures for European solar photovoltaic installations:

Total installed capacity for Europe: **88.7GWp**



Top five countries by installed capacity (end-2014)[408] :

- Germany (38.2GWp);
- Italy (18.8GWp);
- France (5.6GWp);
- United Kingdom (5.2GWp); and
- Spain (4.8GWp)

Together, these countries represent 82% of total capacity in Europe: 73GW

Top five countries by additions to installed capacity made in 2014 only:

- United Kingdom (2.4GWp added);
- Germany (1.9GWp added);
- France (1.0GWp added);
- Romania (0.5GWp added); and
- Italy (0.4GWp added).

Name and location of selected test facilities for PV in Europe:

- (CENER- CIEMAT) National Renewable Energy Centre, Almería, Spain;
- (CEA-INES) Institute-National De L'Energie Solaire, Le Bourget Du Lac, France;
- (FISE) Fraunhofer ISE, Freiburg, Germany;
- (WIP) Renewable Energies , München , Germany;
- (UTTP-ENEA) UTTP-ENEA Portici Technical Unit, Portici, Italy;
- (CRES) Centre for Renewable Energy Sources and Saving, Pikermi Attikis, Greece.

Installed PV capacity at end 2014 for the five countries with the highest consistent[409] growth rates over the period 2011 – 2014:[410]

Growth between 2011 and 2014:	Installed solar PV capacity as at end 2014:
Hungary (1,825%);	Hungary (0.08 GWp);
Netherlands (674%);	Netherlands (1.12GWp);
Cyprus (574%);	Cyprus (0.07GWp);
Malta (533%); and	Malta (0.06GWp); and
United Kingdom (426%).	United Kingdom (5.23GWp)

[408] http://resourceirena.irena.org/gateway/dashboard/

[409] "Consistent growth" means that the pace of growth did not slow down year on year, as is the case in Denmark which actually grew 3447% over the period – from 17MWp to 603MWp. (Combined with the fact that Denmark is far in excess of its NREAP, this means that we are not considering Denmark as a country of interest.) This also excludes Bulgaria, which had growth rates of 574%. In addition, countries with a negligible capacity in 2011 (i.e. 1MWp or less) are not considered as a growth rate does not make sense and excludes Romania (121,800% growth) and Poland (2,000% growth) from the highest consistent growth list.

[410] Due to commencing from very low levels, the growth rates for the top 5 countries are all in the hundreds or thousands, because the market size is orders of magnitude different.

Social Acceptance:

Social acceptance issues relating to solar PVs are typically related to this technology's high demand for water and land use impacts (e.g. habitat loss for wildlife) [IRENA & DNV KEMA, 2013]. Issues relating to end-of-life impacts of this technology are also raised.

Planning and Permitting:

Analysing consenting and permitting procedures in 12 European countries (Bulgaria, Czech Republic, France, Germany, Greece, Italy, Netherlands, Poland, Portugal, Slovenia, Spain and United Kingdom), the PV Legal consortium[411] has identified four main types of barriers that hamper PV solar installations development:

- Barriers in permitting procedures, which include all administrative processes needed to authorise the construction of a PV system;

- Barriers related to grid connection rules and technical standards, those that excessively complicate the requirements for a PV system to be accepted on the electrical grid;

- Barriers in grid connection processes, which include both the initial grid connection permit and the final grid connection phases;

- Barriers related to grid capacity issues, which arise when the number of grid connection requests exceed the available capacity of the electric infrastructure in a specific area.

The analysis – made through a series of interviews – assess the costs, labour, duration and waiting times involved with each main phase of the development of a PV system.

The average overall percentage share of legal-administrative costs over total project development costs (excluding PV equipment) is equal to 36.1% for a residential rooftop PV system, 26.6% for a commercial rooftop and 38.9% for an industrial ground-mounted PV system.

The total labour required to complete legal-administrative permitting processes can give an idea of the complexity and the lack of transparency of the procedures in place: the labour man-hours related to the compliance with legal-administrative requirements fluctuate widely across the 12 target countries, varying from the 4 hours of Germany and UK to 227 hours of Bulgaria in the residential rooftop sector, while for an industrial ground-mounted PV system man-hours vary from 187 hours of Spain to 1,230 hours of Italy.

The duration of a PV project development – on the other hand – provide insights on the economic risk involved in a project, as the longer the duration, the longer a PV developer in financially exposed before it can start earning revenues. Duration includes also the waiting time spent by a developer to receive answers from an authority or a grid operator.

The average PV project development process duration in weeks is equal to 23.4 weeks for residential rooftops, 36.4 weeks for commercial rooftops and just over 2 years (105.9 weeks) for industrial ground-mounted.

Interviews carried out by PV Legal also allowed to scope a list of recommendations that can be applied to all European countries. Among the others:

- Enforce lean and appropriate permitting procedures;
- Define a one-stop shop for all permitting procedures;
- Set clear deadlines for permitting procedures;
- Provide guidance for planning authorities;
- Involve the PV industry in the definition of standards and grid connection rules;
- Define clear technical standards and grid connection rules at national level;
- Streamline grid connection procedures;
- Set clear deadlines for the assignment of a grid connection point;
- Enforce penalties for missed deadlines.

[411] PV Legal – Final Report – Reduction of bureaucratic barriers for successful PV deployment in Europe

Table 4.8 Photovoltaic installed capacity, developments in European countries 2011 – 2014

Country	Installed capacity at end 2014 (MW)	Specified NREAP targets for 2020 (MW)[412]	NREAP target reached	Additions to capacity in 2012 (MW)	Additions to capacity in 2013(MW)	Additions to capacity in 2014(MW)
Belgium	2,977	1,340	in 2011	1,190	331	65
Bulgaria	1,038	303	in 2012	859	23	2
Czech Rep.	2,067	1,695	in 2010	109	42	3
Denmark	603	6	in 2010	385	169	32
Germany	38,236	51,753	not yet	7,604	3,694	1,901
Estonia	-	-	not applicable	0	0	0
Ireland	1	5	not yet	0	0	0
Greece	2,595	2,200	in 2013	924	1,043	16
Spain	4,772	8,367	not yet	294	120	6
France	5,600	4,860	in 2014	1,150	672	975
Croatia	34	-	not applicable	4	16	14
Italy	18,805	8,000	in 2011	3,647	2,000	385
Cyprus	65	192	not yet	7	18	30
Latvia	-	2	not yet	0	0	0
Lithuania	71	10	in 2013	7	61	3
Luxembourg	110	113	not yet	34	20	15
Hungary	77	63	in 2014	8	23	42
Malta	57	27.8	in 2013	9	13	26
Netherlands	1,123	722	in 2013	220	374	384
Austria	766	322	in 2012	46	263	140
Poland	21	3	in 2013	0	1	19
Portugal	391	1,000	not yet	66	56	97
Romania	1,219	260	in 2013	40	720	458
Slovenia	260	139	in 2012	85	45	73
Slovakia	590	300	in 2011	17	75	2
Finland	10	10	in 2014	1	1	0
Sweden	79	8	in 2011	8	19	36
UK	5,228	2,680	in 2013	753	1,033	2,448
Switzerland	1,076	-	not applicable	214	319	320
Iceland	-	-	not applicable	-	-	-
Norway	13	-	not applicable	0	1	2
Ukraine	819	-	not applicable	184	376	71

[412] Mapping Renewable Energy Pathways towards 2020, European Renewable Energy Council (2011). Available here. Croatia Ref. Ares(2014)443294 - 21/02/2014 Available here p110; Norway Ref. Ares(2013)117932 - 30/01/2013 Available here p135; Iceland Ref. Ares(2014)806315 - 19/03/2014 p58 Available here

Not applicable means either that the country did not specify a PV target in its NREAP report or it is not an EU member

Countries that have the greatest installed PV capacity

Country	Outlook	Key market condition developments
Germany	☺	■ Lean administrative processes in place. ■ The June 2012 PV amendment to the Erneuerbare-Energien-Gesetz (EEG) introduced a 52GW cap on PV installations. Once this is surpassed, PV installations will become ineligible for FiT support. ■ Since November 2012 the rate of degression of the FiT is determined monthly based on how much capacity has been added.[413] ■ Since January 2014, 10% of electricity generated from roof-top applications sized 10-1,000kW will not be eligible for FiTs. Installations bigger than 10MW will also be no longer eligible for FiTs. Incentives are therefore focused on 1-10MW systems. ■ Uncertainty about grid connection requirements, which primarily affects smaller-scale installations. ■ "As of August 2014, a fraction [30%] of the EEG surcharge is to be imposed on the self-consumed electricity from newly installed systems larger than 10 kWp."[414] [415] ■ Since 1st May 2013, a new programme of incentives was instituted for storage units, seeking to increase self-consumption and decrease the share of FiT-based photovoltaics. "This programme financed 8,300 battery storage systems installed in Germany by the end of 2014."[416] ■ In addition, a number of new regulations around grid integration were introduced, including: "The frequency disconnection settings of inverters (in the past set at 50.2 Hz) has been changed to avoid a cascade disconnection of all PV systems in case of frequency deviation"; and "Peak shaving at 70% of the maximum power output (systems below 30 kW) that is not remotely controlled by the grid operator."[417,418]
Italy	😐	■ Italy has undergone substantial changes to its incentives scheme, introducing new controls on net metering and incentives for self-consumption. There is differentiation across the scale of PV plants. ■ In November 2014, owners of plants above 200kW were asked to choose between the following options: "Reduced FiT paid during the foreseen 20 years, depending on plant size; Maintain the cumulative 20 years FiT incentives but paid during 24 years; [and] Reduced FiT paid during 20 years but with an increase in the last period."[419] ■ Self-consumption schemes are available below 20MWe through a Private Purchase Agreement (PPA). Small-scale systems of below 20kW are exempt from grid and system costs; systems of between 20kW and 200kW are partially exempt; those above 200kW are exempt only from system costs.[420]

[413] German Federal Network Agency, Figures, Dates and Information about the EEG, available here.

[414] Fraunhofer ISE, Recent Facts about Photovoltaics in Germany, 2015, available here.

[415] International Energy Agency Trends 2015 in photovoltaic Applications: Survey Report of Selected IEA Countries between 1992 and 2014, available here, pp.23.

[416] Ibid, pp.23.

[417] Ibid, pp.24.

[418] Norton Rose Fulbright: Italy energy law update, (September 2014), Available here.

[419] International Energy Agency Trends 2015 in photovoltaic Applications: Survey Report of Selected IEA Countries between 1992 and 2014, available here, p.24.

[420] Commission Staff Working Document "Best practices on Renewable Energy Self-consumption", Available here, p.13.

		■ Net metering is available for RES below 500kW since January 1st, 2015, with no maximum capacity. “Remuneration is based on time-of-use price”.[421] ■ In addition, a net-billing system (Scambio Sul Posto) incentivises self-consumption through compensating PV production and consumption for systems up to 200kW (and up to 500kW for plants commissioned in 2015). New PV systems can receive a premium for self-consumption along with the FiT for electricity inserted into the grid.[422] ■ In December 2014, the same technical standards are imposed on electricity storage facilities that are required of distributed generation units.[423]
France	😐	■ Slow administrative processes, combined with the removal of the FiT bonus for local content. ■ Recent announcement of renewables push, a reduction in the reliance of nuclear power and increases in carbon taxation may improve market conditions for solar PV in the medium term.[424]
United Kingdom	😐	■ Lean administrative process in place. ■ Support focus was initially on residential-scale development although significant developments of 1MW or larger occurred, including on commercial rooftops and farmland which created massive growth in the market. ■ Self-consumption schemes are available for PV and wind systems below 50kWp. A generation tariff plus export premium of £4.77/kWh is applied for up to half of the surplus power inserted into the grid. A FiT is in effect for systems between 50kWp and 5MWp.[425] ■ Large and unforeseen growth has triggered a series of subsidy cuts and the uncertainty of government policy changes has created market and investment uncertainty. A new ruling that any new commercial scale solar PV generating station (over 5MW) will be ineligible for accreditation (either full or preliminary) under the Renewables Obligation[426] has hit investor confidence. ■ A recent announcement removing climate change levy exemption from electricity generated from renewable sources from 1 August 2015[427] also impacts commercial scale plants and reduce market confidence.
Spain	☹	■ Slow and heavy administrative processes. Financial support frozen from 2012. New developments blocked, but some attempts to encourage commercial-scale development. ■ In October 2015, the Spanish Government approved the “sun tax”, imposing a taxation on solar self-consumption. In June, the fee was reported to range between €8.9/kW (domestic consumers) and €36/kW for medium-sized enterprises.[428]
Countries with the greatest additions to installed PV capacity in 2014 (if not included above)		

[421] Ibid, p.14.

[422] International Energy Agency Trends 2015 in photovoltaic Applications: Survey Report of Selected IEA Countries between 1992 and 2014, available here, p.24.

[423] Italian Institute for International Political Studies: Has time for batteries in Italy arrived or not? (28 July 2015), available here

[424] Carbon Pulse: France passes sweeping energy bill, to raise CO2 tax to €100/t by 2030, (22 July 2015), available here

[425] Commission Staff Working Document “Best practices on Renewable Energy Self-consumption”, available here, p.13.

[426] Ofgem guidance: Renewables Obligation: closure of the scheme to large-scale solar PV, available here [Renewables Obligation supports large-scale renewable plants as opposed to the FiT]

[427] Press release: Controlling the cost of renewable energy, DECC, (31 July 2015), available here

[428] PV Tech, Spanish government under fire after approving ‘sun tax’, (12 October 2015), available here

Country	Outlook	Key points
Romania	😐	■ Drastic reduction in available green certificates. One third of available green certificates were frozen until 2017 to reduce the fall in their market price. In addition, only 3 green certificates were granted to new PV installations. “Romania illustrates the case of an RPS [Renewable Portfolio Standard[429]] system with Green Certificates where the level of the RPS was not adjusted fast enough to cope with the growth of installations”.[430]

Countries with highest consistent solar PV capacity growth rates over period 2011-2014 (if not included above)

Country	Outlook	Key points
Netherlands	☺	■ In 2014 the Netherlands set up reverse auctions[431], in which PV is trying to compete with other renewable energy sources.[432] ■ Support scheme initiated for solar panels, with a grant scheme available for solar panel buyers in the private sector (small and large schemes). A total sum of €50 million was made available for this scheme.[433] ■ Net-metering was previously limited to 5,000kWh per connection. As of 2014 there is no upper limit, and net-metering is presently guaranteed up to 2020.[434]
Hungary	😐	■ There are several EU and Hungarian government direct and non-refundable funds available to support PV installations: for companies, organizations and local governments allowing 40-70% of costs to be refunded.[435] ■ Systems with a capacity exceeding 500 kWp need to obtain a permit from the Hungarian Energy Office.[436] ■ A major obstacle for PV generators is the grid connecting process which requires a Hungarian Certificate of the inverters. These certificates are issued by the Hungarian Testing Laboratory and result in extra costs for investors.[437] ■ Self-consumption schemes are available for households and commercial Renewable Energy Systems (RES) <50kW, and a connection size <3X63A. The compensation for electricity is the retail price, “free from system charges.”[438]

[429] RPS is a regulation requiring greater energy production from renewable energy sources

[430] International Energy Agency Trends 2015 in photovoltaic Applications: Survey Report of Selected IEA Countries between 1992 and 2014, available here, pp.27.

[431] An auction in which sellers compete to obtain business from a buyer (of electricity) and in which prices typically end up being reduced as underbidding occurs from competition

[432] IEA Photovoltaic power systems programme, 2014 Snapshot of Global PV markets. Available here

[433] IRENA Policy database, Netherlands, Solar, Available here

[434] International Energy Agency Trends 2015 in photovoltaic Applications: Survey Report of Selected IEA Countries between 1992 and 2014, available here, p.25.

[435] Interactive Eur’ObservER available here.

[436] Interactive Eur’ObservER available here.

[437] Interactive Eur’ObservER available here.

[438] Commission Staff Working Document “Best practices on Renewable Energy Self-consumption”, Available here, p.13.

Cyprus	😐	■ ERDF funded projects include provisions for the establishment of photovoltaic systems in public buildings.[439] ■ Net-metering is available to residential customers connected to the Grid, for systems of size below 3kWp. Customers do not receive a self-consumption bonus, but they receive Renewable Energy Credits. If their net consumption is positive they pay the retail price, but if it is negative the energy balance is transferred to the next billing period (bimonthly).[440]
Malta	☺	■ On 15th June 2015 the Malta Resources Authority announced a new grant scheme for PV. Systems larger than 1kWp but smaller than 40kWp will benefit from a FiT of 15.5c, and those larger than 40kWp will receive 15c, both guaranteed for 20 years. For residential panels, the grant will cover 50% of total eligible expenditure up to the lower of € 2,300 or €757/kWp. A FiT of 16.5c/kWh (capped at 1600kWh/kWp/year) is guaranteed for 6 years, and payment of marginal cost (for exported electricity) thereafter.

Countries which have not yet met their NREAP solar PV capacity targets (if not included above)

Country	Outlook	Key points
Portugal	☹	■ Administrative barriers hampering commercial-scale schemes while political changes to FITs have undermined investment in residential-scale schemes. ■ Self-consumed electricity (or surplus electricity sold back to the grid) receives the "average Iberian electricity market price minus 10%". If the self-consumption (SC) system has a capacity below 1% of the total power capacity then SC receives an exemption; between 1% and 3% SCs pay 30% of the grid fees, otherwise SC pays half of the grid fees.[441] ■ A new net-metering law, introduced in 2015 provides an exemption from taxation for self-consumption (for small-scale mainly household systems under 1.5kW). However, it has been cautioned that without stringent targets, this new law may not have much effect.[442]
Luxembourg	😐	■ FiT enables the promotion of all renewable energy sources, except for geothermal energy. A 2013 amendment has led to solar PV systems larger than 30kW no longer being eligible for FiTs, although sub-30kW systems installed on rooftops and building walls are eligible.[443]
Ireland	☺	■ Accelerated Capital Allowance Scheme offers a tax incentive to companies paying corporation tax, incentivising investment in energy efficient equipment. This enables companies to write off 100% of the purchase value of qualifying energy efficient equipment against their profit in the year of purchase.[444]

[439] Expert Evaluation Network Delivering Policy Analysis on the Performance of Cohesion Policy 2007-2013: Cyprus, Tsipouri (2011), p3, available here

[440] Net Metering Policy and Electricity Market in Cyprus, University of Cyprus and Electricity Authority of Cyprus. Available here.

[441] Commission Staff Working Document "Best practices on Renewable Energy Self-consumption", Available here, p.13.

[442] PV Magazine, Portugal's net-metering law raises faint hopes, (8 December 2014), Available here

[443] IRENA Policy database, Luxembourg, Solar, Available here,

[444] Sustainable Energy Authority of Ireland (SEAI), Solar Grants. Available here.

Country	Outlook	Key points
Latvia		■ A new tax on subsidised electricity producers introduced in January 2014 results in a requirement of tax to be paid by companies receiving financial support for power generation from renewable energy sources or from combined heat and power plants, making these low carbon technologies less attractive.[445] ■ Household systems and commercial RES systems of <50kW are eligible for net metering, with "installation <400V and <16A per connection." No capacity cap is in place.[446]

Additional countries

Country	Outlook	Key points
Poland		■ Pilot programme KAWKA, along with other aims, seeks to increase consumption from renewable sources by offering beneficiaries a financial return of up to 45% on qualified investments in the form of a grant and funding.[447] ■ RES systems below 40kW are eligible for net metering schemes. Below 10kW customers are on FiTs (15 years): approximately €0.18/kWh< 3 kW; €0.11/kWh for projects <10 kW. Between 10kW and 40kW, compensation is the average competitive sales price for electric energy in the preceding quarter. ■ A capacity cap is in place: 300 MW for systems of capacity below 3kW and 500MW <0kW.[448]

Countries of particular interest

Most Member States have already met their 2020 NREAP targets and so there may be little political will to continue supporting development of solar PV. However:

- **Germany** has been and still is a key market for solar PV development in Europe. Despite having by far the largest installed capacity of PV in place, the ambitious NREAP target indicates that the solar PV market will continue to develop.
- Other countries of interest that have exhibited significant and consistent growth in installed capacity (all in excess of NREAP targets) include the **Netherlands** and **Romania**.

Source unless otherwise indicated: EPIA Global Market Outlook for photovoltaics 2014-2018[449].

[445] DG Climate Action (2014) Assessment of climate change policies in the context of the European Semester, Country Report: Latvia, p4. Available here

[446] Commission Staff Working Document (2015) "Best practices on Renewable Energy Self-consumption", Available here, p.14.

[447] IRENA Policy database, Poland, Solar, Available here,

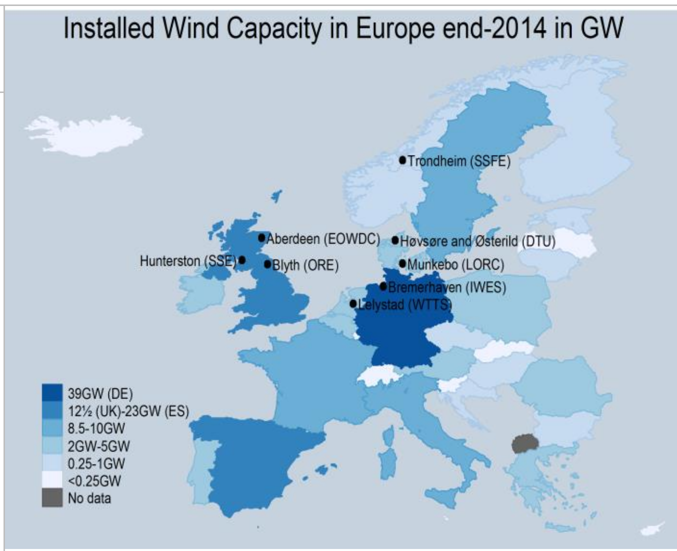
[448] Commission Staff Working Document "Best practices on Renewable Energy Self-consumption", Available here, p.14.

[449] Solar Resources (June 2014) Global Market Outlook for Photovoltaics 2014-2018, p36, Available here

4.12 Wind Energy

Key facts and figures for European Wind Energy

Total installed capacity for Europe: **128.8 GW**



Top five countries by installed capacity as at end-2014 [450] :

- Germany (39,165 MW);
- Spain (22,987 MW);
- United Kingdom (12,440 MW);
- France (9,285 MW);
- Italy (8,663 MW)

Together, these countries represent 72% of total capacity in Europe: 92,540 MW

Top five countries by additions to installed capacity made in 2014 only:

- Germany (5,279MW);
- United Kingdom (1,736 MW);
- Sweden (1,050 MW);
- France (1,042 MW);
- Austria (411 MW).

Name and location of selected test facilities for Wind Energy in Europe:

- (SSE) Scottish and Southern Energy Renewables, Hunterston, UK;
- (EOWDC) European Offshore Wind Deployment Centre (Vattenfall), Aberdeen, UK;
- (ORE) Offshore Renewable Energy Catapult, Blyth, UK;
- (WTTS) Ecofys Wind Turbine Testing Services, Lelystad, Netherlands;
- (IWES) Fraunhofer Institute, Bremerhaven, Germany;
- (LORC) LORC, Munkebo, Denmark;
- (DTU) Department of Electrical Engineering of the Technical University of Denmark Wind Energy, HøvsøreDanish National Test Centre for Large Wind Turbines, Østerild, Denmark;
- (SSFE) Norwegian Centre for Renewable Energy - NTNU - SINTEF - IFE , Trondheim, Norway.

Top five countries by highest consistent[451] growth rates over the period 2011 – 2014:

Growth between 2011 and 2014:

- Ukraine (229%);
- Finland (218%);
- Romania (200%);
- Croatia (165%);
- Poland (137%).

Installed wind energy capacity as at end-2014:

- Ukraine (498 MW);
- Finland (627 MW);
- Romania (2,954 MW);
- Croatia (347 MW);
- Poland (3,834 MW).

---

[450] Wind in power 2014 European statistics, EWEA, 2015. Available here.

[451] "Consistent growth" means that the pace of growth did not slow down year on year over the period.

Social Acceptance: One of the main issues hindering social acceptance of wind turbines relates to its visual impacts. Other issues, such as impact on bird wildlife (fatalities due to collision), noise, electromagnetic interferences and extensive land-use have also been raised. In the case of offshore wind turbines, the impacts relating to ocean energy may also be cited.
Planning and Permitting: According to EWEA's[452] response to public consultation "Preparation of a new Renewable Energy Directive for the period after 2020", administrative and permitting procedures, besides financing and technology, are among the most important hurdles to the development of wind energy. According to the WindBarriers[453] survey, the main barriers faced by wind energy developers are often related to the approval and scope of the Environmental Impact Assessment (EIA), compliance with spatial planning, the number of authorities involved in the decision making process and the barriers posed by other stakeholders involved in the process. For offshore developments, the most important barriers identified is the lack of experience amongst administrative bodies, together with unclear EIA processes and difficult interaction with other users of the sea (e.g. fishing, navy, oil exploration, etc.). In the EU, the average total lead time to obtain a building permit and grid connection consent for onshore wind is 4.5 years (54.8 months), but closer to 3 years (32 months) for offshore wind development. Furthermore, the EU average for the building consent time only (or administrative lead time) of an onshore wind energy project is 42 months while it is 18 months for an offshore one. On average, across Member States, a total of nine authorities have to be contacted directly and an additional nine indirectly, for onshore wind projects. For offshore developers, interactions have to be made with seven authorities directly and 16 indirectly. The main improvements suggested by EWEA and recognised in the WindBarriers report in order to keep average target total lead times in the EU to below 2 years (24 months) are: - Development of a "one-stop-shop" approach at national level to allow more streamlined permitting procedures; - Harmonisation of administrative procedures and permitting policy so that they are coherent with planning requirements and grid developments; - Dissemination of clear information to developers about administrative procedures and the decision-making processes; - Defining a maximum time limit for permitting procedures and effective consequences if deadlines are missed; and, - Provision of clear definition of administrative requirements, making clear the requirements for the EIA process and reducing the number of irrelevant documents.

[452] EWEA response to public consultation Preparation of a new Renewable Energy Directive for the period after 2020 - February 2016

[453] WindBarriers – Administrative and grid access barriers to wind power – July 2010

Table 4.9 Wind energy installed capacity, developments in European countries 2011 – 2014[454][455]

Country	Installed capacity at end 2014 (MW)	Specified NREAP targets for 2020 (MW)[456]	NREAP target reached	Additions to capacity in 2012 (MW)	Additions to capacity in 2013 (MW)	Additions to capacity in 2014 (MW)
Belgium	1,959	4,320	not yet	297	308	294
Bulgaria	691	1,256	not yet	158	7	9
Czech Republic	282	743	not yet	44	9	14
Denmark	4,845	3,960	in 2012	220	657	67
Germany	39,165	45,750	not yet	2,297	3,238	5,279
Estonia	303	650	not yet	86	11	23
Ireland	2,272	7,145	not yet	121	288	222
Greece	1,980	7,500	not yet	117	116	114
Spain	22,987	38,000	not yet	1,110	175	28
France	9,285	25,000	not yet	814	631	1042
Croatia	347	400	not yet	48	122	86
Italy	8,663	12,680	not yet	1,239	444	108
Cyprus	147	300	not yet	13	0	0
Latvia	62	416	not yet	12	2	0
Lithuania	279	500	not yet	60	16	1
Luxembourg	58	131	not yet	14	0	0
Hungary	329	750	not yet	0	0	0
Malta	0	109.58	not yet	0	0	0
Netherlands	2,805	11,178	not yet	119	303	141
Austria	2,095	2,578	not yet	296	308	411
Poland	3,834	6,650	not yet	880	894	444
Portugal	4, 914	6,875	not yet	155	196	184
Romania	2,954	4,000	not yet	923	695	354
Slovenia	3	106	not yet	0	2	1
Slovakia	3	350	not yet	0	0	0
Finland	627	2,500	not yet	89	162	184
Sweden	5,425	4,547	in 2014	846	724	1,043
United Kingdom	12,440	27,880	not yet	2,064	1,883	1,599
Switzerland	60	-	not applicable	4	13	0
Iceland	3	2	in 2014	0	2	1
Norway	819	3,535	not yet	166	110	48
Ukraine	498	-	not applicable	125	95	126

Not applicable means either that the country did not specify a specific wind energy target in its NREAP reports or that the country is not an EU member.

[454] Wind in power 2014 European statistics, EWEA, 2015. Available here
[455] Wind in power 2013 European statistics, EWEA 2014, Available here

Countries that have the greatest installed wind energy capacity

Country	Outlook	Key market condition developments
Germany	☺	▪ Further supporting measures beyond the German Renewable Energy Act (EEG) taken to promote offshore wind energy, primarily a dedicated loan programme by the KfW Bank. ▪ Market based policies have replaced feed-in tariffs.[457] ▪ The FiT for offshore wind will be flat until 2018, instead of 2015, however is set to decrease at a faster rate afterwards at -7% instead of -5%. In addition, investors can opt for a shorter, but higher FiT schedule.[458]
Spain	☹	▪ In 2014 renewables regulation was overhauled, and under the new rules a renewable generator is entitled to receive a 'specific remuneration' on top of the pool price, with the specific remuneration based upon 1) the installed capacity of the generation unit and consequently the initial investment made by the generator, and 2) the operation costs of the renewable facility, rather than on their production as was the case under the FiT regime[459]. ▪ The impact is considerable because for the majority of renewable assets their estimated future income will be substantially decreased.
United Kingdom	☺	▪ Introduction of a government supported Contracts for Difference scheme in 2014 to help ensure reliable returns on investments in new, low-carbon generation.[460] It has also supported some offshore wind projects. ▪ The Crown Estate has put significant efforts into supporting the licensing of sites for offshore wind farms as well as stimulating the supply chain. ▪ UK government has established the Offshore Renewables Energy Catapult to help industry to focus on technology innovation to drive down the cost of offshore wind (and ocean) energy. It has a team of over 120 people with extensive technical and research capabilities, industry experience and a track record in offshore engineering and commercialisation. ▪ Offshore Wind Cost Reduction Task Force is looking at ways of driving down generation costs to £100/MWh by 2020[461] ▪ Onshore wind subsidies under the Renewables Obligation (RO) will end from 1 April 2016 instead of 2017.[462] For planned projects which satisfy a variety of requirements, the government has provided an early closure grace period to accredit under the RO up to 31 March 2017, the original RO closure date[463]. It remains uncertain whether new onshore wind installations may continue to be covered by the CfD scheme.

[457] Clean Energy Wire, Comparing old and new: Changes to Germany's Renewable Energy Act, 2014. Available here

[458]IRENA policy database, Germany, Wind Energy. Available here

[459] Real Decreto 413/2014, June 2014, Available here

[460] Study on the Competitiveness of the EU Renewable Energy Industry, (2014) , ICF International, p28

[461] GOV.UK: Offshore Wind Cost Reduction Task Force, available here

[462] UK Department of Energy and Climate Change, Changes to onshore wind subsidies protect investment and get the best deal for bill payers. 18 June 2015. Available here

[463] UK Department of Energy and Climate Change, Information on the proposed RO grace period for new onshore wind, 18 October 2015. Available here

France	☺	■ The French Ministry of Ecology, Energy , Environment and Sustainable Development launched the French Offshore Wind tendering programme whereby rounds of 3 GW of offshore installed capacity is to be tendered, aiming to reach 6 GW by 2020.[464] ■ Onshore wind will continue to benefit from a feed-in tariff for the time being, though the new subsidy system will be revised well ahead of a 2024 European Commission deadline.[465]
Italy	😐	■ In July 2012, a new FiT program replaced the quotas and green certificates system. While onshore wind projects below 60kW have direct access to a market FiT premium for 20 years, larger projects up to 5MW have to apply to a registry. ■ Projects with more than 5MW generation capacity need to bid in a reverse auction for the premium, limited to 500MW annually. Total incentives to non-solar PV renewable energy will be capped as well to €5.8bn annually.[466] ■ Since 2013 there has been a system in place of competitive price-based tenders for offshore wind power.

Countries with the greatest additions to installed wind energy capacity in 2014 only (if not included above)

Country	Outlook	Key points
Sweden	☺	■ Sweden has had a renewable energy certificate scheme since 2012 which it launched with Norway, the first of its kind. ■ Anticipation of simplification to the concession process, for instance, fewer complications in planning permissions, owing to formal obligations set by the EU Renewable Energy Directive, intending to reduce development barriers.[467]
The Austria	☺	■ Since 2007, the Austrian government has more than tripled funding for energy research, development, and demonstration (RD&D), which has been encouraged to be maintained and increased by the IEA.[468] ■ Austria has a FiT, with the tariff reduced by 1% per annum for a group of technologies including wind.[469]

[464] IRENA policy database, France, Wind Energy. Available here

[465] Sgurr Energy, The end of the onshore wind feed-in tariff in France?,Blog 9 March 2015. Available here.

[466] European Union Wind and Solar Electricity Policies: Overview and Considerations, Congressional Research Service, (August 2013), p29. Available here

[467] Governing Growing Wind Power: Policy Coherence of Wind Power Expansion and Environmental Considerations in Sweden, with Comparative examples from Norway, CEDREN, (2014), p7

[468] Energy Policies of IEA Countries – Austria, 2014 Review IEA, p12. Available here

[469] EurObserv'ER Country policy profile, Austria 2015. Available here

Countries with the highest consistent wind energy capacity growth rate from 2011-2014 (if not included above)

Country	Outlook	Key points
Finland	😐	■ Energy Aid Scheme in place since 1999 involves annual funding of €39 million, enabling the provision of subsidies for the study, research and production of renewable energy production approaches including wind energy. [470] ■ In 2015 the government announced an amendment to the Act on production subsidies for electricity produced from renewables, with an aim of reducing spending in the state budget on operating aid for wind. The bill proposes that the FiT for wind will close when the total capacity of wind power plants having been accepted to the tariff system or having received a quota decision first exceeds 2,500 MVA. In the future, the approval of a wind power plant into the total capacity of the feed-in premium scheme 2,500 MVA would require a quota decision which is in force for two years, however, not beyond November 2017.[471]
Ukraine	🙂	■ The Ukrainian 'The Green Tariff' FiT scheme started in 2009 and operational until January 2030 and features a minimum floor rate for different energy types, allowing a certainty for investors. However, as anticipated, FiT rates will be decreased further in 2019 and 2024, following a decrease in 2014, to incentivise prompt investments and as a result of decreasing technology costs.[472] ■ New legislation was recently passed which relaxes certain restrictions placed on requirements on alternative energy sources qualifying for FITs.[473]
Croatia	😐	■ Concerns regarding the regulatory framework owing to the lengthy and bureaucratic process of obtaining permits, estimated to take an average of 3 – 4 years. ■ From 2013, the feed-in-tariffs guarantee was extended from 12 to 14 years and provides stable finance conditions. Renewable energy producers have guaranteed access to both transmission and distribution grids.[474]

Selected countries which have not yet met their NREAP wind energy capacity targets (if not included above)[475]

Country	Outlook	Key points
Greece	😐	■ Operational Programme for 'Competitiveness and Entrepreneurship' approved by the European Commission in 2007 constituted a total budget of circa €1.52 billion until 2013, being channelled into the energy sector along with other primary sectors in the economy. This expects to assist Greece in achieving commitments in the Kyoto Protocol by increasing renewable energy.[476] ■ Current renewable project development has stalled due to uncertainty regarding the threat of exit from the Euro.[477]

[470] IRENA policy database, Finland, Wind Energy. Available here

[471] Eduskunta Riksdagen: Hallituksen esitysHE152015 vp, (3 September 2015), Available here

[472] IRENA policy database, Ukraine, Wind Energy. Available here

[473] Ukraine wind energy association. Available here

[474] Eastern Winds – Emerging European wind power markets, European Wind Energy Association (2013) pp.82-86

[475] Countries have been selected by their representativeness of different stages of development and geographical placement (e.g. one small country, one non-EU, one Eastern European etc.)

[476] Operational Programme 'Competitiveness and Entrepreneurship', EC Regional Policy, Available here

[477] News article from Euractiv.com on the impact of Greece's financial crisis on renewable project development, Available here

Malta	☹	■ In the formal NREAP submitted in 2010, Malta had planned to achieve its 2020 renewable energy targets through various identified major projects, including wind. However, studies drew attention to significant environmental concerns around the proposed wind farm projects, and attempts to access NER300 funds to develop a floating wind farm were also unsuccessful. A result of this renewable energy will be generated from a higher number, but smaller capacity sources of renewable energy. Priority is given to deployed technologies, mainly solar PV and solar water.[478]
Netherlands	☺	■ In 2014 the Netherlands set out its road map to increase offshore wind capacity from 1,000 MW to 4,500 MW by 2023 as part of its National Energy Agreement for Sustainable Growth. To assist this, the government has designated three wind farm zones where new wind farms can be developed. The roadmap foresees an annual tendering of 700 MW in the period 2015-2019. [479] The government has indicated €18bn in subsidies will be available for constructing offshore wind parks. ■ Hosting of the largest ever offshore wind financing, a €2.8 billion 600 MW Gemini project has boosted the Netherlands' ranking to 13th in 2014.[480] ■ For onshore wind, following the Energy Agreement the government aims to increase installed onshore wind capacity to 6,000 MW by 2020 (from the current 2,465 MW). To facilitate this the Ministry of Infrastructure and Environment and Ministry of Economic Affairs have designated 11 areas for the construction of 11 large-scale onshore wind farms.[481] ■ On the 7th of December 2015, the plans for the 2016 SDE+, the Dutch Renewable Energy Subsidy, were announced to be at €8 billion more than double the amount of the 2015 SDE+ and does not include offshore wind[482]
Norway	☺	■ The Offshore Energy Act, enforced in 2010 and currently in operation, includes financial assistance for research and prototype projects, regulation of project licensing processes, infrastructure deployment and the delineation of specific assessment guidelines for offshore resource exploitation.[483] ■ Norway has a common renewable support scheme with Sweden, see above.
Poland	😐	■ The green certificates market has been experiencing oversupply since 2012, by a substantial amount of 12,103GWh, amassing circa 80% of the expected 2014 GC demand.[484] ■ Poland has in 2015 announced a FiT for the first time in its renewables sector through the Renewable Energy Sources Act, to apply to energy installations up to 10kW, which will come into force in 2016.[485]

[478] Malta National Reform Programme, Ministry for Finance 2015. Available here.
[479] Offshore wind energy in the Netherlands, Netherlands Enterprise Agency 2015. Available here.
[480] Renewable Energy Country Attractiveness Index (RECAI), EY, September 2014, p5. Available here.
[481] Legal developments in wind energy in the Netherlands, Lexology 2014. Available here
[482] Rijksdienst voor Ondernemend Nederlands, Stimulering Duurzame Energieproductie (SDE), December 2015, Available here
[483] IRENA policy database, Norway, Wind Energy. Available here
[484] Oversupply of green certificates, The Polish Wind Association (2014), Available here
[485] Polish Information and Foreign Investment Agency: Legal framework for renewable energy projects in Poland, available here

Belgium	☺	■ Electricity from renewable sources is promoted mainly through a quota system based on the trade of certificates. In general, renewable energy is a regional matter; only offshore wind power and hydro power are governed by national regulations. ■ Offshore wind farms receive support through a feed-in tariff, which is set through a competitive auction process. Power off-take in Denmark is largely handled via the DEA, as part of the incentive scheme. There is no power purchase obligation in place in Denmark, but power from renewable energy enjoys priority access to the grid.[486] ■ In the Brussels-Capital Region, the production of energy from renewable energy sources is promoted through the federal system of green certificates, energy subsidies, investment assistance for companies and net-metering. [487] ■ In the Flanders region, renewable energy is supported through a quota system, an ecological premium and a net-metering scheme. Furthermore, electricity from renewable sources is given priority in both connection to and use of the grid. [488] ■ In the Wallonia region, the quota system aims to increase the proportion of renewable energy in total generation. [489]
Bulgaria	☹	■ As of June 2012, the State Energy and Water Regulatory Commission (SEWRC) published new feed-in tariffs for electricity from RES, which consisted of a reduction in wind energy tariffs by circa 23%.[490] ■ From 2015, Bulgaria has ceased wind energy incentives in an attempt to rectify energy sector deficits and contain power prices in the EU's poorest member states.[491]
Cyprus	☹	■ Encountering of many land planning problems when attempting to locate wind renewable energy owing to the recognition of Cyprus as a developed tourism country. [492] ■ Electricity from renewable sources is promoted through a combination of a subsidy scheme premium tariff as well as a net metering scheme.

[486] Offshore wind policy and market assessment- A global outlook. Fowind 2015. Available here.
[487] Legal sources on renewable energy, Belgium summary. Res-Legal 2014. Available here.
[488] Ibíd.
[489] Legal sources on renewable energy, Belgium: Wallonia quota summary. Res-Legal 2014. Available here
[490] Continental Wind: Bulgaria, Available here
[491] Bulgaria ends wind incentives, Wind power monthly 2015. Available here
[492] Workshop on Renewable Energy Policies, IRENA, p18. Available here

Czech Republic		■ Amongst a few member states which have operational programmes as a source of funding for wind energy.[493] ■ Up to 85% of most wind farms are affected by environmental planning restrictions. While there are numerous commercial banks which are experienced in wind energy financing, the act of obtaining permits is generally a long and cumbersome process.[494] ■ A day after the European Commission declared that the Czech support scheme was in line with EU state aid rules the Czech Ministry of Industry made a draft amendment to the Renewables Act, establishing a ceiling for the amount of energy available for support, new cost obligations on producers, and a review mechanism of retroactive adjustments to investment conditions.[495]
Estonia		■ Premium tariff support scheme for renewable energy sources through the Transmission System Operator, with wind as one of the greatest beneficiaries. The tariff support scheme can be combined with investment support from the state. ■ Investment support schemes available for renewable energy sources including wind energy through EU structural funds and Green Investment Schemes, for installation of wind energy capacities up to 12.9 MW.[496] The overall budget for renewable energy generation for the period 2014-2020 is €719.9 m.[497]
Hungary		■ Installation capacities for wind power are capped at 330 MW to reflect grid availability,[498] limiting wind energy development and investment with wind capacity remaining in stasis from end of 2011 at 329 MW.[499]
Ireland		■ Wind energy projects developed and brought into operation in 2014 made up an investment of €350 million, producing enough capacity to power an additional 144,000 homes in 2014.[500] ■ Employment of wind energy to meet growing demands from large data centres has the impact of lowering energy prices in Ireland and offers cost savings of at least €43 million per annum.[501]

[493] Eastern winds, Emerging European wind power markets, European Wind Energy Association (2013), p28

[494] Ibid, p28

[495] EurObserv'ER Country policy profile, Czech Republic 2015. Available here

[496] Renewable Energy Policy Framework: Estonia, Republic of Estonia Ministry of Economic Affairs and Communications (2015), Available here, p3

[497] (2015/C 044/01), Available here

[498] Renewable energy country focus: Hungary, Ernst and Young, Available here

[499] Romania Slowing Bulgaria and Hungary fall off the radar, Wind Power Monthly, Available here,

[500] Irish Wind Energy Association, Irish Wind Energy Investment Tops €350 Million in 2014, January 2015, Available here

[501] Irish Wind Energy Association, Using Wind Energy to Meet Growing Energy Demand from Large Data Centres Will Lower Electricity Prices in Ireland, New study finds, April 2015, Available here

Lithuania	☺	■ The main policy to support renewables is a FiT for installed capacity not exceeding 10 kW (there is a tendering mechanism for larger plants), which is guaranteed for 12 years. Wind capacity up to 10 kW receives €0.081 per kWh, compared with €0.2 for Solar, €0.116 for Biogas, €0.078 for Hydro, and €0.087 for Biomass. The FiT is accompanied by investment grants, a loan programme and exemption from excise tax. [502] ■ Fund offered to all renewable energy types in the form of subsidies and loans under the 'Special Programme for Climate Change Mitigation'. Subsidies are also offered by 'The Lithuanian Environmental Investment Fund' (LEIF) to projects which aim to reduce environmental damage in the long term, including renewable energy projects.[503] ■ Lithuania has international electrical power connections which create very substantial potential and promising conditions for renewable energy growth. In 2015 besides hydro, wind energy was the cheapest electricity source in Lithuania. Despite lagging behind other countries with respect to generation capacity development so far, there is very promising potential, and the high interconnectivity of the Lithuanian electricity market ensures safety and provides the possibility for export of electricity overproduction. [504]
Luxembourg	☺	■ Programmes and initiatives available for the promotion of the development of renewable energy, including wind energy. The Multi-Annual Research Thematic Research Programme (CORE) funded under the National Research Fund (FNR) has a focus upon sustainable resource management, including the management of renewable energy. A Promotion of International Cooperation (INTER) encourages international research collaboration in several areas including the sustainable management of resources, all easing the platform for wind energy development.[505]
Latvia	☹	■ Significant opposition to wind power, substantially owing to the influence of conservation groups that prefer Latvia's abundant wildlife to be free if visible human influence, and also due to the notion that renewable energy is too expensive for an 'impoverished' country.[506] ■ January 2014 saw the introduction of a tax for companies receiving financial support for electricity from Renewable Energy Sources.[507]
Romania	😐	■ Considerations to increase support for renewable energy by the government, as a recent decline in support rendered wind projects unprofitable. Significant investors have halted investment plans until these new incentives are revealed, placing an onus on the government to proceed with its plans.[508] ■ In 2015 Romanian lawmakers began to discuss the possibility of dropping the green certificate price floor, which has become the going price due to an oversupply of certificates. If it actually happens, the price of green certificates is expected to collapse.[509]

[502] Legal sources on renewable energy, Lithuania Feed-in-tariff. Res-Legal 2014. Available here.

[503] Legal sources on renewable energy, Promotion in Lithuania, Res-Legal 2014. Available here.

[504] Lithuania has developed perfect conditions for wind energy expansion, Euromonitor international 2015. Available here.

[505] European Commission Energy Resource Knowledge Centre, Luxembourg, Available here.

[506] Dispateches: Times for RE to emerge from Latvia's policy deep freeze, Recharge 2015. Available here.

[507] Country Policy Profile, Latvia, EurObserv'ER (2014), p6

[508] Romania considers reviving support for renewable energy, Bloomberg 2015. Available here.

[509] Market status: Romania – Progress falters as prices fall, Wind power monthly 2015. Available here.

Slovakia	☹	■ Wind energy deployment has ceased. ■ A movement from FiT support mechanisms to reverse auctions is strongly anticipated.[510]
Slovenia	😐	■ Developers can choose between a feed-in-tariff and a feed-in premium, however, above 10 MW a wind energy project is only eligible for the premium. ■ Administrative procedures for building permits and grid connections are burdensome and opaque.[511]

Additional Countries

Country	Outlook	Key points
Denmark	☺	■ Continues to be central to the development, testing and deployment of wind energy technologies, with 74% of renewable electricity production from wind power[512]. This is against a figure of 14.1% for the EU as a whole.[513] ■ In March 2012, a new Energy Agreement was reached in Denmark which set an ambitious renewable energy target. For wind power specifically, the goal is 50% of Danish electricity consumption by wind power in 2020. ■ The main stimulation measures for RE investment in Denmark are Feed-in Premiums (FIPs). The FIP is paid on top of the market price, whereas the sum of the two is capped - it should not exceed a statutory maximum per kWh[514]. ■ The government is currently calling for tenders for 1,450MW offshore wind power before 2020, and the successful bidder will receive a fixed FiT for the first 50,000 full load hours of its wind farm for a maximum of 20 years.[515]
Portugal	😐	■ Special tax payable to the local municipality of 2.5% of total revenue from wind projects was introduced to ensure benefits to local communities.[516] ■ A 25MW floating offshore wind farm was recently granted state aid approval by the European Commission, with floating wind turbine technology seen as a key step in efforts to bring down the cost of offshore wind power.[517]

Countries of particular interest

Wind energy continues to develop rapidly in Europe, with increasing focus being placed on the development of the offshore market sector.

- **Denmark** continues to be central to the development, testing and deployment of wind energy technologies.
- **Germany**, the **UK** and the **Netherlands** are increasingly focussing on the offshore wind market potential.
- Recent legislative and project developments in **France**[518] indicate increasing interest in supporting renewables overall and wind power specifically.[519]

[510] Eastern winds, Emerging European wind power markets, European Wind Energy Association (2013), p103

[511] Ibid, p106

[512] Graphic Information System EurObserver, 2014 (http://www.energies-renouvelables.org/observ-er/sig/erec/sig.asp)

[513] Wind in power 2014 European statistics, EWEA 2015. Available here.

[514] Only in certain cases, plant operators are granted a guaranteed bonus on top of the market price. In such cases the maximum is not defined by law (§§ 36-48 VE-Lov).

[515] Offshore wind support schemes: Current status of European support scheme. OffshoreWIND.biz, 2015. Available here.

[516] Portugal, Market Overview, Available here, p113

[517] Business Green, Portuguese floating wind farm gets green light from Brussels, April 2015, Available here

[518] France passes sweeping energy bill, to raise CO2 tax to €100/t by 2030, Carbon pulse, 2015. Available here.

[519] A similar statement could be made of Ukraine, though not in relation to offshore wind.

4.13 Findings and conclusions

4.13.1 Generally positive outlook, 13 countries of particular interest

The nine sector-specific market condition description sheets serve to identify European countries that have supportive frameworks and buoyant market growth perspectives, both of which need to be present for there to be any chance of the considerable financing requirements of first-of-a-kind commercial-scale SET demonstration projects being met.

On the basis of information obtained and presented in the market conditions description sheets, Table 4.10 overleaf shows for each SET, which of the 32 countries have a positive outlook for market conditions, and which have a negative outlook. It also shows which countries are of particular interest due to recent sustained growth in capacity (or development and deployment budget, in the case of advanced electricity networks) combined with a positive (or at least neutral) outlook.

The legend below identifies the symbols used to categorise countries across the sectors:

☺ = positive outlook for market conditions

😐 = neutral outlook for market conditions

☹ = negative outlook for market conditions

= particular interest

In general, across all SET and all countries, the outlook can be taken as generally positive, considering that, for each SET, there at least as many countries with a positive outlook as there are countries with a negative outlook. Furthermore:

- At one end of the spectrum, advanced electricity networks, large-scale energy storage and ocean energy have several countries that have a positive outlook and none with a negative;
- At the other end of the spectrum, wind energy roughly equal numbers of countries that have a positive outlook and countries that have a negative outlook.

It is also noteworthy that, for each SET, there is at least one country of particular interest, and that:

- CSP has the fewest countries of interest: two
- Biomass conversion technologies has the most: fifteen

Clearly the most fundamental factor determining this SET market condition “landscape” is the availability of the natural resources required for the SET (e.g., the availability of a viable ocean energy resource in the North West of Europe). However, the successful development of first-of-a-kind, commercial-stage demonstration projects for a particular SET in a particular country depends also on the presence there of a stable and supportive policy framework, and strong and mature supply chains. (Installed capacity is a measure of the latter. As might be expected, these maps show that most facilities are located within countries that have the greatest installed capacity.) As policy frameworks vary widely, it is no surprise that capacities and capacity growth rates vary too, even between countries whose resource availabilities are similar.

Table 4.10 Countries where market outlook is positive (or negative) and which are of particular interest

Country	AEN*	Biomass conversion technologies	CCS**	CSP	Geo-thermal energy	LSES***	Ocean energy	Solar PV	Wind energy
Belgium	😐	☹	😐	😐	😐	😐	😐	😐	☺
Bulgaria	😐	**☺**	😐	😐	😐	😐	😐	😐	☹
Czech Republic	😐	**☺**	😐	😐	☹	😐	😐	😐	☹
Denmark	😐	☺	☹	😐	😐	😐	😐	😐	**☺**
Germany	**☺**	**☺**	😐	😐	**☺**	**😐**	😐	**☺**	**☺**
Estonia	😐	☺	😐	😐	😐	😐	😐	😐	☺
Ireland	☺	😐	😐	😐	😐	😐	☺	☺	😐
Greece	😐	☺	😐	☺	☹	😐	😐	😐	😐
Spain	☺	😐	☺	☹	😐	**😐**	😐	☹	☹
France	**☺**	**☺**	😐	☺	**☺**	😐	**☺**	😐	**☺**
Croatia	😐	😐	😐	😐	☺	😐	😐	😐	😐
Italy	☺	**☺**	😐	**😐**	☺	☺	😐	😐	😐
Cyprus	😐	😐	😐	😐	😐	😐	😐	😐	☹
Latvia	😐	☺	😐	😐	😐	😐	😐	😐	☹
Lithuania	😐	😐	😐	😐	😐	😐	😐	😐	☺
Luxembourg	😐	☺	😐	😐	😐	😐	😐	😐	☺
Hungary	😐	😐	😐	😐	😐	😐	😐	😐	☹
Malta	😐	😐	😐	😐	😐	😐	😐	☺	☹
Netherlands	😐	☺	**☺**	😐	**😐**	😐	☺	**☺**	**☺**
Austria	😐	😐	😐	😐	😐	😐	😐	😐	☺
Poland	😐	**☺**	😐	😐	😐	😐	😐	☺	😐
Portugal	😐	☺	😐	☹	☺	☺	☺	☹	😐
Romania	😐	☹	😐	😐	😐	😐	😐	**😐**	😐
Slovenia	😐	☺	😐	😐	😐	😐	😐	😐	😐
Slovak Republic	😐	☺	😐	😐	☹	😐	😐	😐	☹
Finland	☺	😐	😐	😐	😐	😐	😐	😐	😐
Sweden	😐	😐	😐	😐	😐	😐	☺	😐	☺
United Kingdom	**☺**	😐	**☹**	😐	😐	**☺**	**☺**	😐	**☺**
Switzerland	😐	😐	😐	😐	😐	😐	😐	😐	😐
Iceland	😐	😐	😐	😐	**😐**	😐	😐	😐	😐
Norway	😐	😐	**😐**	😐	😐	😐	😐	😐	☺
Ukraine	😐	😐	😐	😐	😐	😐	😐	😐	☺

☺ = positive outlook
😐 = negative outlook
☹ = negative outlook

AEN* = Advanced electricity networks
CCS** = Carbon Capture & Storage
LSES*** = Large scale energy storage

= particular interest

4.13.2 Policy frameworks are complex, support mechanisms are not FOAK-specific

Policy frameworks at European Union and Member State level for SET are very extensive and complex, and thus is it is not possible to provide an overview that captures every element in this deliverable. Further, simply listing the type and magnitude of any direct financial support mechanisms available will not provide a comprehensive understanding of non-observable market conditions at work in each of the sectors. To illustrate, in Section 4.13.3.1, we provide a summary of the Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013 published by the Council of European Energy Regulators (CEER) in January 2015.

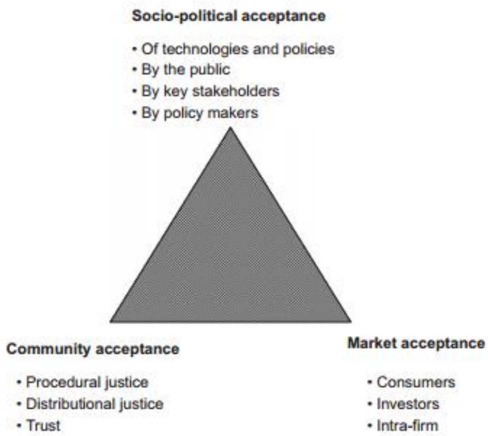
More fundamentally, a detailed review of direct financial support mechanisms may have limited impact in forming an understanding of the market conditions for first-of-a-kind, commercial-scale demonstration projects in respective SET sectors. This is because financial support mechanisms are calculated on the basis of the perceived rate of return for commercialised technologies. Clearly such mechanisms can greatly help to accelerate the deployment of technically proven and early commercial technologies. However, there may be minimal benefits from financial support schemes to first-of-a-kind commercial-scale SET demonstration projects, other than to have a positive signalling effect to potential investors/financiers that a successful demonstration of a particular technology may find a future foothold in a supported market. (The existence and extent of the support scheme signals that the respective Member State government is committed to that SET sector, or a subsector within a SET, and wishes to increase the overall levels of deployment for that particular technology or the production of renewable energy more generally.)

Given the recent changes to state aid guidelines, we have also avoided a review of past cases. However, in Section 4.13.4, we do provide comment on the potential impact of the new state aid regulations across different SET sectors.

4.13.2.1 Social acceptance can be a barrier to the roll out of certain technologies

Figure 4.1 presents an illustration of the definition of social acceptance introduced by Wüstenhagen et al (2007). The authors distinguish between three dimensions of social acceptance, namely socio-political acceptance, community acceptance and market acceptance. In this study, a particular focus is given to the socio-political acceptance dimension.

Figure 4.1 The triangle of social acceptance of renewable energy innovation



Source: Wüstenhagen et. al.(2007)

The literature review conducted by the study team pointed out to an overall lack of country specific information on social acceptance of renewable energy systems. From a sector perspective, it was possible to identify relevant surveys highlighting key social concerns.

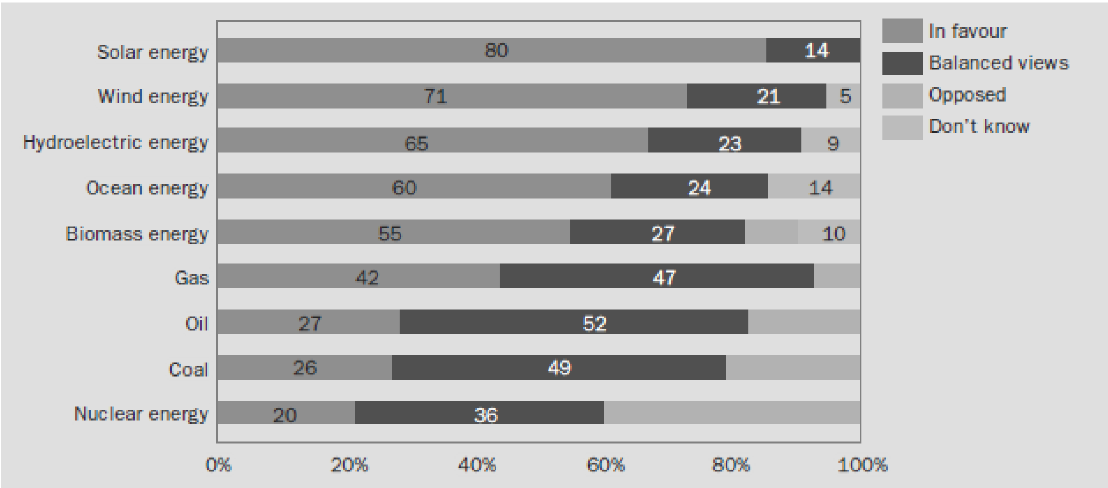
Likewise, on an EU level and in certain Member States (e.g. the UK) there are also more active research on these issues, leading to a greater information availability.

The next section presents the sector profiles of with regards to social acceptability, while the following section highlights the results of two surveys focusing on Europe and in the UK.

4.13.2.2 Social acceptance of energy technologies in Europe

The results from EC's report "Attitudes towards energy" allow a closer look into the social acceptance of a set of energy technologies in Europe. Although this survey was undertaken in 2006, it enables some overall trends to be observed including the high overall acceptance of renewable energy generation compared with fossil-fuels or nuclear energy. According to the survey, solar energy is the most widely accepted energy technology across Europe, while biomass is the least accepted. The lower acceptance of biomass is most likely linked to the uncertainty relating to this source's net environmental impact as well as to issues regarding its competition with food crops (i.e. with regards to prices and land availability). Figure 4.2 provides an overview of the survey results.

Figure 4.2 General attitudes towards energy sources in the EU



Source: European Commission (2007) apud Lago et al. (200?)

In the UK, the Department of Energy and Climate Change (DECC) implements an annual survey to understand and monitor public attitudes to the Department's main business priorities. In its latest edition, the "DECC Public Attitudes Tracker – Wave 15" found that the level of support for specific renewable technologies were: 65% for biomass, 66% for on-shore wind, 73% for off-shore wind and wave and tidal, and 80% for solar. Interestingly, these results are consistent throughout the years. Moreover the results are also consistent with EC's research from 2006 presented above, in which solar is the most widely accepted renewable energy source and biomass is the least accepted[520]. Regarding smart metering, a study has found that 76% of British citizens would like a smarter home. Nevertheless, only 28% are willing to pay for this[521].

[520] DECC, 2015. DECC Public Attitudes Tracker – Wave 15. UK Department of Energy and Climate Change [PDF]. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/474170/Wave_15_Summary_of_Key_Findings.pdf [Accessed 11 December 2015]

[521] GfK, 2014. 76 percent of Brits would like a smarter home – they just don't want to pay for it. Press release [PDF]. Available at: http://www.gfk.com/en-gb/insights/press-release/76-percent-of-brits-would-like-a-smarter-home-they-just-dont-want-to-pay-for-it-1/ [Accessed 11 December 2015

With regards to wind energy, the EC's report "Attitudes towards energy" provides a country by country overview of acceptance. On a scale from 1 (strongly opposed) to 7 (strongly in favour), the EU average was 6.3. The Member States with the highest acceptance were Denmark (6.7) and Greece. Poland, Hungary and Malta all averaged 6.4, while the UK, Germany and Finland showed the lowest level of support, with their average ratings falling between 5.7 and 5.8[522].

4.13.2.3 Planning and Permitting

Planning and permitting are some of the major factors that need to be taken into account in assessing the potential for FOAK technology deployment. From the analysis, it is possible to conclude that one of the difficulties for FOAK technologies is that they require, in some cases, new regulatory regimes to be established in order to help facilitate initial demonstration. This creates a 'Catch-22' for developers because until successful plants are in operation, the ability to establish a regulatory regime may be delayed. Other insights which are evident from the analysis include:

- The burden of consenting and permitting processes can vary widely across sectors. This includes the number of consents required as well as the number of agencies that project sponsors are required to engage with. The availability of 'one-stop-shops' to facilitate consenting are being used in some sectors (e.g. ocean energy);
- Timescales are subject to big variations across technologies, varying from half a year for PV solar to 7 years for CCS. Unpredictable planning and permitting timescales can create risks around the ability to access incentives or the capacity to lock in a project into the planned tariff scheme.
- Data availability is greater for mature technologies, while FOAK projects suffer lack of information and knowledge that negatively affects the permitting processes.

A summary of key planning and permitting issues (combined with social acceptance issues) are shown in Table 4.11.

[522] Lago, C., Prades, A., Lechón, Y., Oltra C., Pullen A., Auer H., 200?. Wind Energy - The facts. Part V: environmental issues.

Table 4.11 Summary of planning and permitting and social acceptance issues

SET Sectors	Planning and Permitting				Average lead time	Other barriers	Social Acceptance
PV solar	Legal – administrative Permitting Procedures	Grid connection and technical standards	Grid capacity issues		Total administrative labour required in man-hours: 4 to 227 for rooftops, 187 – 1230 for ground-mounted	Planning requirements Biodiversity requirements and limits	High demand for water and land use impacts (e.g. habitat loss for wildlife) and issues relating to end-of-life impacts.
Wind	Approval of the Environmental Impact Assessment (EIA)	Spatial planning procedure	High number of authorities involved in the decision-making process	Lack of experience among administrative bodies	Average lead time to obtain a building permit and grid connection consent: onshore= 4.5 years offshore = 2.5 years	Barriers posed by other stakeholders involved in the process.	Predominance of visual impacts issues. Other issues are impact on bird wildlife (fatalities due to collision), electromagnetic interferences, noise, and extensive land-use.
Geothermal	Complex procedures to obtain exploitation rights	Fragmentary environmental regulation	Grid infrastructure development	Difficulties in securing a grid connection	-		Induced seismicity, noise impacts during construction/operation, visual impacts, competition with recreational purposes, NIMBYism and issues of community engagement.
Ocean energy	Burdensome and expensive planning and consenting processes	Time taken to obtain consents	High number of authorities involved in the decision-making process	Lack of clarity and consistency in EIA obligations	-	Lack of knowledge and expertise due to nascent technology	Impacts on sea and aerial wildlife. Noise and vibration of machinery disturbing sea wildlife. Interference with shipping and naval activities
Bioenergy	Spatial planning procedure and land use approval	Multitude of permits and licenses used by different authorities.	Lack of bio-energy specific legislation and lack of well-defined administrative structures and procedures.	No clear and transparent procedures for grid access	Total permit procedure ~2 years, with potential to deviate by 2 years. For procedures with an EIA, average lead times nearly 3	Official authorities lack knowledge, capacity and expertise to properly evaluate and adjudicate innovative bio-energy power	Social issues: competition with food crops, food price volatility, land rights. Environmental issues: biodiversity impacts, high water demand, indirect land use change (ILUC) and land use impacts.

SET Sectors	Planning and Permitting				Average lead time	Other barriers	Social Acceptance
					years.	plants.	
CCS	High number of permitting requirements that applies to different stages and condition of the capture, transportation and storage facilities	High number of authorities involved in the decision-making process.			-	Lack of knowledge and expertise due to nascent technology	Limited demonstration (and nothing yet at full-scale, full-chain CCS), reduces evidence on impact. Potential for both "NIMBY effect" relating to transportation and “NUMBY” effect for storage.
CSP	Difficulties in securing land, water and grid connections.	Difficulties in obtaining permits for land use and grid access.	Environmental impacts evaluation process, including assessment of loss of animal habitat, water use, visual impact and effects on endangered species.		-	Slow planning and permitting processes for electricity transmission lines	Main issues encompasses impacts on birds, high water demand, land use impacts, and potential visual impact.
Advanced Electricity Network	Regulatory advancements that allow the development of smart grid solutions	High number of stakeholders involved in the decision-making process.			-	Lack of knowledge and expertise due to nascent technology	Concerns regarding security and privacy of data and to a potentially high cost burden
Energy storage	Permitting on existing sites (e.g. distribution substations) potentially easier due to existing planning permissions	Additional permitting for large-scale new capacity, coupled with potential EIAs (e.g. for pumped storage reservoirs)	Abstraction licensing for pumped storage		0.5 year up to 12 years (for hydropower schemes)		Competition with recreational purposes (e.g. pumped storage in national parks, mountainous areas); visual impacts; impacts on wildlife

Source: ICF based on various sources (see individual sector profiles)

4.13.3 Influence of financial support schemes compared to that of other factors

In order to account accurately for the impact of the most common renewable electricity source (RES) support mechanisms[523], it would be necessary to contrast the levels of support that operators would actually receive in the operation period and the levels of perceived support expected when construction on a project was completed.

For large commercial projects, this information would differ on a case-by-case basis, as there are significant differences from project to project, even within the same country. In addition, as noted, RES support schemes are calculated on the basis of the perceived rate of return for commercialised technologies, and are rarely targeted towards specific technology types at the demonstration stage. Consequently, the specific, quantifiable RES support schemes currently available, as covered in the aforementioned CEER report, may be less crucial for the decision to invest in a first-of-a-kind commercial-scale SET demonstration project than other factors such as, for example, site location, the ability to achieve permitting, or proximity to technical knowledge and/or a supply chain.

We have thus spent less time assessing direct RES support schemes and instead attempted to identify other factors which may impact market conditions for first-of-a-kind commercial-scale demonstration projects in each SET sector across all the countries. In particular, for technologies with relatively high market deployment (e.g. solar, wind, biomass), countries with existing high penetration rates are more likely to have policies and non-observable factors (e.g. supply chains) in place and therefore more likely to have more optimal market conditions for demonstration of new developments in these sectors. Conversely, for technologies which have relatively low market deployment (e.g. ocean, geothermal, large scale energy storage) policy support plays a more crucial role in fostering support.

4.13.3.1 Council of European Energy Regulators (CEER) Status Review of Renewable and Energy efficiency support schemes in Europe (2015)[524]

The magnitude of direct policy support mechanisms (e.g. FiTs) is often used as a proxy for the attractiveness of different countries' investment environments and thus the bankability of projects. However, calculating the bankability of projects requires substantial knowledge on a Member State level of not only the factors affecting the development of the SET project in question but also the supply chains and the infrastructure in place and, not least, the "counterfactual" scenario which the project is being measured against.

The counterfactual is particularly important because direct policy support mechanisms are set within an existing regulatory regime to incentivise optimal investment behaviour and will feed off other existing legislation, including the complexities of securing planning permission, gaining environmental and other permits, as well as other factors.

A quantitative analysis that provided comprehensive information on the level of bankability of SET projects would require a breakdown of the existing regulatory regime on a country basis, including the costs of financing. A high level of, for example, FiTs in one country does not necessarily signify that the market conditions are better within that country – it is equally (if not more) likely that high levels of subsidy support are required to overcome non-observable and less transparent barriers.

The CEER Status Review provides some evidence which illustrates that high levels of direct policy support are not directly correlated with attractive market conditions. It also provides an indication of the difficulties in sourcing the data on comparable policy measures.

Data from 23 national regulatory authorities in the EU and EEA[525] were collected in mid-2014 on support schemes for national renewable energy sources and summarised on a comparable basis. Key highlights from the report include:

[523] Note that a plethora of EC support mechanisms for CCS and CCUS are listed in the CCS sector summary

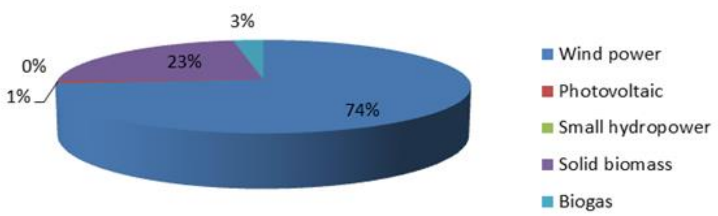
[524] Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, CEER, 2015. Available here.

- Instruments used to promote RES include:
  - Investment grants;
  - Feed-in tariffs (FiTs);
  - Feed-in premiums (FiPs);
  - Green certificates; and,
  - Calls for tender (which is often coupled with the above types of support).
- Most RES support schemes are funded through non-tax levies or possible pass down of RES costs from the supplier to consumers;
- RES electricity is generally sold through the same channels as conventional electricity and often subject to the same electricity balancing responsibilities;
- In the majority of the 23 countries surveyed, RES plants are given priority in terms of network access and dispatch of generated electricity.

The CEER Status Review also provides the proportion of total gross electricity produced which received RES support in 2012 (making no distinction between different RES). Across the 23 countries surveyed, this proportion was 12.6% on average, ranging from < 1% in Norway to > 55% in Denmark. There is no correlation between the proportion of gross electricity which receives RES support in a given country and the supportiveness of market conditions in that country, since we have considered market conditions by sector by country.

It is possible that, if the report contained a breakdown of the share of supported electricity against *sector-specific* production of electricity (including by SET), a correlation between supportive market conditions and supported sector-specific electricity generation might have been found. For instance, Figure 4.3 shows that the share of wind energy generation in gross electricity production in Denmark is very high (74%), and we have identified Denmark as a country of particular interest in relation to wind energy (see the Wind Energy description sheet and Table 4.11). Assuming that the share of supported electricity at least partially covers the share of electricity generated by wind, an argument could be made that where these two are correlated there exists a supportive market environment. Unfortunately, it has not been possible to investigate this further, given the data available.

Figure 4.3 Gross electricity production per sector in Denmark (share, 2012)



Source: Geographic Information System, EurObserv'ER[526]

4.13.3.2 Scope of the CEER Status Review with respect to RES support

The overview of RES electricity support instruments for the surveyed countries in the CEER report covers five of the SET sectors covered by our current study (i.e. Bioenergy,

[525] Countries included Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden and the United Kingdom.

[526] *Geographic Information System, EurObserv'ER.* Available here.

Geothermal, Ocean, Solar and Wind) and an “Other” category which covers renewable energy technologies not included in the other sectors. For the reporting years of 2012 and 2013, this overview illustrates a preponderance of the use of FiTs. Tables in the annex of the report provide the full breakdown of the main support instruments across technology type, although no differentiation is made as to the scale (in kW or MW) of the technologies which are supported. This report can therefore not yield any substantive insights on the market conditions for demonstration of commercial-scale SET projects.

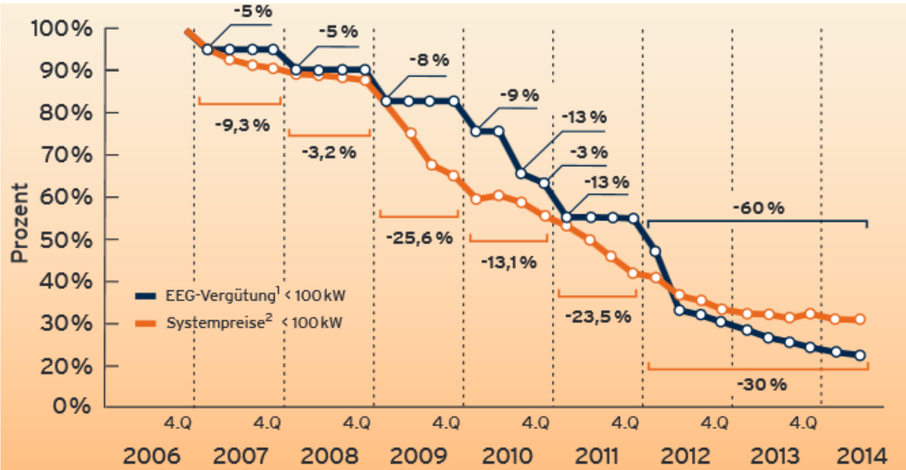
It should be noted that the focus of the CEER Status Review focuses on direct RES policy support for electricity. Indirect policy measures, including planning permission restraints for various technology types (e.g., eligible sites for onshore and offshore wind turbines, environmental impact assessment requirements; and blending requirements for biofuels), are not included.

4.13.3.3 Changes to RES support

The CEER Status Review provides further information on impending changes to policy support for RES electricity (e.g., in 2014) for some of the surveyed Member States. In total, 21 out of the surveyed 23 countries indicated that there had either been recent changes or that there were impending changes due to take effect in the near future.

This is of particular interest, as it indicates an ever-changing policy environment, evolving in response to developments in national strategies, technology innovations and cost reductions for commercial systems. This is illustrated very well by the reduction of FiTs in Germany, where the level of FiTs for solar PV has been gradually reduced to reflect the fall in PV system prices (see Figure 4.4).

Figure 4.4 Reduction of FiTs in Germany compared to reduction in PV system prices



Key: [1] Feed-in-Tariffs: in Q2 of 2012, tariffs were adapted as a result of legislative change in the Erneuerbare-Energien-Gesetz (EEG); [2] System prices; [3] Provisional numbers from 01/2014

Source: German Solar Industry Association, 2014 based on data from BSW-Solar, Bundesnetzagentur[527]

The CEER Status Review also gives changes in the weighted average support level of FiTs by technology for 2012 and 2013. For example, the minimum level of support provided for solar technologies decreased from €14.5/MWh in 2012 to €10.6/MWh in 2013 (both rates for Estonia), while the maximum support level also reduced from €462.1/MWh in 2012 to €448.0/MWh in 2013 (both for the Czech Republic).[528] Interestingly, solar technologies are the only category for which there are clear reductions to both the minimum and maximum levels of support, indicating a widespread recognition of large system cost reductions for this technology.

[527] http://www.solarwirtschaft.de/fileadmin/media/Grafiken/pdf/kosten_foerderung_solarstrom.pdf

[528] Note that this RES support figures do not appear to have been corrected for inflation

4.13.3.4 Impact of RES support on overall market conditions

It is important to note that low levels of direct RES support are not necessarily indicative of worse market conditions for specific technology types.

For instance, the weighted average support level for offshore wind in Denmark for 2012 and 2013 was €37.2/MWh and €57.4/MWh respectively.[529] For the same years, the range in support offered across the other CEER member states was €37.2/MWh to €127.2/MWh in 2012 and €44.8/MWh to €135.5/MWh in 2013, placing Denmark at the lower end of the scale for RES support for offshore wind.

The three countries with the highest levels of support for offshore wind in 2012 and 2013 were Germany, Portugal and Belgium, with support levels of €127.2/MWh, €123.74/MWh and €107.0/MWh for 2012 and €135.5/MWh, €131.4/MWh and €104.9/MWh for 2013, respectively.

Given that Denmark has support that is two to three times lower than the top three countries, some readers might conclude that market conditions were worse in Denmark than in Germany, Portugal and Belgium. They could attribute this to a variety of reasons, including relative market maturity, availability of sites and suitable supply chains for construction and operation. However, the fact that Denmark possesses world class testing and demonstration facilities through eight DTU-operated sites at Høvsøre and Østerild would give any prospective technology developer pause for thought over where best to locate a demonstration project.

The amount of energy receiving RES support in each of these four countries is reproduced in Table 4.12 below from Annex 9 in the CEER Status Review:

Table 4.12 Comparison of offshore wind energy receiving RES support in 2012 and 2013

Country	MWh of offshore wind energy receiving RES support in 2012	MWh of offshore wind energy receiving RES support in 2013	Annual increase from 2012 to 2013 (percentage change)
Denmark	3,073,700	3,982,400	29.6%
Germany	721,650	904,818	25.4%
Portugal	2,925	3,919	34.0%
Belgium	873,540	1,539,699	76.3%

Reproduced from Annex 9, CEER Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, January 2015

It is clear from the figures above that there is also no obvious relationship between the MWh receiving RES support and the magnitude of the RES support reported in the preceding paragraphs for the three CEER member states with the highest level of support and Denmark.

If lower RES support magnitudes implied lower levels of technology penetration, then Denmark would have much lower levels of offshore wind than Germany, Portugal or Belgium. However, Denmark has higher levels of supported MWh than Germany, Portugal and Belgium combined. Germany has higher RES support levels than Portugal or Belgium, but the annual increase in MWh for the three countries is clearly inversely related to the level of support provided.

Four conclusions may be drawn from the data on offshore wind support and generation for 2012 and 2013. First, that there is a significant lag between the construction of an offshore wind farm and announced support levels. Unfortunately the previous 2013 edition of the

[529] Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, CEER, 2015. Available here.

CEER Status Review[530] does not include support levels for onshore and offshore wind separately and did not include values for Denmark at all. This precludes any like-for-like comparison of previously reported support levels and MWh generated. Given the timescales involved in the planning of wind farms, the likelihood is very low that policy changes in 2012 support levels for offshore wind will have had any impact on the finalisation of construction of wind farms in 2013. Policy changes are much likely to impact offshore wind farms to be constructed in 2015-2016 or later[531].

Second, Denmark has the lowest level of RES support of the four countries. However, it does not follow that Denmark has the least attractive market conditions for offshore wind. Denmark's increase in RES support from 2012 to 2013 and high levels of generation is more likely to reflect that the cheapest sites (in terms of construction and servicing) have already been exhausted and the support needs to be adjusted if less attractive sites are to be considered viable.

Third, Portugal has almost no offshore wind generation[532] and here it is more likely that the RES support level increase is an attempt to overcome non-observable barriers, including supply chain infrastructure and to create a signalling effect to help support innovative deployment. The Portuguese support also illustrates that the relationship between subsidy support levels and installed capacity is unclear at best. Germany's increases in RES support levels may be due to a combination of the factors influencing both Portugal and Denmark.

Fourth, Belgium was the only country of the four to reduce RES support levels from 2012 to 2013. Belgium also has the highest percentage increase in additional generation, so it is likely that the reduction in RES support levels accounts for reductions in non-observable costs for offshore wind deployment in the country.

4.13.4 Recent changes to European state aid regulations

4.13.4.1 Guidelines on State aid for environmental protection and energy 2014–2020

In 2014, the European Commission introduced the new ***Guidelines on State aid for environmental protection and energy 2014–2020***.[533] These guidelines are applicable from 1 July 2014 until 2020. Member States have until 1 January 2016 to transpose these guidelines into national regulations.

Of particular interest to this report are the following requirements[534]:

- Phasing out of FiTs (possibly in favour of feed-in premiums); and
- A gradual introduction of calls for tender for new generation capacity.

[530] CEER Status Review of Renewable and Energy Efficiency Support Schemes in Europe, February 2013. Available here.

[531] Note that a new tendering system is now in effect in Denmark for offshore wind which supersedes the old FiT system.

[532] Portugal has one single 2MW floating wind turbine offshore

[533] Available here.

[534] Adapted from European Environment Agency, *Energy support measures and their impact on innovation in the renewable energy sector in Europe*, EEA Technical report No 21/2014.

For other SET sectors, the new guidelines give the following allowances:

- **Bioenergy** - both operating and investment aid are permitted to support fossil fuels and biomass plants (including biomass co-fired power plants);
- **Biofuels** - the European Commission recognises the current overcapacity in the food-based biofuel market and therefore no longer sees investment aid from government institutions in new and existing capacity to be justified. Allowable state aids for biofuels are shown in Box 4.1 below. These show there is an opportunity for Member States to provide support to new innovative production plants or bio-refineries which can lead to novel biofuels.
- **CCS** - both operating and investment aid are permitted to support industrial installations equipped with CO_2 capture, transport and storage facilities or individual elements for the CCS chain. However, aid to support CCS projects does not include aid for the installation emitting the CO_2 – rather it refers to aid for the costs resulting from CCS projects.
- **Smart grids** – whilst acknowledging that tariffs are the most appropriate means to fund energy infrastructure, it recognises that such financing may not be sufficient. Thus, state aids may be granted to partially or wholly finance such projects in order to overcome market failures that often characterise energy infrastructure investments;

Box 4.1 State aid Guidelines on biofuel production[535]

Investment aid should only be allowed in cases of conversion of plants into advanced biofuel plants. In contrast, operational aid until 2020 should only be granted to plants in operation before 31 December 2013; and operational aid to food-based biofuels can no longer be granted after 2020.

Biofuels that fall under a blending obligation and receive state aid as well will not result in an increased level of environmental protection and therefore should not receive any state aid. Member **States are only allowed to grant state aid in case they can demonstrate the aid is meant for sustainable biofuels that are too expensive to come on the market without financial support.**

New and existing aid schemes for food-based biofuel should be limited to 2020.

Despite these limitations for financial support for biofuels, Member States will still be allowed to provide non-financial incentivises for food-based biofuel consumption after 2020. For examples, by the continuation of the current blending obligations.

As the CEER Status Review 2015 confirmed, a majority of the Member States surveyed had FiTs for RES generation in 2013. It is anticipated that for those countries that have not changed their FiTs between 2013 and 2015, changes will be announced up to January 2016. However, demonstration projects are exempt from the transition from FiTs to feed-in premiums and are also exempt from standard balancing responsibilities. These exemptions could be used by Member States to create demonstration-specific support schemes for SETs of particular interest.

The increasing use of calls for tender for RES projects (e.g. the UK's Contracts for Difference regime which will replace the Renewables Obligation) is likely to be of particular importance to the developers and investors of the first-of-a-kind demonstration projects covered in this study. This is because it is more likely to impact the larger scale of projects, particularly next-of-a-kind and commercialised versions of the first-of-a-kind demonstration technology. The new state aid guidelines include provisions for technology-specific tenders on the basis of the potential of a new or innovative renewable energy technology.

4.13.4.2 Other related Frameworks on State aid for Research and Development and Innovation

In June 2014, the European Commission adopted new rules to facilitate the granting of aid measures by Member States in support of Research and Development and Innovation

[535] *EC, Guidelines on State aid for environmental protection and energy 2014–2020, 2014.* Available here.

(RD&I) activities. More specifically, the new ***Framework for State aid for R&D&I***[536] sets outs the conditions under which Member States can provide aid to companies in this field, including identifying the rationale for intervention. For example, it recognises that:

"State aid may be necessary to increase R&D&I in the Union in a situation where the market, on its own, fails to deliver an efficient outcome." [paragraph 48]

In this regard, the Framework sets out the market failures which might warrant allowable state aid including overcoming: positive externalities/knowledge spillovers; imperfect and asymmetric information; and coordination and network failures. A key condition for the acceptability of state aid is that it should have an incentivising effect on the behaviour of the undertaking. Some of the most important elements of any proposed case for Member State aid in the context of this current study of first-of-a-kind commercial-scale SET demonstration (as set out in paragraph 68) and include the:

1. **Specification of intended change** – i.e. the incentivising and catalytic effect of the aid in triggering a project or the speed or scale of investment;

2. **Level of profitability** – a project which is not, in itself, profitable might carry generate important benefits to society, such as CO_2 emissions reductions from a CCS project;

3. **Investment amount and timeframe of cash flows** – particular examples that would attract more support would include low levels of cash flows or a significant proportion of cash flows arising either sometime in the far future or in a very uncertain manner; and,

4. **Levels of risk involved** – there may be high probability of commercial failure or that the project will be less productive than expected which could undermine other activities of the aid beneficiary or the project costs might undermine its financial viability.

To "ensure predictability and a level playing field", maximum aid intensities are applied by the European Commission for R&D&I aid on the basis of three criteria (paragraph 74):

(i) Closeness of aid to the market;

(ii) Size of beneficiary – smaller undertakings are recognised as having more acute difficulties to finance a risky project; and,

(iii) Acuteness of the market failure.

In general, the intensity of aid is suggested to be lower when activities are linked to development and innovation than for research activities.

Alongside the Framework for State aid for R&D&I, the new ***General Block Exemption Regulation*** (GBER)[537] sets outs the conditions under which RD&I aid is exempt from the adoption of prior information notification to the Commission (i.e. it is "block-exempted"). The new rules offer more flexibility to grant aid and quicker deployment of aid.

Based on the new GBER, the thresholds up to which aid can be exempted from prior notification to the Commission for approval have increased significantly, with allowable aid for experimental development (defined in the Box below) now at €15 million (formerly €7.5m)[538].

Experimental development: *"means acquiring, combining, shaping and using existing scientific, technological, business and other relevant knowledge and skills with the aim of developing new or improved products, processes or services. This may also include, for example, activities aiming at the conceptual definition, planning and documentation of new products, processes or services; Experimental development may comprise prototyping, demonstrating, piloting, testing and validation of new or improved products, processes or*

[536] Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0627(01)&from=EN

[537] Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0651&from=EN

[538] See European Commission Memo on new rules facilitating support for RD&I. Available here.

services in environments representative of real life operating conditions where the primary objective is to make further technical improvements on products, processes or services that are not substantially set. This may include the development of a commercially usable prototype or pilot which is necessarily the final commercial product and which is too expensive to produce for it to be used only for demonstration and validation purposes. Experimental development does not include routine or periodic changes made to existing products, production lines, manufacturing processes, services and other operations in progress, even if those changes may represent improvements."

Source: Framework for State aid for R&D&I (2014); Definitions paragraph 1.3

Importantly, the scope of aid measures for RD&I projects exempted from the obligation of prior notification to the Commission has been widened. Under the new rules, this covers not only innovation and aid for process and organisational innovation but also pilot projects and prototypes under the research infrastructure measure.

4.14 Overall conclusions

Market conditions for first-of-a-kind commercial-scale SET demonstration projects vary significantly from country-to-country and across SET sectors. This creates a complex landscape, making it often challenging to analyse and draw meaningful conclusions across countries about their role in supporting such demonstration projects – especially since the policy environment for SET project support is constantly evolving.

In order to account for the full scope of direct and indirect policy support, in addition to non-observable factors (such as attitudes towards specific technologies), proxy measures such as the location of test centres, existing installed capacity of renewables, and year-on-year changes in capacity) have been used to identify key countries which offer some of the most favourable framework conditions. Countries which have been identified as being of interest to first-of-a-kind, commercial-scale SET demonstration projects either have consistent policy support (for SET sectors with relatively low levels of overall technology maturity) or a combination of consistent policy support with high levels of SET deployment (for innovations in SET sectors with a mixture of technology maturities, e.g., biomass conversion technologies).

When evaluating on the impact of policy support on market conditions across the different SET sectors, it is not enough to consider direct RES support measures. For instance, some countries have significant levies or taxation on fossil fuels (e.g. Denmark, UK, and Germany) which indirectly support RES generation by improving the relative investment case for such technologies relative to their fossil-fuel counterparts.

A plethora of planning, permitting and social acceptance issues also have the potential to act as important barriers to development of key SET projects: many are generic to energy developments; some are site- or technology-specific and require project sponsors to expend significant time and resource to compile the right dossier of permits and regulatory acceptance to progress. Efforts to create one-stop-shops for facilitating planning and permitting have been identified in some sectors such as ocean energy.

For well-developed SET sectors, such as solar PV and wind energy, there may be linkages between R&D efforts and commercial-scale direct policy support mechanisms, which in turn indicate clear cases of full-scale demonstration potential, since demonstration-stage projects are located between R&D activities and full commercialisation.

For other SET sectors and for countries which favour either R&D efforts or commercial activities only, gaining a clear understanding for the potential of support for first-of-a-kind, commercial-scale SET demonstration projects is less straightforward. Very few countries are likely to have established track records, and development may be contingent on political interest, which is subject to abrupt change if government strategies change.

4.15 Identification of installed capacity in each SET

The International Renewable Energy Agency (IRENA) database contains data on the installed capacity of seven of the nine SET sectors: biomass conversion technologies, CSP, geothermal energy, large scale energy storage solutions, ocean energy, solar photovoltaics, and wind energy. Installed capacity data for the years 2011-2014 for the 28 EU Member States plus Iceland, Norway, Switzerland and Ukraine were collected. From these data, overall rates of growth in capacity for the years 2011-2014 were calculated. These form a significant part of the quantitative analysis for this deliverable, since these values – along with those for total installed capacity and growth in 2014 – determine in large part the countries of particular interest for further analysis.

The IRENA database was used for most sectors. The benefit to use the database are its consistency and comprehensiveness: IRENA covers all 32 countries and most of the sectors, the data is recent as well as historical, and allows us to calculate similar growth rates for all sectors. The disadvantage of the IRENA database is that better or more relevant data sources might be available specific to the EU or sector. In the end, in four out of the nine sectors other data sources than the IRENA data source was used for the identification of installed capacity.

Owing to the absence of data on the installed CCS capacity in the IRENA database, data on capture capacity (in Mtpa) were instead sourced from the Global CCS Institute. Owing to the absence of data on the installed capacity of advanced electricity networks and the difficulty with defining this in terms of megawatts, the development and deployment budget for each country was used as an alternative measure. Data was sourced from the European Commission Joint Research Centre, where data regarding the research and development budget and demonstration & deployment budget for advanced electricity networks for the years 2011-2014 were gathered. For wind energy the European Wind Energy Association (EWEA) annual European Statistics reports were used as it provides a comprehensive and consistent data for all 32 countries for the relevant time period with more accurate data sources than the IRENA database for European wind energy. For geothermal energy, a combination of the IRENA and Bertani (2015) WGC report was used to obtain the most accurate and up-to-date figures in geothermal energy.

For each SET, installed capacity at the end of 2014 was compared with the respective country's National Renewable Energy Action Plan (NREAP) target for the year 2020 in order to measure progress against meeting the target. Data for the NREAP were sourced from the European Commission website, where each European country has outlined their estimation of total contribution expected from each renewable source type every year until 2020. This information was not available for CCS and advanced electricity networks.

4.16 References

Sources are listed below in reverse chronological order by sector:

Advanced electricity networks

- Iberdrola (press release 2 June 2015) Iberdrola installs over five million Smart Meters in Spain. Available here.
- Smart Grid Projects Outlook 2014, JRC Science and Policy Reports, (2014), pp. 82-83 Available here.
- Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation"), 18 February 2014, Council of European Energy Regulators. Available here.
- Council of European Energy Regulators, CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation"), Ref: C13-EQS-57-04, February 2014;
- Catalin Felix Covrig, Mircea Ardelean, Julija Vasiljevska, Anna Mengolini, Gianluca Fulli, Eleftherios Amoiralis, Manuel Sanchez Jimenez, Constantina Filiou, Smart Grid Projects Outlook 2014, JRC Science and Policy Reports, Institute for Energy and Transport, 2014;
- JRC (2014) Smart Grid Projects Outlook 2014, Available here, pp.42, 61.

- Real Decreto 216/2014, Available here.
- CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation"), Council for European Energy Regulators, (2014), Available here.
- VDE Association of electrical, electronic and information technologies, The German Roadmap E-Energy/Smart Grids 2.0: Smart Grid Standardization status, trends and prospects, DKE German Commission for Electrical, Electronic and Information Technologies, March 2013;
- The German Roadmap E-Energy / Smart Grids 2.0, Smart Grid Standardisation Status, Trends and Prospects, VDE, DKE, (2013), p12
- SilverSprings Networks, How the Smart Grid Enables Utilities to Integrate Electric Vehicles, 2013. Available here.
- Petrov, K., 2012. Smart Grids and Regulatory Challenges. KEMA Consulting GmbH, Bonn [Presentation]
- Orden IET/290/2012, Available here.
- Technology Roadmap Smart Grids, OECD/IEA, (2011). Available here.
- The budgets for Demonstration and Deployment projects are used as a measure of Advanced Electricity Networks capacity
- The renewables-Grid-Initiative Constructing the Future Electricity Grid of the EU: 8 Key Issues to Be Included in the Infrastructure Package. Available here.
- Larisa Dobriansky, Mini-grid Opportunities: Policy and Regulatory Issues. Available here.
- International Smart Grid Action Network (ISGAN): Case 10. Spain. Available here.
- JRC, European smart grid projects: budget. Available here.

Biomass conversion technologies

- EurObservER Biofuels Barometer, 2015. Available here.
- Didier Bourguignon, EU biofuels policy: Dealing with indirect land use change, EPRS (European Parliamentary Research Service), Members' Research Service Briefing, January 2015;
- EDIE, CfD auction: What it really means for renewables, February 2015. Available here.
- Department for Transport, Advanced Biofuels Demonstration Competition: grant award, statement to parliament, 7 September 2015. Available here.
- European Biofuels Technology Platform: Advanced biofuels demonstrations and R&D Projects in Italy, July 2015, Available here.
- Task 37 Biogas Country Report Overview (Country Reports), IEA Bio-energy, (2015), p29, Available here.
- Portugal Biofuels Standing Report, USDA FAS, (2015), Available here
- Portugal Biofuels Standing Report, USDA FAS, (2015), p3. Available here
- Task 37 Biogas Country Report Overview (Country Reports), IEA Bio-energy, (2015), p18, Available here
- Bioenergy, IEA. Available here. [Accessed 02 Dec 2015.]
- European Biofuels Technology Platform, Biofuel Production. Available here. [accessed 3rd Dec 2015.]
- NER 300-2, European Commission. Available here, accessed 4th Dec 2015.
- IEA Bioenergy Task 40 – Country report 2013 for Norway, Norwegian University of Life Sciences 2015. Available here
- EU Biofuels policy: Dealing with indirect land use change, (2015), EPRS, p8, Available here

- Bernhard Drosg, Gunther Bochmann, Cicero Jayme Bley, Teodorita Al Seadi, David Baxter, Jukka Rintala, Olivier Theobald, Guillaume Bastide, Bernd Linke, Jerry Murphy, Mathieu Dumont, Roald Sorheim, Tobias Persson, Nathalie Bachmann, Ho Kang, Clare Lukehurst, Charles Banks (IEA Bioenergy Task 37 workgroup), Biogas Country Overview (Country Reports), January 2014;
- Monica Dobrescu, Romania revises down the biofuels mandates, USDA Foreign Agricultural Service, January 2014;
- Zwölftes Gesetz zur Änderung des Bundes-Immissionsschutzgesetzes, November 2014. Available here.
- Department for Transport (statement 10 December 2014) Advanced biofuel demonstration competition, Available here.
- GU Serie Generale n.250 del 27-10-2014, October 2014. Available here.
- Romania revises down the biofuels mandates, USDA, (2014), p1, Available here.
- Loi du 29 avril 2014 (Loi du 29 avril 2014 concernant le budget des recettes et des dépenses de l'Etat pour l'exercice 2014 - Law of 29 April 2014 regarding the budget of the State´s receipts and expenses for the tax year 2014)
- FEK B 937/2014 (Call for Participation to the Distribution of 133,000 kiloliters of biodiesel in accordance with Art.15A Par.7 Law No.3054/2002 for 2014)
- Incentive Measures Rulebook (Pravilnik o uvjetima i postupku za ostvarivanje poticaja za proizvodnju biogoriva za prijevoz – Rulebook on the Conditions and Procedure for Incentives for the Production of Biofuels for Transport)Subsidy Decision 2014 (Odluka o visini udjela iz prihoda od trošarina koji se izdvaja za proizvodnju biogoriva u 2014. godini - Decision on the Amount of Excise Tax Revenues that are set aside for the Biofuel Production in the Year 2014)
- Incentive Fee Decision 2014 (Odluka o jediničnom iznosu novčanog poticaja za proizvodnju biogoriva u 2014. godini - Decision on the Amount of the Incentive Fee for the promotion of Biofuel Production in the year 2014)
- Report on the present state of biofuels in Malta and measures for their promotion (and update), (2014), Malta Resource Authority, Available here
- Strategy 2014: Priority focus areas and implementation measures for the strategy Part 1, (2014) Energi21, p21. Available here
- Dutch Ministry of Economic Affairs, Agriculture and Innovation, Sustainable biomass and bioenergy in the Netherlands: Report 2013, December 2013;
- IRENA & DNV KEMA, 2013. Study on environmental impact from large-scale deployment of renewable energy technologies. [Presentation]. Available here.
- Beta Renewables World's First Refinery Turning Farm Waste to Bioethanol Opens, press 14 October 2013. Available here
- Feed-in Tariff specifications, features, amendments, and current and future challenges in Cyprus, IRENA Workshop, (2013), p9, Available here
- Options to increase EU biofuels volumes beyond the current blending limits, TNO Delft, (2013), Available here
- Sustainable Biomass and Bio-energy in the Netherlands: Report 2013, (2013) Copernicus Institute, Utrecht University, p12. Available here
- Bio-energy in the Netherlands, IEA (Guest Editorial), (2013), Available here
- Promotion Of Residual Forestry Biomass In The Mediterranean Basin, Proforbiomed, (2012), p117. Available here
- Ecologic Institute, 2012. The Social Dimension of EU Biofuel Policy. -. Available here. [Accessed 11 December 2015]

- Mapping Renewable Energy Pathways towards 2020, European Renewable Energy Council (2011). Available here.
  Croatia Ref. Ares(2014)443294 - 21/02/2014 Available here p110; Norway Ref. Ares(2013)117932 - 30/01/2013 Available here p135; Iceland Ref. Ares(2014)806315 - 19/03/2014 p58 Available here, N.B. Czech Republic has a target of 364MW solid biomass and 4,156MW in bioliquids in its revised 'National Renewable Energy Action Plan of the Czech Republic' of August 2012, p82, Available here.
- Country policy assessment report on Bioenergy – Germany, (2012), Bioenergy Promotion, p19, Available here.
- Council of European Energy Regulators, Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, January 2015. Available here.
- Biomass in Croatia, (2012), cluster Inteligentna Energija, pp. 8, 12. Available here.
- Renewable Energy in Hungary, (2012), Hungarian Investment and Trade Agency, p8, Available here.
- EU Handbook Biogas markets, (2012), Cross Border Bioenergy, p91. Available here.
- The potential for the production and use of biomass-based energy sources in Hungary, (2012), Garay et al, p8, Available here.
- IRENA policy database, Ireland, (2012), Available here.
- IRENA policy database, Spain, bio-energy, (2011), Available here.
- Forest biomass resources for industrial energy conversion in Portugal, (2011), Monteiro et al. Available here.
- Outlook on Market Segments for Biomass Uptake by 2020 in Greece, Intelligent Energy Europe, (2011), p22. Available here.
- Task 1: Policy Paper On Renewable Energy And Energy Efficiency Of Residential Housing, Slovenia, (2011), Institute For Economic Research, Ljubljana pp. 12, 16, Available here.
- EREC (2011) Mapping Renewable Energy Pathways towards 2020: EU Roadmap, p10, Available here.
- Regulation No. 133/2010 Coll. on the Quality and the Registering of Fuels. Available here.
- Bioenergy in Belgium, IEA, (2010), Available here.
- Evaluation of Cyprus' Electricity Generation Planning Using Mean-Variance Portfolio Theory, Cyprus Economic Policy Review, (2010), p25, Available here.
- A report on bio-fuels in Malta in the light of 2020 targets, (2010), Malta Intelligent Energy Management Agency, p13, Available here.
- Ecofys and Golder Associates, Benchmark of bioenergy permitting procedures in the European Union, DG TREN, 2009
- National Biomass Action Plan for Germany: Biomass and Sustainable Energy Supply, Federal Ministry of Food, Agriculture and Consumer Protection (2009), pp. 12.Available here.
- Directive 2009/30/EC of the European Parliament and of the council. Available here.
- Act No. 353/2003 on Consumption Taxes. Available here.
- IRENA dashboard. Available here.
- "Consistent growth" means that the pace of growth did not slow down year on year, as is the case in Poland which actually grew more than Lithuania over the period: 182% from 277MW to 782MW. (Poland is nonetheless a country of interest as there is growth, the policy outlook is good and the NREAP target has still to be met, see overleaf.)
- UK government response to the campaign against green investment bank funding for big biomass. Available here.

- IRENA policy database, Sweden, Biomass, Available here.
- IRENA policy database, Italy, Biomass. Available here.
- IRENA policy database, France, Bio-energy, Available here.
- Ministère de l'Écologie, du Développement Durable et de L'Énergie: La transition énergétique pour la croissance verte. Available here.
- IRENA policy database, Czech Republic, Bio-energy, Available here.
- IRENA policy database, Latvia, Bio-energy, Available here.
- IRENA policy database, Lithuania, Bio-energy, Available here.
- IRENA policy database, Ukraine, Bio-energy, Available here.
- IRENA policy database, Bulgaria, Bio-energy, Available here.
- IRENA policy database, Slovakia, Bio-energy, Available here.
- IRENA policy database, Poland, Bio-energy. Available here.
- IRENA policy database, Denmark, Bio-energy. Available here.
- Legal sources in renewable energy, Spain biofuel quota. Available here.
- CrossBorderBioEnergy.eu, Hungary. Available here.
- CrossBorderBioEnergy.eu, Ireland. Available here.
- EBRD, Estonia. Available here.
- Renewable energy directive, European Parliament. Available here.
- Land use change, European Commission. Available here.
- Renewable energy directive, European Parliament. Available here.
- Feedstocks projects, European Commission. Available here.
- Sustainable projects, European Commission, Available here.
- Sustainable Transport overview, INTERREG IVC. Available here.
- Integrated promotion of biodiesel chain, INTERREG IVC. Available here.

Carbon Capture and Storage

- Julio Carneiro, Antonio Olimpio Goncalves, Rodrigo Iglesias, Carlos Moniz, Elisa Pereira, Anisio Pinto Manuel, Carbon Capture and Storage in the Community of Portuguese Language Countries: Opportunities and Challenges, part of the project CCS-PT: Perspectives for capture and sequestration of CO2 in Portugal, funded by the Global CCS Institute, May 2015;
- Carmine Marzano, Peter Petrov, Søren Bøwadt, Proceedings of the scoping workshop Transforming CO2 into value for a rejuvenated European economy Brussels, Directorate-General for Research and Innovation Key Enabling Technologies, March 2015
- Dept of Energy & Climate Change (25 November 2015) “HM Government Statement to Markets Regarding Carbon Capture and Storage Competition”, Available here.
- Power Capture (press release 25 November 2015) Government withdraws CCS Commercialisation Programme, Available here.
- HM Treasury (updated 27 November 2015) Spending review and autumn statement 2015, Available here.
- BBC (24 November 2015) Spending Review: Department-by-department cuts guide. Available here.
- Carbon Pulse (July 22, 2015) France passes sweeping energy bill, to raise CO2 tax to €100/t by 2030, Available here.

- BusinessGreen (26 Oct 2015) “Climeworks says world's 'first' commercial-scale atmospheric carbon capture plant on track for 2016 launch”, Available here; SGS: Overview carbon capture and storage, Available here.
- Virdis, M.R. et al. (2015). Pathways to deep decarbonization in Italy, SDSN – IDDRI. Available here.
- JRC (2015) Capacity Mapping: R&D investment in SET-Plan technologies. Available here.
- Global CCS Institute (May 2015) Carbon Capture and Storage in the Community of Portuguese Language Countries, Opportunities and Challenges, p5. Available here.
- Power Capture (press release 25 November 2015) Government withdraws CCS Commercialisation Programme. Available here.
- Energie actueel (article 26 November 2015) Finally progress in offshore CO2 storage project (original: “Eindelijk schot in project voor CO2-opslag onder zeebodem), Available here (Dutch)
- Carbon Capture Journal (18 November 2015) Special report from the 8th Dutch CCS: Symposium. Available here.
- European Commission (2015) Proceedings of the scoping workshop Transforming CO2 into value for a rejuvenated European economy, p13. Available here.
- Technopolis Group, Hinicio, LBST, FEEM, Evaluation of the impact of projects funded under the 6th and 7th EU Framework Programme for RD&D in the area of non-nuclear energy, FP6/7 Energy projects, Mid-term Evaluation, June 2014.
- Duetschkea, E., Schumannb D., Pietznerc, K., Wohlfartha, K., Höllerc, S., 2014. Does it make a difference to the public where CO2 comes from and where it is stored? Energy Procedia 63 (2014) 6999 – 7010[PDF]
- BMBF presentation (21 October 2014) “The German R&D Program for CO2 Utilization – innovations for a green economy”. Available here.
- ENEA and SOTACARBO (presentation conference 20-22 May 2014) 9th CO2GeoNet Open Forum: Building a full CCS value chain towards an Italian demonstration project in the Sulcis area. Available here.
- Greenpeace (27 October 2014) Denmark’s commitment to 100% renewable energy. Available here.
- The Local SE (7 May 2014) Vattenfall abandons research on CO2 storage. Available here.
- Vattenfall (press release 24 June 2014) Vattenfall divests Danish power plant. Available here.
- Scottish Carbon Capture and Storage (2015) Recommendations and Conference 2014 report, Available here.
- Capture Power (press release 1 August 2014) White Rose CCS Project secures award decision on European NER300 funding. Available here.
- 2CO 7 July 2014 Press release, Available here, followed by The Star 26 June 2015 ‘Doncaster carbon capture power plan still on track, says new boss. Available here.
- N.B. the figure includes research money for Clean Coal Technology (CCT). Technopolis Group, Hinicio, LBST, FEEM (19 June 2014) Evaluation of the impact of projects funded under the 6th and 7th EU Framework Programme for RD&D in the area of non-nuclear energy, pp vi, 17. Available here.
- European Commission Decision C (2015)2453 of 17 April 2015, Revised Horizon 2020 Work Programme 2014 – 2015: 10. Secure, clean and efficient energy, p93. Available here.
- IP/14/673, European Commission (press release 13 June 2014) State aid: Commission adopts new rules to support important projects of common European interest. Available here.
- Shogenova, A., Piessens, K., Holloway, S., Bentham, M., Martínez, R., Flornes, K.M., Poulsen, N.E., Wójcicki, A., Sliaupa, S., Kucharič, L. and Dudu, A. Implementation of the EU

CCS Directive in Europe: Results and Development in 2013, Energy Procedia, 63, pp.6662-6670, December 2014.

- Shogenova et al (2014) Implementation of the EU CCS Directive in Europe: results and development in 2013, Energy Procedia, 63: 6662 – 6670
- Tom Jonker, "The permitting process – Special report on getting a CCS project permitted, January 2013.
- Bundesamt für Energie BFE (presentation 31 May 2013) Roadmap for a Carbon Dioxide Capture and Storage pilot project in Switzerland. Available here.
- Shogenova et al. (2014) Implementation of the EU CCS Directive in Europe: Results and Development in 2013. Available here.
- DECC (20 March 2013) Preferred bidders announced in UK's £1bn CCS Competition. Available here.
- Viebahn, Vallentin, Höller, Fischedick (2012). Integrated assessment of CCS in the German power plant sector with special emphasis on the competition with renewable energy technologies. Mitigation and Adaptation Strategies for Global Change, 17(6), 707-730. Available here.
- EC Climate Action (press release 18 December 2012) "23 innovative renewable energy demonstration projects receive €1.2 billion EU funding". Available here.
- Other countries of interest are selected as the top five countries (in addition to the three countries already mentioned above) with the highest Public and Corporate R&D spending on CCS in 2011, based on JRC (2015) Capacity Mapping: R&D investment in SET-Plan technologies. Available here.
- Since 2009 four major CCS demonstration projects under the European Energy Programme for Recovery (EEPR) have been terminated due to a lack of financial support or agreement of CCS in national frameworks. These include: Belchatow (Poland), Porto Tolle (Italy), Janschwalde (Germany), Compostilla (Spain).
- Triple E, Ricardo-AEA and TNO, Support to the review of Directive 2009/31/EC on the geological storage of carbon dioxide (CCS Directive), European Commission Directorate-General for Climate Action, December 2014.
- Report from the Commission to the European Parliament and the Council on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide. EC COM(2014)99 final, Report from the Commission to the European Parliament and the Council on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide, p3. Available here.
- Support to the review of Directive 2009/31/EC on the geological storage of carbon dioxide (CCS Directive)", report from Triple E, Ricardo-AEA and TNO to the European Commission, December 2014. Available here.
- IEA Greenhouse Gas R&D Programme, "Permitting issues for co2 capture and geological storage", 2006.
- Global CCS Institute, Large Scale CCS Projects. Available here.
- With a further three regions, Finland, Luxembourg and Brussels Capital Region of Belgium notified that they will not allow CO_2 storage due to the lack of geological suitability.
- Shell, Peterhead CCS Project announcement. Available here.
- Global CCS Institute: Norwegian CCS legislation. Available here.
- Carbon Sequestration Leadership Forum: Italy. Available here.
- EC Climate Action: Carbon Capture and Geological Storage. Available here.
- EC Climate Action: NER 300 programme. Available here.

– National Grid: Don Valley. Available here.
– ROAD CCS: State Aid. Available here.
– EC Horizon 2020: Leadership in Enabling and Industrial Technologies. Available here.
– COM(2015) 6317 Communication from the Commission - Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation, p8. Available here.
– European Commission: The European Fund for Strategic Investments (EFSI). Available here.
– European Investment Bank: InnovFin Energy Demo Projects, flyer Available here. CCS out of scope at this stage.
– EC European Structural And Investment Funds, Data: Low-Carbon Economy, Theme 4. Available here.
– EC Energy: Funding. Available here.
– EC Energy: Projects of common interest - Overview of projects by country.Available here.
– The European Renewable Energy Centres (EUREC): Commission adopts new SET Plan communication. Available here.

Concentrated Solar Power

– EurObserv'ER, Solar Thermal and Concentrated Solar Power Barometer, May 2015;
– OECD/IEA, Technology Roadmap: Solar Thermal Electricity, 2014.
– International Energy Agency, Technology Roadmap, 2014.
– Study on the Competitiveness of the EU Renewable Energy Industry, (2014), ICF International, p12. Available here.
– Technology Roadmap, Solar Thermal Electricity (2014), International Energy Agency. Available here.
– European Commission, (July 2014), State aid: Commission approves German renewable energy law EEG 2014. Available here.
– Thematic Research Summary, Concentrating Solar Power, European Commission (2014), p51. Available here.
– Legal sources on renewable energy, Promotion in Portugal, Res-Legal, 2014. Available here.
– Legal sources on renewable energy, Promotion in France, Res-Legal, 2014. Available here.
– Energy Research Knowledge Centre, Thematic Research Summary: Concentrating Solar Power; Strategic Energy Technology Plan (SETIS), European Commission, November 2013.
– IRENA & DNV KEMA, 2013. Study on environmental impact from large-scale deployment of renewable energy technologies. [Presentation]. Available here.
– Mapping Renewable Energy Pathways towards 2020, European Renewable Energy Council (2011). Available here.
– IRENA dashboard. Available here.
– Concentrating Solar Thermal Power (CSP), CLEANLEAP. Available here.
– Thematic Research Summary, Concentrating Solar Power, European Commission, p42
– Greece country information, SolarPACES. Available here.

Geothermal energy

– Ruggero Bertani, Geothermal Power Generation in the World 2010-2014 Update Report, Proceedings World Geothermal Congress 2015, April 2015. Available here.

- Nikolaos Andritsos, Paschalis Dalambakis, Apostolos Arvanitis, Maria Papachristou, Michael Fytikas, Geothermal Developments in Greece – Country update 2010-2014, Proceedings World Geothermal Congress 2015, April 2015.
- Aniko N. Toth, Hungarian Country Update 2010-2014, Proceedings World Geothermal Congress 2015, April 2015.
- Arrizabalaga Inigo, De Gregorio Margarita, Garcia de la Noceda Celestino, Hidalgo Raul, Urchueguia Javier F., Country Update for the Spanish Geothermal Sector, Proceedings World Geothermal Congress 2015, April 2015.
- Romain Vernier, Philippe Laplaige, Alain Desplan, Christian Boissavy, France Country Update, Proceedings World Geothermal Congress 2015, April 2015.
- Bergur Sigfusson, Andreas Uihlein, 2014 JRC Geothermal Energy Status Report: Technology, market and economic aspects of geothermal energy in Europe, JRC Science and Policy Reports, 2015.
- Ministre de l'Écologie, du Développement durable et de l'Énergie (30 March 2015) Ségolène Royal annonce la création de GEODEEP, un fonds de garantie pour accompagner le développement de la géothermie. Available here.
- France Country Update: Proceedings, World Geothermal Congress 2015, (2015), p2. Available here.
- Greece Country Update: Proceedings, World Geothermal Congress 2015, p7. Available here.
- Spain Country Update: Proceedings, World Geothermal Congress 2015, p1. Available here.
- Hungary Country Update: Proceedings, World Geothermal Congress 2015, pp. 2, 4-5. Available here.
- Press release, 2015, Statistics Netherlands. Available here.
- Installed capacity as at end 2015 is drawn from Bertani (2015), whereas NREAP targets and installed capacity in 2012, 2013, and 2014 is drawn from IRENA. Available here.
- Christian Boissavy, Virginie Schmidle – Bloch, Manual for implementing sustainable support schemes for GEODH, GeoDH, October 2014.
- European Geothermal Energy Council, Bureau de Recherches Geologiques et Minieres, Centre for Renewable Energy Sources and Saving, Consiglio Nazionale Delle Ricerche, Istituto Di Geoscienze e Georisorse, Asociacion De Productores De EnergiasRenovables, Gassner, Groth, Siederer & Coll, EnBW Energie Baden Wurttemberg, Helmhotz Zentrum Postdam – Deutsches Geoforschungszentrum, Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek, Towards more Geothermal Electricity Generation in Europe, 2014.
- Thorsten Agemar, Josef Weber and Rudiger Schulz, Deep Geothermal Energy Production in Germany, Energies:7, pp 4397-4416, July 2014.
- Agency for geothermal power engineering, Association Francaise des professionnels de la geothermie, Consorzio per lo Sviluppo delle Aree Geotermiche, European Geothermal Energy Council, Gemeente Heerlen, Gron Energi, Magyar Foldtani es Geofizikai Intezet, Instytut Gospodarki Surowcami Mineralnymi i Energia, Slovensko drustvo za daljinsko energetiko, Union of Bulgarian Black Sea Local Authorities, Developing geothermal district heating in Europe, GeoDH, 2014.
- Vukica Jankovic, Helena Mitwallyova, The potential of the usage of renewable energy in the Czech Republic, International Journal of Social Sciences, Vol. III(4), 2014.
- EEA Grants (10 April 2014) Iceland and Portugal Expand Geothermal Cooperation. Available here.
- Deep Geothermal Energy Production in Germany, Energies, (2014), p4407. Available here.
- German feed-in tariffs 2014, German energy blog, 10 May 2015. Available here.

- 2014 JRC Geothermal Energy Status Report, European Commission, (2015), p33
- Developing geothermal district heating in Europe (2014), p34. Available here.
- Climate action: Commission uses polluters' revenues to fund clean energy projects across Europe, European Commission Press Release 2014. Available here.
- Report on support schemes for geoDH (2014) p15-16. Available here.
- Looking to tap geothermal potential, The Slovak spectator, 2014. Available here.
- World Energy Resources: Geothermal, World Energy Council 2013, p11. Available here.
- European Geothermal Energy Council, Financing Geothermal Energy, EGEC Policy Paper, July 2013.
- World Energy Council, World Energy Resources: Geothermal, 2013.
- IRENA & DNV KEMA, 2013. Study on environmental impact from large-scale deployment of renewable energy technologies. [Presentation]. Available here.
- GEOELEC, "Report on geothermal regulations", September 2013. Available here.
- Financing Geothermal Energy, EGEC, (2013). Available here.
- Geothermal power plants planning and environmental regulation - November 2010. Available here.
- IEA geothermal, Members' Activities, France. Available here.
- The potential of the usage of renewable energy in the Czech Republic, International Journal of Social Sciences, p47. Available here.

Large-scale energy storage

- IRENA, Battery Storage for Renewables: Market Status and Technology Outlook, January 2015.
- Houses of Parliament, Parliamentary Office of Science & Technology, PostNote: Energy Storage, Number 492, April 2015.
- Ernst&Young, Renewable energy country attractiveness index, Issue 44, June 2015.
- Directorate-General for Internal Policies; Study for the ITRE Committee; "Energy Storage: Which Market Designs and Regulatory Incentives Are Needed?" 2015. Available here.
- France announces tenders for PV and battery storage systems, PV Magazine 2015. Available here.
- French renewables power grid pilot shows limits of batteries in Europe, Reuters, 2015. Available here.
- Study of energy storage installation potential: executive summary, Artelys, ENEA Consulting & G2Elab (2015), pp. 14, 18. Available here.
- EC new energy market design consultation (2015). Available here.
- Battery Storage for Renewables: Market Status and Technology Outlook (2015), Irena, pp 18, 38. Available here.
- Renewable Energy World (11 February 2015) Energy Storage Market Outlook 2015 , Available here, and; Younicos: Schwerin Battery Park. Available here.
- Bundesministerium der Justiz und für Verbraucherschutz (7 July 2015) Gesetz über die Elektrizitäts- und Gasversorgung (Energiewirtschaftsgesetz - EnWG). Available here.
- Draft Real Decreto 900/2015 (June 2015), Modalidades de Suministro de Energía Eléctrica con Autoconsumo y de Producción con Autoconsumo. Available here.
- Younicos (press release May 2015) Younicos and Leclanché partner on Graciosa project. Available here.

- Energy Storage, Houses of Parliament Parliamentary Office of Science and Technology, April 2015, p4. Available here.
- Renewable energy country attractiveness index, Issue 44, (2015), p23. Available here.
- High Level Group on Baltic interconnections, Baltic Energy Market Interconnection Plan: 6th Progress Report, September 2014.
- OECD/IEA, Energy Policies of IEA Countries: Executive Summary and Key Recommendations, Austria, 2014 Review.
- Navigant Consulting, Energy Storage for the Grid and Ancillary Services, 2014.
- The German Energy Storage RD&D Initiative, Federal Ministry for Economic Affairs and Energy, (2014). Available here.
- Bundesministerium für Wirtschaft und Energie, Trilaterale Studien zu Pumpspeicherkraftwerken in Deutschland, Österreich und der Schweiz, (August 2014). Available here.
- Executive Summary and Key Recommendations: Austria, OECD/IEA (2014), p11. Available here.
- Executive Summary and Key Recommendations: Luxembourg, OECD/IEA (2014), pp. 7,10. Available here.
- Baltic energy market interconnection plan, 6th progress report (2014) p32. Available here.
- Deliverable 5.1 – Greece. Overview of the electricity system status and its future development scenarios – Assessment of the energy storage infrastructure needs, store, February 2013.
- Arnaud Renaud, Laurent Fournie, Pierre Girardeau, Maxime Chammas, Guillaume Tarel, Alice Chiche, Pierre De Freminville, Olivier Lacroix, Loic Rakotojaona, Luc Payen, Delphine Riu, Anne-Fleur Kerouedan, Study of energy storage installation potential: Executive summary, Artelys, ENEA Consulting and G2Elab, October 2013.
- Pumped storage in Spain, Waterpower magazine 2013. Available here.
- Hydro in Europe: Powering Renewables Full Report, Eurelectric Renewables Action Plan (RESAP), 2011. Available here.
- Mapping Renewable Energy Pathways towards 2020, European Renewable Energy Council (2011). Available here.
- Spain's national renewable energy action plan 2011-2020, Ministry of Industry, Tourism and Commerce, (2010). Available here.
- IRENA dashboard. Available here.
- UK Power Networks, Smarter Network Storage - Design and planning considerations for large-scale distribution-connected energy storage (SNS1.2). Available here.
- Pumped Storage Hydroelectricity (Energy Engineering). Available here.
- The Future Role and Challenges of Energy Storage. Available here.
- Pers Comm. JRC, Peten
- National action plans, Available here, Bulgaria p212, Germany p114, Estonia p58, Greece p104, Croatia 16.3GWh p110, Norway p134, Portugal p119, Slovakia p73
- U.S. DOE Global Energy Storage Database. Available here.
  Note that the total capacity indicated by this site does not correspond with the values from the IRENA database.
- E.ON, Huntorf power plant. Available here.
- Current situation in Austria, Store-project. Available here.

- U.S. DOE Global Energy Storage Database: Energy Storage Exchange, Available here. Note that the total capacity indicated by this site does not correspond with the values from the IRENA database.
- Facilitating Energy Storage to allow high penetration of intermittent renewable energy – Greece (2013), D5.1, pp.16, 31, 32. Available here.

Ocean energy

- Davide Magagna, Andreas Uihlein, Ocean energy development in Europe: Current status and future perspectives, International Journal of Marine Energy (11), pp 84-104, June 2015;
- UK Marine Energy Programme Board, Wave and Tidal Energy in the UK: Capitalising on Capability, February 2015.
- Davide Magagna, Andreas Uihlein, 2014 JRC Ocean Energy Status Report: Technology, market and economic aspects of ocean energy in Europel, JRC Science and Policy Reports, Institute for Energy and Transport, 2015.
- WavEC – "Consenting processes for ocean energy on OES (Ocean Energy Systems) countries", Feb 2015. Available here.
- Ocean Energy Forum – "Strategic Roadmap: Collated "Three-Pagers", July 2015. Available here
- News article from South Wales Evening Post, 24 September 2015. Available here.
- DECC press release, Swansea Bay Tidal Lagoon project gets green light on planning, June 2015. Available here.
- 2014 JRC Ocean Energy Status Report, European Commission, (2015). Available here.
- Ocean Energy Development in Europe: Current Status and future perspectives, European Commission, DG JRC, Institute for Energy and Transport, (2015), pp. 91,93. Available here.
- COM (2014) 8 final, Impact Assessment Accompanying the document: The action needed to deliver on the potential of ocean energy by 2020 and beyond. Available here.
- SI OCEAN, "Wave and tidal energy market deployment strategy for Europe", June 2014
- Strategic Initiative for Ocean Energy, Wave and Tidal Energy Market Deployment Strategy for Europe, June 2014. Available here.
- Legal sources on renewable energy, Finland RD&D policies, Res-Legal 2014. Available here.
- Teodora Diana Corsatea, Davide Magagna, Overview of European innovation activities in marine energy technology, JRC Scientific and Policy Reports, Institute for Energy and Transport, 2013.
- IRENA & DNV KEMA, 2013. Study on environmental impact from large-scale deployment of renewable energy technologies. [Presentation]. Available here.
- Overview of European innovation activities in Marine Energy Technology, European Commission and Joint Research Centre, (2013), p18
- Mapping Renewable Energy Pathways towards 2020, European Renewable Energy Council (2011). Available here.
- IRENA dashboard. Available here.
- OES Country Report: Netherlands. Available here.
- OES Country Report: Norway. Available here.
- OES Country Report: Sweden. Available here.

Solar photovoltaics

- IRENA Data and Statistics database, “Global Trends in Renewable Energy Investment 2016”. Available here.
- EurObserv’ER, Photovoltaic Barometer, April 2015.
- Fraunhofer ISE, Recent Facts about Photovoltaics in Germany, 2015. Available here.
- Norton Rose Fulbright: Italy energy law update, (September 2014). Available here.
- Commission Staff Working Document “Best practices on Renewable Energy Self-consumption”. Available here.
- Italian Institute for International Political Studies: Has time for batteries in Italy arrived or not? (28 July 2015). Available here.
- Carbon Pulse: France passes sweeping energy bill, to raise CO2 tax to €100/t by 2030, (22 July 2015). Available here.
- Press release: Controlling the cost of renewable energy, DECC, (31 July 2015). Available here.
- PV Tech, Spanish government under fire after approving ‘sun tax’, (12 October 2015). Available here.
- Commission Staff Working Document (2015) “Best practices on Renewable Energy Self-consumption”. Available here, p.14.
- International Energy Agency Trends 2015 in photovoltaic Applications: Survey Report of Selected IEA Countries between 1992 and 2014. Available here.
- Arnulf Jager-Waldau, PV Status Report 2014, JRC Science and Policy Reports, Institute for Energy and Transport, 2014.
- Gaetaan Masson, Sinead Orlandi, Manoel Rekinger, Global Market Outlook for Photovoltaics 2014-2018, European Photovoltaic Industry Association, 2014.
- Mapping Renewable Energy Pathways towards 2020, European Renewable Energy Council (2011). Available here. Croatia Ref. Ares(2014)443294 - 21/02/2014 Available here p110; Norway Ref. Ares(2013)117932 - 30/01/2013 Available here p135; Iceland Ref. Ares(2014)806315 - 19/03/2014 p58 Available here.
- IEA Photovoltaic power systems programme, 2014 Snapshot of Global PV markets. Available here.
- PV Magazine, Portugal's net-metering law raises faint hopes, (8 December 2014), Available here.
- DG Climate Action (2014) Assessment of climate change policies in the context of the European Semester, Country Report: Latvia, p4. Available here.
- Solar Resources (June 2014) Global Market Outlook for Photovoltaics 2014-2018, p36. Available here.
- Lucy O. Smith, Lena Donat, Elke Karola Velten, Matthias Duwe, Assessment of climate change policies in the context of the European Semester Country Report: Latvia, Ecologic Institute and Eclareon, November 2013.
- Arnulf Jager-Waldau, PV Status Report 2013, JRC Science and Policy Reports, Institute for Energy and Transport, 2013.
- IRENA & DNV KEMA, 2013. Study on environmental impact from large-scale deployment of renewable energy technologies. [Presentation]. Available here.
- Expert Evaluation Network Delivering Policy Analysis on the Performance of Cohesion Policy 2007-2013: Cyprus, Tsipouri (2011), p3. Available here.

– Lena Tsipouri, Dariya Rublova, Expert Evaluation Network Delivery Policy Analysis on the Performance of Cohesion Policy 2007-2013, Task 1: Policy Paper on Renewable Energy and Energy Efficiency of Residential Housing, Cyprus, National and Kapodistrian University of Athens, 2011.
– PV Legal – Final Report – Reduction of bureaucratic barriers for successful PV deployment in Europe
– German Federal Network Agency, Figures, Dates and Information about the EEG. Available here.
– Commission Staff Working Document "Best practices on Renewable Energy Self-consumption". Available here, p.13.
– Ofgem guidance: Renewables Obligation: closure of the scheme to large-scale solar PV, Available here. [Renewables Obligation supports large-scale renewable plants as opposed to the FiT]
– IRENA Policy database, Netherlands, Solar, Available here.
– Interactive Eur'ObservER. Available here.
– Commission Staff Working Document "Best practices on Renewable Energy Self-consumption".Available here, p.13.
– Net Metering Policy and Electricity Market in Cyprus, University of Cyprus and Electricity Authority of Cyprus. Available here.
– Commission Staff Working Document "Best practices on Renewable Energy Self-consumption".Available here, p.13.
– IRENA Policy database, Luxembourg, Solar.Available here.
– Sustainable Energy Authority of Ireland (SEAI), Solar Grants. Available here.
– IRENA Policy database, Poland, Solar.Available here.
– Commission Staff Working Document "Best practices on Renewable Energy Self-consumption".Available here, p.14.

Wind energy

– EWEA response to public consultation Preparation of a new Renewable Energy Directive for the period after 2020 - February 2016
– EWEA, Wind in power: 2014 European statistics, February 2015;
– UK Offshore Wind Programme Board, Annual Report, March 2015;
– EurObserv'ER, Wind Energy Barometer, February 2015;
– EurObserv'ER Country policy profile, Czech Republic 2015. Available here.
– EurObserv'ER Country policy profile, Austria 2015. Available here.
– Jesse Broehl, Roberto Rodriquez Labastida, Bruce Hamilton, World Wind Energy Market Update 2015: Executive Summary, Navigant Research, Q1 2015;
– Javier Serrano Gonzalez, Roberto Lacal Arantegui, The regulatory framework for wind energy in EU Member States: Part 1 of the Study on the social and economic value of wind energy, JRC Scientific and Policy Reports, Institute of Energy and Transport, 2015;
– Wind in power 2014 European statistics, EWEA, 2015. Available here.
– UK Department of Energy and Climate Change, Changes to onshore wind subsidies protect investment and get the best deal for bill payers. 18 June 2015. Available here.
– UK Department of Energy and Climate Change, Information on the proposed RO grace period for new onshore wind, 18 October 2015. Available here.

- Sgurr Energy, The end of the onshore wind feed-in tariff in France?,Blog 9 March 2015. Available here.
- Eduskunta Riksdagen: Hallituksen esitysHE152015 vp, (3 September 2015).Available here.
- Malta National Reform Programme, Ministry for Finance 2015. Available here.
- Offshore wind energy in the Netherlands, Netherlands Enterprise Agency 2015. Available here.
- Rijksdienst voor Ondernemend Nederlands, Stimulering Duurzame Energieproductie (SDE), December 2015.Available here.
- Offshore wind policy and market assessment- A global outlook. Fowind 2015. Available here.
- Bulgaria ends wind incentives, Wind power monthly 2015. Available here.
- Renewable Energy Policy Framework: Estonia, Republic of Estonia Ministry of Economic Affairs and Communications (2015).Available here, p3
- (2015/C 044/01). Available here.
- Irish Wind Energy Association, Irish Wind Energy Investment Tops €350 Million in 2014, January 2015.Available here.
- Irish Wind Energy Association, Using Wind Energy to Meet Growing Energy Demand from Large Data Centres Will Lower Electricity Prices in Ireland, New study finds, April 2015. Available here.
- Lithuania has developed perfect conditions for wind energy expansion, Euromonitor international 2015. Available here.
- Dispateches: Times for RE to emerge from Latvia's policy deep freeze, Recharge 2015. Available here.
- Romania considers reviving support for renewable energy, Bloomberg 2015. Available here.
- Market status: Romania – Progress falters as prices fall, Wind power monthly 2015. Available here.
- Wind in power 2014 European statistics, EWEA 2015. Available here.
- Offshore wind support schemes: Current status of European support scheme. OffshoreWIND.biz, 2015. Available here.
- Business Green, Portuguese floating wind farm gets green light from Brussels, April 2015. Available here.
- France passes sweeping energy bill, to raise CO2 tax to €100/t by 2030, Carbon pulse, 2015. Available here.
- Eur'ObservER, Country Policy Profile Latvia, October 2014.
- EWEA, Wind in power: 2013 European statistics, February 2014.
- Wind in power 2013 European statistics, EWEA 2014. Available here
- Clean Energy Wire, Comparing old and new: Changes to Germany's Renewable Energy Act, 2014. Available here.
- Real Decreto 413/2014, June 2014. Available here.
- Study on the Competitiveness of the EU Renewable Energy Industry, (2014) , ICF International, p28
- Governing Growing Wind Power: Policy Coherence of Wind Power Expansion and Environmental Considerations in Sweden, with Comparative examples from Norway, CEDREN, (2014), p7
- Energy Policies of IEA Countries – Austria, 2014 Review IEA, p12. Available here.

- Renewable Energy Country Attractiveness Index (RECAI), EY, September 2014, p5. Available here.
- Legal developments in wind energy in the Netherlands, Lexology 2014. Available here
- Oversupply of green certificates, The Polish Wind Association (2014). Available here
- Legal sources on renewable energy, Belgium summary. Res-Legal 2014. Available here.
- Legal sources on renewable energy, Belgium: Wallonia quota summary. Res-Legal 2014. Available here.
- Legal sources on renewable energy, Lithuania Feed-in-tariff. Res-Legal 2014. Available here.
- Legal sources on renewable energy, Promotion in Lithuania, Res-Legal 2014. Available here.
- Country Policy Profile, Latvia, EurObserv'ER (2014), p6.
- Graphic Information System EurObserver, 2014. Available here.
- Phillip Brown, European Union Wind and Solar Electricity Policies: Overview and Considerations, Congressional Research Service, United States, August 2013;
- Peter Rudberg, Nina Weitz, Kari Dalen and Jens Jacob Kielland Haug, Governing Growing Wind Power: Policy coherence of wind power expansion and environmental considerations in Sweden, with comparative examples from Norway, Stockholm Environment Institute, Project Report 2013-04, June 2013;
- Mihaela Dragan, Jacopo Moccia, Pierre Tardieu, Honorata Fijalka, Raluca Voinica, Bogdan Belciu, Iulian Circiumaru, Jan Brazda, Martin Dolezal, Michal Miklovic, David Schneider, Michael Sponring, Eastern Winds: Emerging European wind power markets, European Wind Power Association, February 2013;
- IEA/OECD, Technology Roadmap Wind Energy, 2013.
- European Union Wind and Solar Electricity Policies: Overview and Considerations, Congressional Research Service, (August 2013), p29. Available here.
- Eastern Winds – Emerging European wind power markets, European Wind Energy Association (2013)
- WindBarriers – Administrative and grid access barriers to wind power – July 2010
- IRENA policy database, Germany, Wind Energy. Available here.
- IRENA policy database, France, Wind Energy. Available here.
- IRENA policy database, Finland, Wind Energy. Available here.
- IRENA policy database, Ukraine, Wind Energy. Available here.
- IRENA policy database, Norway, Wind Energy. Available here.
- GOV.UK: Offshore Wind Cost Reduction Task Force, Available here
- Ukraine wind energy association. Available here.
- Operational Programme 'Competitiveness and Entrepreneurship', EC Regional Policy. Available here.
- News article from Euractiv.com on the impact of Greece's financial crisis on renewable project development. Available here.
- Polish Information and Foreign Investment Agency: Legal framework for renewable energy projects in Poland. Available here.
- Continental Wind: Bulgaria. Available here.
- Workshop on Renewable Energy Policies, IRENA, p18. Available here
- Renewable energy country focus: Hungary, Ernst and Young. Available here

– Romania Slowing Bulgaria and Hungary fall off the radar, Wind Power Monthly. Available here

– European Commission Energy Resource Knowledge Centre, Luxembourg. Available here.

– Portugal, Market Overview. Available here, p113.

Conclusions

– Ecologic Institute, 2012. The Social Dimension of EU Biofuel Policy. Available here. [Accessed 11 December 2015].

– Kortscha, T., Hildebrandb, J., Schweizer-Riesb, P., 2015. Acceptance of biomass plants – Results of a longitudinal study in the bioenergy-region Altmark. Renewable Energy. Volume 83, November 2015, Pages 690–697 [PDF]. Available here. [Accessed 11 December 2015].

– DECC, 2015. DECC Public Attitudes Tracker – Wave 15. UK Department of Energy and Climate Change [PDF]. Available here [Accessed 11 December 2015].

– Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, CEER, 2015. Available here.

– GfK, 2014. 76 percent of Brits would like a smarter home – they just don't want to pay for it. Press release [PDF]. Available here [Accessed 11 December 2015].

– Duetschkea, E., Schumannb D., Pietznerc, K., Wohlfartha, K., Höllerc, S., 2014. Does it make a difference to the public where CO2 comes from and where it is stored? Energy Procedia 63 (2014) 6999 – 7010[PDF].

– EC, Guidelines on State aid for environmental protection and energy 2014–2020, 2014. Available here.

– IRENA & DNV KEMA, 2013. Study on environmental impact from large-scale deployment of renewable energy technologies. [Presentation]. Available here.

– CEER Status Review of Renewable and Energy Efficiency Support Schemes in Europe, February 2013. Available here.

– Petrov, K., 2012. Smart Grids and Regulatory Challenges. KEMA Consulting GmbH, Bonn [Presentation].

– Lago, C., Prades, A., Lechón, Y., Oltra C., Pullen A., Auer H., 200?. Wind Energy - The facts. Part V: environmental issues.

– Countries included Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden and the United Kingdom.

– Geographic Information System, EurObserv'ER. Available here.

– European Commission Memo on new rules facilitating support for RD&I. Available here.

5 Regional Analysis

5.1 Overview

The study team examined various support mechanisms being used in Australia, Canada, Japan, New Zealand and the USA to incentivise commercial investors and financiers to become involved with first commercial scale projects of innovative low carbon energy generation technologies.

This Section contains a detailed review and descriptions of third country public-sector schemes that deploy financial instruments[539] to support Research, Development and Demonstration (RD&D), either specifically in the area of low carbon energy technologies (energy production plants and manufacturing facilities for energy technologies) (SET) or more generally but with SET within scope.

This Deliverable follows the same structure as earlier deliverables developed by the ICF Team under Sub-task 1.2 of this Study, namely the "*Instrument Descriptions*", in which we examined in detail 14 EU and Member State support schemes judged to cover projects in SET at TRLs 7 & 8.

Table 5.1 provides an overview of the seven schemes reviewed.

Table 5.1 Third country schemes used to support SET projects including TRL 7-8

Scheme	Region/ Country	Started	Implementer
Advancing Renewables Programme (ARP)	Australia	2015	Australian Renewable Energy Agency (ARENA)
NextGen Biofuels Fund™	Canada	2007	Sustainable Development Technology Canada (SDTC)
Loan Programs Office (LPO)	USA	2009	U.S. Department of Energy
Carbon Capture Program	USA	2009	U.S. Department of Energy - Office of Fossil Energy
ARPA-E grants program	USA	2009	Advanced Research Projects Agency - Energy (ARPA-E)
Grant support	Japan	1980	NEDO – New Energy & Industrial Technology Development Organisation
Project and Growth Grants	New Zealand	2013	Callaghan Innovation

5.2 Approach

The ICF Team identified the schemes from five different countries, reviewed published evaluation reports and other available documentation to find useful information and insights, and obtained interviews with the ARENA (Australia), the US Department of Energy, ARPA-E (US) and Callaghan Innovation (New Zealand). The same topic guide as that used for the Instrument Descriptions of Task 1.2 was employed to guide consultations and ensure consistency.

Through the interviews and online research described, the ICF Team sought information on the following areas:

- Technological coverage and Technology Readiness Levels (TRLs) of projects supported by the scheme;
- Type(s) of instrument deployed by the scheme, e.g., loan, equity;

[539] Note that the term "financial instruments" here includes grants as well as debt, guarantees and equity mechanisms. A scheme may deploy one or more instruments.

- Annual budget of the scheme;
- Maximum level of funding for any given project, both in absolute terms and as a percentage of the project's budget, supported by the scheme;
- Eligibility criteria that projects have to meet;
- Contractual conditions to which project developers have to agree;
- Market acceptance and relevance of the scheme (in terms, for example, of the number of applicants per year/call and the success rate of applicants);
- Scheme effectiveness (in terms of the known outcomes and impacts, including, the number of successful demonstration projects introduced to the market); and,
- Efficiency of the scheme (for example, in terms of the extent to which private funds have been leveraged and from which sources this has been obtained).

Additionally, the ICF Team has made an assessment of the appropriateness of the scheme for supporting first-of-a-kind commercial-scale demonstration-stage projects and explored insights and learning points from each of scheme which might provide useful for the scoping of new instruments in the EU.

Description sheets for each of the schemes listed in Table 5.1 are provided in Section 5.3 below.

5.3 Instrument (Scheme) Description Sheets

Name	**Advancing Renewables Programme (ARP) - Australian Renewable Energy Agency (ARENA)**
Geographical area	Australia
Year started	2015 - 2022 (programme) 2012 - 2022 (agency)
Status	Open
Type of instrument	Grants
Annual budget [540]	Circa €217million for FY 2015/16 (total agency budget)
Project funding amount	€70,000 to €33 million (funding over that threshold requires ministerial approval) with applicants typically expected to at least match the funding being sought from ARENA
TRL focus	TRL 4 – 9
Technology coverage	Renewable energy generation (i.e. wind, ocean, solar, geothermal, bioenergy) and energy storage

http://arena.gov.au/ http://arpa-e.energy.gov/

Contact details:
Matt Walden
Investment Director – Transactions and Business Development
T: +61 2 6243 7773
Matthew.Walden@arena.gov.au

Instrument objective

The Advancing Renewables Programme's mission is to fund activities that contribute to one or more of the following outcomes[541]:

a. reduction in the cost of renewable energy;
b. increase in the value delivered by renewable energy;
c. improvement in technology readiness and commercial readiness of Renewable Energy Technologies;
d. reduction in or removal of barriers to renewable energy uptake; and,
e. increased skills, capacity and knowledge relevant to Renewable Energy Technologies.

Those objectives are in line with ARENA's overarching objectives to improve the competitiveness of renewable energy technologies and increase the supply of renewable energy in Australia.

Target beneficiaries

Any Australian incorporated entity with an Australian Business Number.

Eligibility criteria and specific contractual conditions

ARENA believes that it is really important for each technology they are assessing to understand what the technological and commercial risks are and how to manage and mitigate those risks. Thus, they assess risk on a case-by-case basis, with the aims of reducing costs and increasing deployment opportunities.

ARENA has a two-stage assessment process which consists of an expression of interest and a full application stage. Applicants should meet six eligibility criteria pertaining to:

1. Eligibility of applicant – applicants should hold an Australian Business Number and be an incorporated Australian entity;
2. Eligibility of activity – applications should involve a Renewable Energy Technology and/or have the

[540] Note that all values have been converted into euro using an exchange rate of 0.6573 EUR/ AUD as of 05/11/2015 obtained from www.xe.com

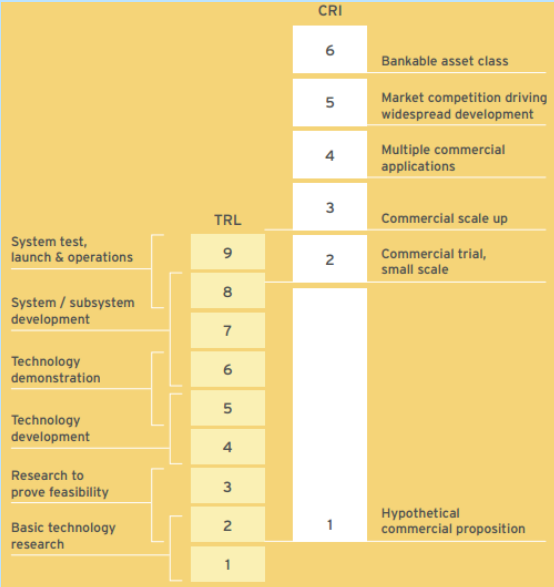
[541] http://arena.gov.au/files/2015/07/Programme-Guidelines.pdf

potential to contribute to the Programme Outcomes. TRLs 1-3 are excluded from funding;

3. Geographical criteria – the activity should primarily take place in Australia with ARENA-funded expenditure incurred outside of Australia limited to 10% of funding received (though exceptions apply);
4. Knowledge sharing criteria;
5. Intellectual property criteria; and,
6. Compliance with other requirements (e.g. workplace gender equality, anti-terrorism requirements, etc.).

Once these six eligibility criteria have been met, applications are assessed on a merit-based approach using the following 'merit' criteria:

1. Contribution to the programme outcomes;
2. Applicant capability and capacity;
3. Activity design, methodology, risk and compliance;
4. Financial viability and co-funding commitment; and,
5. Knowledge-sharing.



Clawback provisions are well-defined and quite complex. They aim to avoid any funding commitments to projects that cannot move forward.

Although not mentioned in the eligibility and merit criteria, the Advancing Renewables Programme (ARP) Guidelines state that *"the Programme rewards Activities that can identify a pathway to commercialisation [in their funding applications]"*. In essence, applicants are required to develop a commercialisation plan and demonstrate how deployment could be achieved having less governmental support. Therefore, alongside the use of TRLs to classify projects, ARENA has developed a Commercial Readiness Index (CRI) which extends to the point at which applications/technologies are commercially deployed and have become a "bankable asset" class (see diagram at right[542]). This framework enables ARENA to evaluate the phases at which industry faces most barriers and thereby structure its funding in a way that reduces risks and most effectively overcomes barriers to commercialisation pathways.

Market acceptance and relevance

The ARP was launched in 2015, following a previous 'Emerging RES Programme'. Currently, there is an open call for funding focused on large-scale solar photovoltaics which closes in November 2015. The number of applications is expected to reach 100 to 200 projects, although just 3-10 final beneficiaries will be given funding. Success rate is therefore estimated to be around 3 to 5% (based on inputs provided by ARENA).

One of the projects financed under ARENA's preceding Emerging RES Programme included the *DeGrussa solar project*[543], led by Juwi Group, an EPC frontrunner, and the French energy company NEOEN. The €26.3million project involves the construction of a 10.6 MW solar PV installation with storage at the DeGrussa Copper Mine aiming to showcase the use of RES at mine sites. Construction activities commenced in July 2015 and the solar power station will become operational in 2016. It has received around €14 million in ARENA funding, complementing up to €10 million in debt finance committed by the Australian Clean Energy Finance Corporation (which finances renewable energy projects that the commercial sector is not ready to finance yet), illustrating an innovative public grant/loan hybrid. Once completed, this will be one of the world's largest integrated solar installations providing peak power load to a mining operation. It will help offset approximately 5 million litres of diesel usage per annum - more than 20 per cent of total diesel consumption at

[542] It is worth noting that the stages of the CRI are slightly out of kilter with the assume commercialisation stages of TRL definitions used in Horizon 2020

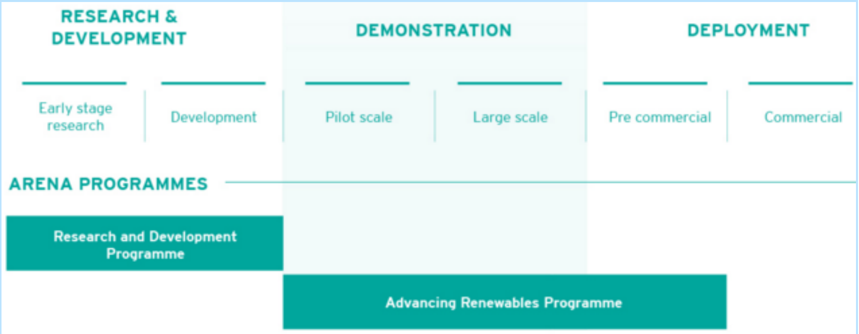
[543] http://arena.gov.au/project/degrussa-solar-project/

the site.
Another ARENA flagship project (and the project that has received the highest level of funding to date from the programme) is the *AGL solar project*[544] involving the construction of two solar photovoltaic power stations which between them will have a generation capacity of up to 155 megawatts (AC) of electricity. The €289 million project was granted circa €110 million in funding by ARENA in 2013 and €43 million by the New South Wales Government, with the balance of 47% of project costs (€136m) expected to be met by AGL[545]. This is the largest solar energy plant in Australia with the 102 MW plant in Nyngan operational since June whereas the 53 MW Broken Hill project will become operational by the end of 2015[546].

Effectiveness and efficiency
ARENA has been in operation for just over three years and has a mandate up to 2022 although their commercialisation spectrum will last until 2030-2040. Moreover, the ARP was established just six months ago. As such, it is too early to review the programme's performance. Furthermore, ARENA reportedly regards "return on investment" not so much in terms of the financial return on investment, but more in terms of knowledge-sharing, dissemination of information and development of the Australian renewables industry. This knowledge-sharing process can last up to 3-5 years post-completion of the project so no conclusions can be drawn yet regarding outcomes and impacts achieved.

Nevertheless, 47 projects have been completed under ARENA's Research and Development Programme and the closed programmes preceding the ARP (i.e. the Emerging RES programme and the I-RAR programme which focused on remote deployment of RES technology)[547].
In terms of leverage, ARENA holds state-specific statistics showing that in Queensland State (one of the largest states), a €0.9 billion in "community investment" has been achieved, with €383 million coming from ARENA and €517m from the private sector, achieving a leverage of 1.3x public investment.

ICF assessment of appropriateness for financing SET projects
As a commercially-oriented government agency, with an independent board of directors and a separate advisory panel, ARENA acts "like an investment community" and takes a commercial approach (like commercial banks and equity financiers would do) to understand the risks involved and determine the level of investment that will cover the financing gap to full commercialisation. They have a clear interest in FOAK projects and play a vital role in taking those technology risks and making projects bankable. Through their funding programmes (i.e. R&D and ARP) ARENA also provides a robust funding 'ecosystem' where applicants are supported throughout the TRL spectrum as indicated in the figure (right).



For later TRL projects, ARENA also works closely with other organisations such as the Australian Clean Energy Finance Cooperation, providing joint funding in some cases such as the DeGrussa Solar Project mentioned above.

The Renewable Energy Venture Capital Fund (REVC), established by ARENA, also provides venture capital to Australian companies that commercialise RES technologies through support to the Southern Cross Renewable Energy Fund[548].

[544] http://arena.gov.au/project/agl-solar-project/
[545] It was not possible to determine from the developer's website in what form the €136m took, although it is assumed to be equity
[546] https://www.agl.com.au/about-agl/media-centre/article-list/2013/jul/agl-to-proceed-with-australias-largest-solar-projects
[547] http://arena.gov.au/projects/
[548] http://arena.gov.au/programmes/renewable-energy-venture-capital-fund/

Name	**NextGen Biofuels Fund™ - Sustainable Development Technology Canada (SDTC)**	*https://www.sdtc.ca/en/funding/funds/nextgen*
Geographical area	Canada	
Year started	31 December 2007 running to 31 March 2015 (with disbursements running to 31 March 2017)	
Status	As of 3 December 2014 the Fund no longer accepts applications for financial support – the focus instead is on construction-ready projects[549]	
Type of instrument	Zero-interest loans	
Annual budget [550]	Circa €42 million (FY14); total fund size €349 million	
Project funding amount	40% of eligible costs or a maximum of €140 million per project (total Government assistance must not exceed 60% of eligible costs)	
TRL focus	TRL 7-8	
Technology coverage	Biofuels (cellulosic ethanol and new biodiesel technologies)	

Instrument objective

The NextGen Biofuels Fund™ supports the establishment of large, first-of-a-kind demonstration-scale facilities for the production of next-generation renewable fuels within Canada. The objective is to stimulate the growth and retention of Canadian technology expertise and innovation capacity for cellulosic ethanol and biodiesel production.

Target beneficiaries

For-profit corporations, partnerships, limited partnerships or business trusts with legal capacity in Canada and access to expertise in next-generation renewable fuels production pathways. However, the lead partner should always be a Canadian for-profit company[551].

Eligibility criteria and specific contractual conditions

Projects should meet the following criteria[552]:

1. Have demonstrated the technology at the pre-commercial pilot scale;
2. Be a first-of-a-kind facility that primarily produces a next-generation renewable fuel at large demonstration-scale;
3. Use Canadian biomass as a feedstock; and,
4. Be located in Canada.

The developer must also have: a bankable business plan; a solid financial plan both during and following project execution; environmental targets; and strong project execution parameters (scope, schedule, budget, required partners, technology and business performance targets, etc.).

The Fund looks at the potential of each project's production pathway to deliver sustainable development

[549] According to the SDTC website, the NGBF will now focus *"on construction-ready projects that have successfully progressed through pre-construction planning in accordance with the NGBF Project Assurance Program (PAP). Based on the remaining program time, new applicants would not be able to complete required phases of project development, construction, plant commissioning and start-up for commercial operation. For this reason, NGBF will not be accepting new applications."*

[550] Note that all values have been converted into euro using an exchange rate of 0.6989 EUR/CAD as of 05/11/2015 obtained from www.xe.com

[551] http://www.mentorworks.ca/blog/government-funding/faq-sdtc-nextgen-biofuels-09-2014/

[552] http://www.investtoronto.ca/InvestAssets/PDF/Reports/funding-programs-awards-prizes-available-cleantech-companies.pdf

benefits (social, economic and environmental) by:

- sustainably expanding renewable fuel production in Canada;
- improving the environmental benefits arising from the production and use of renewable fuels including the life-cycle fossil energy balance and life-cycle emissions of greenhouse gases;
- reducing the overall financial costs of Renewable Fuels; and,
- generating economic benefits for a wide range of communities.

Contractual agreements between eligible applicants the Fund include loan repayment terms based on a negotiable percentage of free cash flow over a period of 10 years after project completion. For example, the amount repayable is calculated as X% of Free Cash Flow derived from the funded project, where X equals SDTC's percentage contribution to the project's eligible project costs. The SDTC due diligence process validates all necessary business, technological, and environmental considerations to manage and mitigate risks prior to agreement.

Market acceptance and relevance

Emerging cellulosic ethanol and biodiesel technologies have greater technology risk than more established industries. Projects with large CAPEX requirements normally rely on debt and equity financing to support them. Unfortunately debt financiers have a very low risk tolerance for technology risk (due to scale-up and process integration risks) and Canadian early-stage equity risk takers remain focused primarily on conventional energy and mining investments. Meanwhile, global equity investors may require more onerous terms for providing equity into such a project. Thus, the Fund is designed to bridge the high CAPEX gap for moving a proven prototype to a large-scale demonstration plant. The Fund's support for innovative demonstrators aims to derisk the technologies and create a more compelling business case for investors and financiers, growing the domestic supply of next-generation biofuels.

To date, while it is unknown how many projects have applied to the Fund, it appears that only two projects have been awarded a loan (see below for project details)[553].

Effectiveness and efficiency

The Enerkem Alberta Biofuels Project in Edmonton, Canada was officially inaugurated in 2014[554] and is the world's first major collaboration between a large city and a waste-to-biofuels producer, converting municipal solid waste into renewable fuels and chemicals (i.e. bioethanol and biomethanol). Enerkem signed a 25-year agreement with the City of Edmonton to build and operate the 38m litres/year (estimate) plant that will produce and sell next-generation biofuels from non-recyclable and non-compostable municipal solid waste using its proprietary technology. At a total cost of €122 million, Enerkem received a €45 million loan (36.8%) from the NextGen Biofuels Fund.

The AE Côte-Nord RTP™ Project, is a joint venture between Ensyn Bioenergy Canada Inc. and Arbec Forest Products Inc. In 2015 it received loan funding from NextGen Biofuels Fund worth €18.9 million or 37.5% of total eligible project costs of €50.3 million. This enabled it to leverage 1.7x the public contribution. The plant will employ Ensyn Technologies' fast pyrolysis process to convert wood and woody materials into liquid fuel. Located at the site of the existing Arbec Port Cartier Sawmill, the facility will be capable of annually processing 36,400m tonnes of dry biomass feedstock into 21m litres of renewable fuel oil[555].

To date, based on available information, the NextGen Biofuels Fund had loaned €63.3 million, leveraging €108.7 million, or 1.7x the public investment, from private industry in Canada[556]. SDTC has until 2027 to collect loan repayments from projects.

553 Source: search for NextGen Biofuels Fund project awards under the scheme database (https://www.sdtc.ca/en/portfolio) using Active, Completed and Inactive search terms

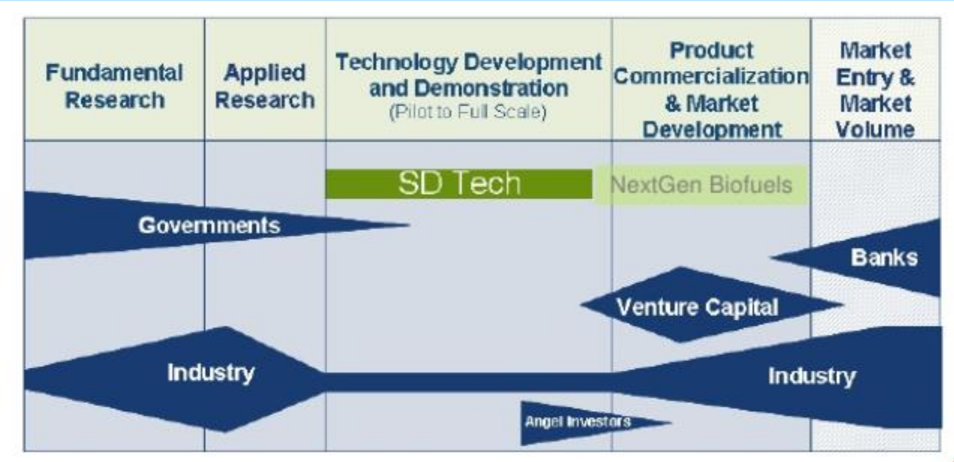
554 http://enerkem.com/facilities/enerkem-alberta-biofuels/

555 https://www.sdtc.ca/en/portfolio/projects/ae-cote-nord-rtptm-project

556 Values reported are based on December 2011 data as no latest data was available, Available at: http://dynamixx.co.uk/files/4913/5361/8953/111412-0920-pres5-SHARPE.pdf

ICF assessment of appropriateness for financing SET projects

The NextGen Biofuels Fund was established to meet policy objectives of exploiting Canadian excellence in innovative biofuels development and an intent to stimulate a domestic supply chain for the production of next-generation renewable fuels. The high value fund (circa €350 million) provides a continuum of funding for innovations proven under the €412 million STDC Tech Fund since the NextGen Biofuels Fund is positioned downstream from the SD Tech Fund (see diagram below) and can therefore in theory benefit from successful technologies that have been piloted under that sister scheme. This funding eco-system appears an important feature that helps to alleviate the commercialisation 'Valley of Death', not least because there is the potential for greater visibility of future innovations to scheme managers before they require FOAK financing.



As at end March 2015, the window for new investment has closed, with the exception of 'construction-ready' plants. The Fund will continue to function in order to receive loan repayments to 2027, enabling the maximum 10 year tenor for loans to be fulfilled. Overall, therefore, despite being in place for 8 years, the scale of investment achieved appears to fall well short of policy expectations, with total spend of less than 20% of the Fund value.

There could be several explanations for this project shortfall, including:

- Canada has fewer companies developing next-generation biofuels than anticipated (perhaps due to less equity investment into new technology companies developing next-generation biofuels);
- There is less appetite for biofuels production in Canada following large reductions in oil prices; and,
- Eligibility criteria for the Fund may have been too restrictive.

Name	Loan Programs Office (LPO) - U.S. Department of Energy
Geographical area	USA
Year started	Around 2009 (for SET funding)
Status	Investing in American Energy Reopened 2015 (closed to new applications in 2012 but recently announced new funding)
Type of instrument	Loans (Full & Partial) and Guarantees
Budget[557]	€31.4 billion ($34.2 billion) (a further €2.8bn ($3bn) for distributed generation was announced by the Obama administration in August 2015[558])
Project funding amount	Average loans/guarantees per SET sector ranged from $25m to over $1bn. Renewable energy generation, solar PV manufacturing and energy storage/transmission received €12.1 billion or 44% of the total budget[559].
TRL focus	7-9
Technology coverage	Bioenergy & Biofuels, CSP, Geothermal power, Utility-scale Solar PV, Solar manufacturing, Wind, Energy Storage & Transmission. Distributed generation including energy storage and smart grid to be targeted in next wave of funding support.

Instrument objective

The LPO aims to provide "the critical financing needed to deploy some of the world's largest and most Innovative"[560] clean energy projects. The diagram below illustrates that the scheme is designed to bridge the commercialisation 'Valley of Death' and focus on 'initial commercial deployment', providing debt financing to complement 'initial private equity' which is typically available for such projects. The LPO is quite unequivocal that it *"fills a critical role in the marketplace by financing the first deployments of a new technology to bridge the gap for commercial lenders"*.[561]

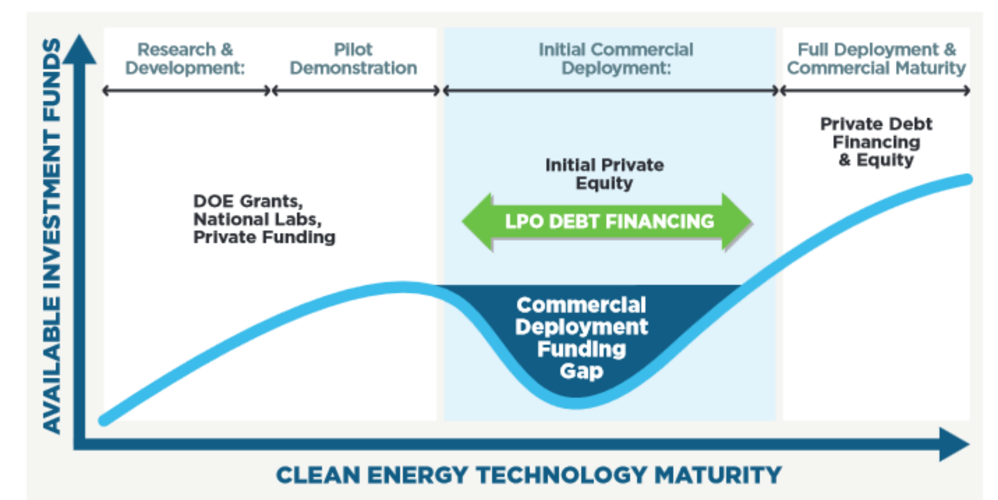
[557] Note that all values have been converted into euro using an exchange rate of 0.9185 EUR/ USD as of 05/11/2015 obtained from www.xe.com

[558] http://energy.gov/articles/president-obama-announces-more-billion-dollars-energy-department-initiatives-advance The funding will cover inter alia *"rooftop solar, energy storage, smart grid technology, and methane capture for oil and gas well"* http://energy.gov/sites/prod/files/2015/10/f27/Supplement%20fourth%20to%20Loan%20Guarantee%20Announcement%2010.14.15.pm_.pdf

[559] Advanced Vehicles Manufacturing and Advanced Nuclear Energy were also covered by the scheme but these are not discussed here although collectively they received $16.1 billion or 54% of the total package.

[560] U.S.DOE LPO, Loans Program Office Financial Performance, November 2014. Available at: http://energy.gov/sites/prod/files/2014/11/f19/DOE-LPO-Financial%20Performance%20November%202014.pdf

[561] U.S.DOE LPO, Loans Program Office Financial Performance, November 2014. Available at: http://energy.gov/sites/prod/files/2014/11/f19/DOE-LPO-Financial%20Performance%20November%202014.pdf



Source: LPO (2014)

Target beneficiaries

USA entities varying from industrial companies and conglomerates to Special Purpose Vehicles (SPVs).

Eligibility criteria and specific contractual conditions

Companies were eligible to apply for funding from 2009 with disbursement occurring from July 2010 through to the last loan in March 2012. The LPO needs to see substantial private equity commitments before it will agree to issue a loan or loan guarantee. A minimum of 20% of the total project cost is required although equity contributions are usually higher.

Market acceptance and relevance

Since starting to lend to large-scale SET projects in 2010, the LPO has supported projects in seven areas, including the following 21 projects[562] which were still operational as at March 2015[563]: CSP (5 projects), solar PV (6), solar manufacturing (1), wind (4), energy storage (1), geothermal (3) and bioenergy (1).

To illustrate the market impact the LPO had, in 2009, there was no single operational solar PV facility in the United States larger than 100 MW megawatts. Although the technology had been proven, LPO found that developers were unable to secure the necessary finance to build such large projects. The LPO claims credit for stimulating the market for utility-scale solar PV plants with its €4.2bn (4.6bn) support for 1.5GW of utility-scale solar PV. For the first four projects, LPO provided loan guarantees that allowed projects to be financed exclusively through the U.S. Treasury's Federal Financing Bank. For the fifth and largest project, Desert Sunlight, LPO worked with a group of 14 financial institutions in order to jointly finance the project through its Financial Institution Partnership Program (FIPP). It did this in order to build experience amongst new lenders in the financing of novel clean energy projects. In its ex-post assessment of the LPO's market stimulation effect, it has had concluded that *"initial investments made by LPO built a market that subsequently financed an additional 17 PV projects larger than 100 MW in the United States – all financed without DOE loan guarantees and many of them by banks that LPO had worked with through FIPP."*[564]

Effectiveness and efficiency

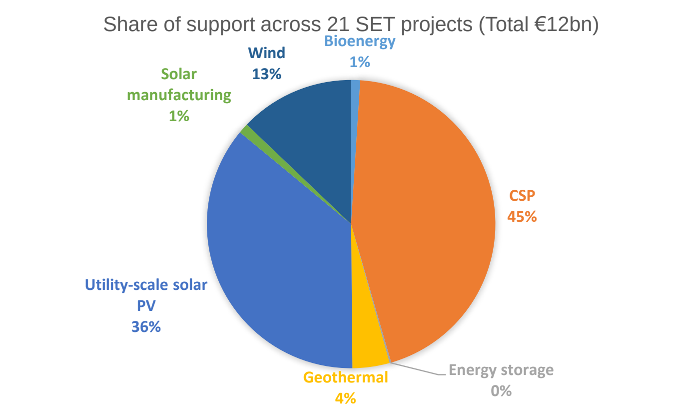
As at September 2014, the LPO overall had amassed a portfolio of over 30 projects worth €27.8bn ($30.3bn) in loans and loan guarantees and a further €3.6bn ($4bn) in conditional commitments. The pie chart below illustrates how CSP has accounted for nearly half (45%) of funding to SET projects, with over a third (36%) to utility-scale solar PV, and 15% to onshore wind energy projects. The scale of project support is visible in the

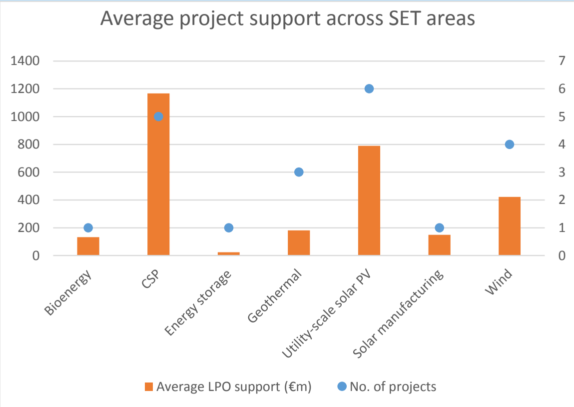
[562] http://energy.gov/lpo/portfolio-projects-technology

[563] The LPO has experienced some failures including Solyndra, electric car company Fisker and solar company Abound.

[564] U.S.DOE LPO, Powering New Markets: Utility-scale Photovoltaic Solar, February 2015. Available at: http://energy.gov/sites/prod/files/2015/02/f19/DOE_LPO_Utility-Scale_PV_Solar_Markets_February2015.pdf

second chart, where it is clear that average support to CSP projects has been in excess of €1bn and close to €800m for utility-scale PV projects. Relative to the number of projects, in other sectors, funding levels are substantially smaller.





Source: ICF. Based on LPO reporting of remaining value of loans/guarantees including principal/interest as at March 2015.

The loans and loan guarantees overall have catalysed a further €18.4bn ($20bn) (leverage of 0.67), bringing total project investments to €45.9bn ($50bn). As of September 2014, the LPO had earned more than €0.73bn ($0.8bn) in interest from its loan book with €3.1bn ($3.4bn) of the principal repaid. The average loan tenor is 22.3 years. The DOE expects to receive over €4.6bn ($5bn) in interest over the course of the programme. In September 2014, after five years of financing projects, the actual and estimated loan losses, were worth €0.72bn ($0.78bn), resulting in a loss ratio on LPO's portfolio of 2.3% of LPO's total commitments and 3.6% of total disbursements[565].

Lester & Hart (2015)[566] reviewed the LPO as part of a broader review of U.S. SET support schemes. Despite some spectacularly large failures, such as the now infamous Solyndra[567], which they note *"became a lightning rod for criticism of the federal loan guarantee program, which backed the company and sought to support the demonstration phase of its technology*", they conclude that overall the LPO programme has been successful since just three borrowers have defaulted out of the 33 loans / guarantees disbursed since 2010. Indeed, they challenge the risk level taken by the LPO due to its high success rate, noting that *"it is quite possible that the program has been too risk-averse to adequately support technology demonstrations, rather than too cavalier in its selections".* Interesting, the authors point out that those demonstration projects that are ultimately unsuccessful are not in itself an indicator of the programme's failure, since one of the main purposes of such demonstration projects *"is to reveal unanticipated obstacles in bringing technologies to commercial scale. The expectation that they should always succeed is misplaced."*

565 U.S.DOE LPO, Loans Program Office Financial Performance, November 2014

566 Lester, R.K. & Hart, D.M., *'Closing the Energy-Demonstration Gap'*, Issues in Science & Technology, Volume XXXI Issue 2, Winter 2015 http://issues.org/31-2/closing-the-energy-demonstration-gap-2/

567 Solyndra, Inc. received a $535M solar project loan guarantee for a manufacturing facility in Freemont, California. Despite restructuring its plans and gaining new equity investment, in September 2011, the company made 1,100 employees redundant, ceasing operations and manufacturing, and filing for bankruptcy protection. According to a 24 August 2015 report from the Department of Energy (DOE), following a four year investigation, the DOE found that the company falsified its plans both during application for the loan guarantee and subsequent drawdowns, stating *"Solyndra provided the Department with statements, assertions, and certifications that were inaccurate and misleading, misrepresented known facts, and, in some instances, omitted information that was highly relevant to key decisions in the process to award and execute the $535 million loan guarantee."* The DOE also recognised failings however on the thoroughness of its own due diligence, stating that "*At various points during the loan guarantee process, Solyndra officials provided certain information to the Department that, had it been considered more closely, would have cast doubt on the accuracy of certain of Solyndra's prior representations."*

Source: DOE press release http://www.energy.gov/ig/downloads/special-report-11-0078-i and Special Report – the Department of Energy's Loan Guarantee to Solyndra, Inc., August 2015

http://www.energy.gov/sites/prod/files/2015/08/f26/11-0078-I.pdf

ICF assessment of appropriateness for financing SET projects
The LPO can rightly claim success in helping to stimulate private sector financing of large-scale SET demonstration projects across several sectors. For utility-solar PV, it has seen a market it started to finance become commercially financeable.

Many of the projects supported by this intervention are using early commercial technologies, seemingly proven already at scale but potentially not in the U.S. context (the example of CSP for example) not perhaps at the plant scale previously built. Hence, the FOAK "financing" nature of the first utility-scale solar PV plants in the USA. The LPO appears to have provided a quality 'stamp of approval' to such capital intensive projects, unlocking private finance (or equity).

Overall, it is uncertain how large the technological risks were identified in such plants; and how much private finance could have been stimulated without such large guarantees?

There is specific learning from the LPO, however, which includes:

- There is a clear need to attract substantial levels of private equity into high risk projects, although the minimum 20% equity level appears generous;

- The loans favoured larger entities – or at least those with access to large sources of private equity. Some of the world's market leading SET technology suppliers were able to access loans. For example:

  - Spanish Abengoa received a €122 loan guarantee[568] in September 2011 for 25 million gallon cellulosic ethanol facility in Kansas[569] which was fully repaid in March 2015; it also received loan guarantees worth €1.1bn in September 2011 and €1.3bn in December 2010 for two CSP projects in California and Arizona respectively, both of which are being repaid. The 250MW Mojave project in California employed parabolic trough technology[570] whilst the 250MW Solana project employed innovative storage to complement the parabolic trough technology, making it *"the first deployment of this thermal energy storage technology in the United States and is one of the largest projects of its kind in the world."*[571]
  - U.S. geothermal market leader, Ormat, secured €321m in September 2011 for a 97MW project in Nevada that aimed to increase geothermal generation in the state by nearly 25%[572].

- Long time horizons are required to pay back the loans - the average loan tenor is 22.3 years, far longer than the typical 10 year tenors for more commercial projects.

Finally, the experience of the LPO begs the question as to what risk levels public support programmes should extend to. Providing financial support to 'safe', technologically and operationally lower risk projects may introduce more deadweight into programmes, crowding out private finance as reducing the flow of support to projects which are most in need. However, creating momentum into SET areas devoid of a financing track record, especially for projects that have never been built at such large scales before can clearly help build market confidence and stimulate future financing provision.

[568] The available information shows on the principal and any interest accumulated on the loan
[569] http://energy.gov/lpo/abengoa-bioenergy
[570] http://energy.gov/lpo/mojave
[571] http://energy.gov/lpo/solana
[572] http://energy.gov/lpo/ormat-nevada

Name	**Carbon Capture Programme – U.S. Department of Energy - Office of Fossil Energy**
Geographical area	USA
Year started	2009 (for current programme although various initiatives have been launched since 2003 and even earlier)
Status	Open
Type of instrument	Grant
Annual budget[573]	Approximately €91.9 million per year (covering everything from research in pre- and post-combustion up to small and large pilots) Demonstration projects currently in place are covered under the American Recovery and Reinvestment Act[574] (Recovery Act with €3.1 billion allocated to the Office of Fossil Energy for RD&D). Budget for new demonstration projects will be requested in about 6-7 years based on information provided by DOE.
Project funding amount	For TRL2 - 4: €2.8 million for laboratory-scale projects For TRL 5 – 8: €13.8 - €18.4 million for small pilot projects capturing 20 million tonnes of CO_2 per day; €55 - €92 million for large pilot projects capturing 200 tonnes CO_2 per day; >€92 million for demonstration scale projects capturing thousands of tonnes CO_2 per day
TRL focus	TRL 2 – 8
Technology coverage	CCS

http://energy.gov/fe/office-fossil-energy

Contact details:
Mark Achiewicz
Coordinator of CCS programmes
Damiani Darin
Project Manager
T: +1 202-586-7920
Mark.Ackiewicz@hq.doe.gov
Darin.Damiani@hq.doe.gov

Instrument objective

The U.S. Department of Energy's Office of Fossil Energy (OFE) is focused on helping the USA meet its continually growing need for secure, reasonably priced and environmentally-sound fossil energy supplies. Their primary mission is to ensure the nation can continue to rely on traditional fossil fuel resources to produce cleaner, secure and affordable energy while enhancing environmental protection. To that end, the overall objective of the programme is to develop and advance CCS technologies, reduce their cost of implementation, mitigate risks pertaining to RD&D efforts and open up the way to widespread commercial deployment in the 2025-2035 timeframe[575].The OFE recognises that CCS can play a vital role in addressing CO_2 emissions reductions. With respect to investment into CCS research, development and demonstration, the OFE notes that *"it is in the interest of all to trigger such investments and address this environmental issue while continuing to provide energy security in the US"*.

573 Note that all values have been converted into euro using an exchange rate of 0.9185 EUR/ USD as of 05/11/2015 obtained from www.xe.com

574 http://energy.gov/fe/fe-implementation-recovery-act

575 http://netl.doe.gov/File%20Library/Research/Coal/carbon-storage/Program-Plan-Carbon-Storage.pdf

Target beneficiaries
USA entities varying from universities and laboratories to industrial companies.

Eligibility criteria and specific contractual conditions

Under the Clean Coal Power Initiative (see below), projects needed to demonstrate technologies that:

- Make progress towards a target CO_2 capture efficiency of 90%;
- Make progress toward a capture and sequestration goal of less than 10% increase in the cost of electricity for gasification systems and less than 35% for combustion and oxy-combustion systems; and
- Capture and sequester or put to beneficial use an amount of CO_2 emissions in excess of the minimum of 300,000 tons per year required by CCPI.

Under the Industrial Carbon Capture and Storage initiative (see below), projects need to demonstrate technologies that[576]:

- Make progress towards a target CO_2 capture efficiency of 90%;
- Make progress toward a capture of 0.4 million to 1.5 million tons per year.

A Cooperative agreement is set out between the project beneficiary and the Office of Fossil Energy. This is accompanied by terms and conditions, such as defining a statement of project objectives, roles of parties within the agreement and key project deliverables. These conditions are explicitly laid out and vary by applicant type.

In terms of clawback provisions, the office of Fossil Energy can request a refund if applicants fail to deliver the deliverables outlined in their cooperative agreements.

Market acceptance and relevance
The number of applications received depends primarily on the research topic, the level of activity in that area by the research community and the scale they are interested in (i.e. early stage research and prototypes or pilot or commercial-scale demonstration). However, according to OFE, fewer applications are received at later TRLs due to difficulties in securing financial investment and a lack of team capability in moving such projects forward. Of these, project attractiveness to the financial community is considered to be the main challenge faced by project applicants.

In general, for CCS projects, success rates depend on project scale and range between 16%-30% for lab-scale projects, 33%-80% for small and large pilots and 33%-50% for large-scale demonstration projects.

Effectiveness and efficiency

The U.S. has long provided support to demonstrate CCS although its commitment has not been continuous. For example, the DOE cancelled the FutureGen project in 2008[577]. However, as noted above, new support programmes have been introduced with funds from the American Recovery and Reinvestment Act. Despite this new injection of grant funding, the OFE reports that successful demonstration and commercialisation of CCS technologies to be challenging. It bases this insight on the experiences of two major schemes it has supported over the past 6 years, including Clean Coal Power Initiative and the Industrial Carbon Capture and Storage. These are dealt with in turn below:

Clean Coal Power Initiative (CCPI)
In 2009 and 2010, OFE selected six projects from two separate solicitations under the third round of the CCPI[578]. The OFE states that, as a result of the CCPI, for 3 projects which totalled €2.92 billion, "an investment of up to €899 million, including funds from the American Recovery and Reinvestment Act, will be leveraged by more than €2 billion in private capital cost share". This shows leverage of 2.2x public investment and an intervention rate of 30.8%. A further €735 million from the Recovery Act was made available, bringing

[576] http://www.netl.doe.gov/File%20Library/Research/Carbon%20Seq/Reference%20Shelf/CCSRoadmap.pdf

[577] Lester, R.K. & Hart, D.M., 'Closing the Energy-Demonstration Gap', Issues in Science & Technology, Volume XXXI Issue 2, Winter 2015 http://issues.org/31-2/closing-the-energy-demonstration-gap-2/

[578] http://energy.gov/fe/clean-coal-power-initiative-round-iii

the total DOE contributions to €1.6 billion.

Of the six projects selected in Round Three, only two (totalling €567 million of DOE funding) remain active, including:

- *Summit Texas Clean Energy* – which will integrate Siemens gasification and power generating technology with carbon capture technologies to effectively capture 2.7m metric tpa at a 400MW power plant to be built in Texas Captured CO_2 will be used for enhanced oil recovery (EOR) in West Texas oilfields. (DOE share: €413 million)

- *Petra Nova 60MW Post-Combustion Carbon Capture Demonstration Project, Texas* - captured CO_2 will be used for enhanced oil recovery (EOR) in a Texas Gulf Coast oilfield (DOE share: €153 million)

The three withdrawn projects include:

- *Mountaineer Carbon Dioxide Capture and Storage Demonstration*[579] - aimed to design, construct and operate a chilled ammonia process to capture 1.5m metric tpa in a 235MW flue gas stream at an existing 1,300MW power plant in West Virginia, followed by permanent storage of all captured CO_2 in two separate saline formations. (DOE share: €307 million);

- *Southern Company CCS Demonstration* - aimed to retrofit a CO_2 capture plant on a 160 megawatt flue gas stream at an existing coal-fired power plant, Alabama Power's Plant Barry, Alabama, capturing up to 1m metric tpa of CO_2 for sequestration in deep saline formations. The potential for EOR was also to be explored. (DOE share: €271 million); and,

- *Post Combustion CO_2 Capture Project* - aimed to install an ammonia-based SO_2 scrubbing technology to capture CO_2 from a 120MWe-equivalent gas stream at a 450MW power plant in North Dakota, yielding 1m metric tpa of CO_2. (DOE share: €92 million).

The final project, now suspended, involved *commercial demonstration of advanced IGCC* with full carbon capture at a newly built power plant in California, converting into hydrogen and CO_2. The hydrogen gas was to be used to fuel the power station and more than 2m metric tpa of CO_2 piped to nearby oil reservoirs for storage and EOR (DOE share: €375 million).

Industrial Carbon Capture and Storage

OFE has funded a CCS demonstration programme for testing large-scale CCS[580] at industrial plants comprising of two phases and involving three shortlisted CCS projects. Phase 1 received total initial investment of €40.5 million (made up of €19.8 million from the Recovery Act and €20.7 million in private funding – roughly a 50% intervention rate) and covered research and development activities leading to 12 projects being selected. After the successful completion of Phase 1, only three projects have now entered Phase 2 for design, construction, and operation. The total investment for Phase 2 is €900 million (with €562 million from the Recovery Act and the rest from €338 million leveraged from private funding from the project sponsors – a 62% intervention rate by the public sector). Although the progress of projects is being monitored, it will take time to make these technologies commercially successful with full commercialisation forecast in 2017 onwards. The projects supported include:

- *Air Products & Chemicals*[581] - will capture and sequester 1 million tons of CO_2 per year from existing steam-methane reformers in Texas (project duration 2009-2017 operational since 2012; DOE share: €261 million);
- *Archer Daniels Midland Company*[582] - will capture and sequester 1 million tons of CO_2 per year from an existing ethanol plant in Illinois (project duration 2009-2017; DOE share: €130 million);
- *Leucadia Energy* - will capture and sequester 4.5 million tons of CO_2 per year from a new methanol plant in Louisiana[583] (project duration: 2009-2020; DOE share: €240 million).

[579] Note the project team included French Alstom
[580] http://energy.gov/fe/science-innovation/carbon-capture-and-storage-research/carbon-capture-and-storage-industrial
[581] http://www.netl.doe.gov/research/coal/major-demonstrations/industrial-carbon-capture-and-storage/iccs-air
[582] http://www.netl.doe.gov/research/coal/major-demonstrations/industrial-carbon-capture-and-storage/iccs-archer
[583] http://www.netl.doe.gov/research/coal/major-demonstrations/industrial-carbon-capture-and-storage/iccs-leucadia

ICF assessment of appropriateness for financing SET projects

A plethora[584] of U.S. programmes and initiatives provide grant funding to support R&D for CCS across the whole spectrum of TRLs for both fossil-fuel power generation and industrial CCS. For example, besides the two initiatives described above, in September 2015, the National Energy Technology Laboratory (that implements the CCS scheme for DOE) announced eight projects[585] were selected under the DOE Carbon Capture Program to construct small- and large-scale pilots for reducing the cost of carbon dioxide (CO_2) capture and compression.

Despite the obvious setbacks for the number of projects being taken forward under the Clean Coal Power Initiative, the DOE continues to support CCS RD&D across power generation and industrial applications, and at various TRLs. It is interesting to see the different grant intervention rates for power plant CCS (30.8%) versus industrial CCS (62%). It is too early to determine the ultimate success of these on-going CCS projects. The OFE's experience of project withdrawals and suspensions does appear to echo the experiences of the EEPR and NER 300 support schemes in Europe with respect to supporting CCS FOAK projects[586]. For example, OFE mentioned in consultation that the main challenges faced by developers are less technical issues such as financing and permitting.

[584] http://www.netl.doe.gov/File%20Library/Research/Coal/carbon%20capture/Program-Plan-Carbon-Capture-2013.pdf

[585] http://www.netl.doe.gov/newsroom/news-releases/news-details?id=b3b81c98-25e0-4698-892d-c7e74b71cad5 Selected projects focus on advancing the development of post-combustion CO_2 capture and supersonic compression systems for new and existing coal-based electric generating plants: (1) supersonic compression systems, (2) small pilot-scale (0.5-5 MWe) post-combustion CO_2 capture development and testing, and (3) large pilot-scale (from 10 to >25 MWe) post-combustion CO_2 capture development and testing

[586] In the case of European CCS projects, carbon pricing has often been blamed for the inability of project sponsors to achieve a final investment decision

Name	**Advanced Research Projects Agency - Energy (ARPA-E)**
Geographical area	USA
Year started	2009
Status	Open
Type of instrument	Grants
Annual budget [587]	€257 million for FY 2015
Project funding amount	€2.8 million on average (max €8.3 million per project) Funding intervention rate depends on type of applicant, but it is no larger than 95% for SMEs and 80% for industries.
TRL focus	Main focus is TRL 2 - 5 (TRL 6 - 7 currently out of consideration)
Technology coverage	Open to projects in all SET sectors

http://arpa-e.energy.gov/

Contact details:
Dave Henshall
Deputy Director of Commercialisation
T:1-202-287-5511
M: 1-301-873-4927
David.Henshall@doe.gov

Instrument objective

ARPA-E's mission is to catalyse energy innovations that will create a more secure, affordable and sustainable American energy future. ARPA-E focuses on early stage technologies that have transformational impacts and can create options for entirely new paths to accelerate the pace of innovation to:

- reduce America's dependence on energy imports;
- reduce energy related emissions;
- improve energy efficiency across all sectors of the economy; and
- ensure the United States maintains a technological lead in developing and deploying advanced energy technologies.

Target beneficiaries

Beneficiaries should be primarily public or private U.S. entities. However, eligibility may vary for each funding opportunity announcement (FOA). Although foreign entitites are eligible for applying, ARPA-E can only make a funding award to a U.S. affiliate or subsidiary entity (i.e. incorporated in the United States or a U.S. territory).

Eligibility criteria and specific contractual conditions

ARPA-E looks at the team composition, the applicants experience, their familiarity and history with the technology along with wehther they have worked with the government before and whether they have been successful in the past. Moreover, ARPA-E looks at the commercialisation aspect of projects focusing on those projects that show some pathway to viability in the market.

In terms of clawback provisions and specific contractual conditions, they can be aggressive in shutting off funding when the programme milestones are not met.

Market acceptance and relevance

ARPA-E announces various FOAs. As such, the number of applications varies as it depends on the technology sector and how broadly or narrowly the call has been written. The main challenge faced by developers is technology-related. Thus, ARPA-E focuses on those risks making sure the technologies are both market-viable as well as technically feasible.

[587] Note that all values have been converted into euro using an exchange rate of 0.9185 EUR/ USD as of 05/11/2015 obtained from www.xe.com

Effectiveness and efficiency

Based on their mandate, ARPA-E focuses on early stage technologies that are 5 to 15 years away from being deployed. As such, it is too early to estimate potential impacts or outcomes achieved. However, they undertake active project management based on which the ARPA-E team along with the programme director and the technical experts visit the awardees on a quarterly basis at their site to ensure that project progress and spending is on track.

An evaluation to verify the organisation's effectiveness is currently underway and results will be made publically available at the end of 2016.

Since it started, ARPA-E has invested circa €1 billion across more than 400 projects (through 23 focused programmes and two open funding solicitations). As a result of tracking the outcomes of projects, ARPA-E has determined that €781 million in follow-on private sector funding has been stimulated. Interestingly, next year ARPA-E hopes to be able to announce that this leveraged follow-on funding has, for the first time, exceeded than which has been invested.

ARPA-E PROGRAMS TO DATE

	PROGRAM NAME	NUMBER OF PROJECTS	FUNDING AMOUNT ($ Million)[3]
EXISTING PROGRAMS	OPEN 2009	41	$175.0
	Batteries for Electrical Energy Storage in Transportation (BEEST)	10	$32.4
	Innovative Materials and Processes for Advanced Carbon Capture Technologies (IMPACCT)	15	$41.0
	Electrofuels	13	$48.7
	Agile Delivery of Electrical Power Technology (ADEPT)	14	$38.7
	Building Energy Efficiency Through Innovative Thermodevices (BEETIT)	17	$37.6
	Grid-Scale Rampable Intermittent Dispatchable Storage (GRIDS)	12	$34.0
	Plants Engineered to Replace Oil (PETRO)	10	$55.4
	High Energy Advanced Thermal Storage (HEATS)	15	$37.9
	Rare Earth Alternatives in Critical Technologies (REACT)	14	$37.5
	Green Electricity Network Integration (GENI)	15	$42.3
	Solar Agile Delivery of Electrical Power Technology (Solar ADEPT)	7	$13.5
	Methane Opportunities for Vehicular Energy (MOVE)	14	$40.5
	Advanced Management and Protection of Energy Storage Devices (AMPED)	14	$30.3
	Small Business Innovation Research / Small Business Technology Transfer (SBIR/STTR)	6	$12.8
	OPEN 2012	67	$158.7
	Innovative Development in Energy-related Applied Science (IDEAS)	6	$2.5
	Robust Affordable Next Generation Energy Storage Systems (RANGE)	22	$36.2
	Reducing Emissions using Methanotrophic Organisms for Transportation Energy (REMOTE)	15	$35.8
	Modern Electro/Thermochemical Advancements for Light-metal Systems (METALS)	18	$35.9
NEW IN FY2014	Full-Spectrum Optimized Conversion and Utilization of Sunlight (FOCUS)[4]	13	$35.3
	Strategies for Wide Bandgap, Inexpensive Transistors for Controlling High Efficiency Systems (SWITCHES) & SBIR/STTR	14	$29.0
	Reliable Electricity Based on ELectrochemical Systems (REBELS)	13	$33.7
	Delivering Efficient Local Thermal Amenities (DELTA)	11	$30.0
	Methane Observation Networks with Innovative Technology to Obtain Reductions (MONITOR)	11	$30.0
	Accelerating Low-cost Plasma Heating and Assembly (ALPHA)	N/A	$30.0

Moreover, based on their annual report for 2014[588], 22 ARPA-E projects have attracted more than €574 million in private sector follow-on funding after ARPA-E's investment of approximately €87 million – an excellent

[588] http://arpa-e.energy.gov/sites/default/files/FY14%20Annual%20Report%207_27_0.pdf

leverage multiple of 6.6x, demonstrating the catalytic effect of the scheme in the market. One of the reasons for this is ARPA-E's support in linking project sponsors where possible with private industry and investors such as venture capital funds and business angels. ARPA-E also works closely with the Energy Efficiency and Renewable Energy (EERE) group within DOE by introducing their projects teams to EERE for potential follow-on public sector funding of promising technologies.

ICF assessment of appropriateness for financing SET projects

ARPA-E has seen increasing levels of interest from potential project sponsors since its establishment six years ago. The community is starting to understand who they are, how they operate, the SET areas they focus on, what their differences are from other support schemes, how to work with them, and what advantages they provide.

The TRL focus of ARPA-E makes it too early-stage as a support scheme for supporting FOAK projects. However, the approach taken provides some valuable insights for both the design of any future intervention and the associated activities which any delivery body would be delivering alongside. These learning points include:

- It takes time for a support scheme to 'bed down' and achieve market branding and credibility;
- It is sensible to take a very strategic market focus to understand the nature and scale of the market opportunity once technologies are commercialised, thereby reducing potentially wasteful investments;
- Working with industrial companies and the venture investment community at the earliest possible stage can increase the visibility of new innovations and help increase levels of "buy-in" to investment propositions (rather than coming 'to the table' late which can increase investor perceptions of risk);
- Adopting a strict procedure for 'dropping' projects that are not delivering against their objectives is prudent;
- Working with the public and private sector to ensure a continuum of funding is on offer for the most promising innovations can avoid potential funding gaps in the commercialisation pathway; and,
- Building a robust monitoring and evaluation framework to determine project outcomes and impacts and to measure the overall success and value of the intervention is vital to demonstrating long-term value.

Name	**NEDO – New Energy and Industrial Technology Development Organisation, Japan**	
Geographical area	Global focus – international demonstration projects currently spread across Europe, Asia and the USA	
Year started	1980 (year established)	
Status	Open	
Type of instrument	Grants to universities and subsidies to industries[589]	
Annual budget [590]	€1.1 billion (FY2015)[591]	
Project funding amount	Not specified (highly variable depending on the technology)	
TRL focus	1-9 (assumed)	
Technology coverage	Wide scope of coverage ranging from energy and environmental technologies to industrial technologies. In essence, they cover all SET sectors (i.e. solar, wind, biomass, geothermal, ocean, smart grids, energy storage and CCS)	NEDO http://www.nedo.go.jp/english/

Instrument objective

Since its establishment, NEDO has been one of the largest public research and development management organizations in Japan. It plays a pivotal role in undertaking technology and demonstration activities with the aim to address energy and global environmental problems and enhance industrial technologies[592]. The organisation was redesigned as a national R&D agency in April 2015 and renamed the New Energy and Industrial Technology Development Organization. It was envisaged as contributing to the international community and actively promoting international demonstration projects in Europe, Aisa and the USA using leading-edge Japanese technologies.

Target beneficiaries
National and international corporates (including SMEs) along with academic and public research institutions.

Eligibility criteria and specific contractual conditions

Although there are no explicitly defined eligibility criteria NEDO's focus is on projects that:
- have a medium to long-term time horizon with a clearly defined scope;
- aim to achieve full-scale technology demonstration;
- support technology commercialisation that can achieve rapid economic growth; and,
- promote international cooperation in line with memoranda of understanding signed with partner countries.

[589] http://www.nistep.go.jp/IC/ic060110/pdf/2-3.pdf

[590] Note that all values have been converted into euro using an exchange rate of 0.0076 EUR/JPY as of 05/11/2015 obtained from www.xe.com

[591] http://www.nedo.go.jp/english/introducing_pja.html

[592] http://www.nedo.go.jp/content/100755419.pdf

Market acceptance and relevance

NEDO has evaluated the cost effectiveness of 100 projects[593] that have deployed project results as core technologies into their products/processes. As presented in the table below (which captures a selection of the 21 key technology areas supported by NEDO), solar power generation is clear frontrunner with respect to forecasted sales for the period 2013 to 2022, equivalent to 124x the total investment to date from NEDO. Although currently a much smaller future market (for the technologies supported by NEDO), wind power has a multiplier of 209x total investment to date.

	Project duration (years)	NEDO budget outlay		Sales performance		Forecasted sales (2013-2022) (m €)	Return on investment ratio
		Project costs pa (m €)	Cumulative project costs (m €)	Most recent annual sales (2012) (m €)	Cumulative sales after release (up to 2011) (m €)		
Solar power generation	30	44	1,319	9,980	59,634	163,959	**124**
Gas turbines	15	27	407	2,308	11,170	34,535	**85**
Residential fuel cell	18	37	669	266	496	16,598	**25**
Wind power generation	21	3	65	926	5,583	13,508	**209**
Coal thermal power and geothermal	11	55	629	60	3,143	2,761	**4**
Waste power generation	4	14	61	13	673	808	**13**

Effectiveness and efficiency

In Japan, NEDO has been championing offshore wind research and demonstration. It supported the installation of an offshore MHI 2.4 MW wind turbine with gravity foundation and offshore platform in 2012 along with the installation of a JSW 2 MW gearless offshore wind turbine in 2013. Japan also has an objective of taking a leading role in offshore floating wind with funding in this area provided by other governmental entities such as the Ministry of Environment (MOE) who backed the Floating Offshore Wind Turbine Demonstration Project (FY2010 to FY2015) and the Ministry of Economy, Trade and Industry's Floating Offshore Wind Farm Demonstration Project (FY2011 to FY2015). In the latter project, METI is supporting an array of three floating wind turbines with a consortium of Japanese conglomerates includes MHI, Hitachi and Mitsui together with RTOs and SMEs[594]. MHI's 7 MW offshore turbine was due to be installed onto one of the three platforms in 2015.

Some of the international demonstration projects supported by NEDO include:

- The inauguration of one of the world's largest digital hydraulically-driven 7 MW offshore wind turbines, developed by Mitsubishi Heavy Industries Ltd. in the UK in February 2015.

- A demonstration project using a battery energy storage system (power output: 500kW, storage capacity: 776kWh) to stabilize distribution networks in an electric substation in Spain[595].

- The first demonstration project under NEDO's "Smart Community Overseas Demonstration Projects" in Los Alamos and Albuquerque in Mexico[596], where tests were performed in collaboration with the state

[593] Adjusted from http://www.nedo.go.jp/content/100749845.pdf

[594] Consortium comprises Marubeni (project integrator), the University of Tokyo, Mitsubishi, Mitsubishi Heavy Industries [turbine supplier], IHI Marine United [turbine supplier], Mitsui Engineering & Shipbuilding [turbine supplier], Nippon Steel, Hitachi, Furukawa Electric, Shimizu and Mizuho Information & Research (source: http://www.mitsubishicorp.com/jp/en/pr/archive/2012/html/0000014308.html)

[595] http://www.nedo.go.jp/english/news/AA5en_100021.html

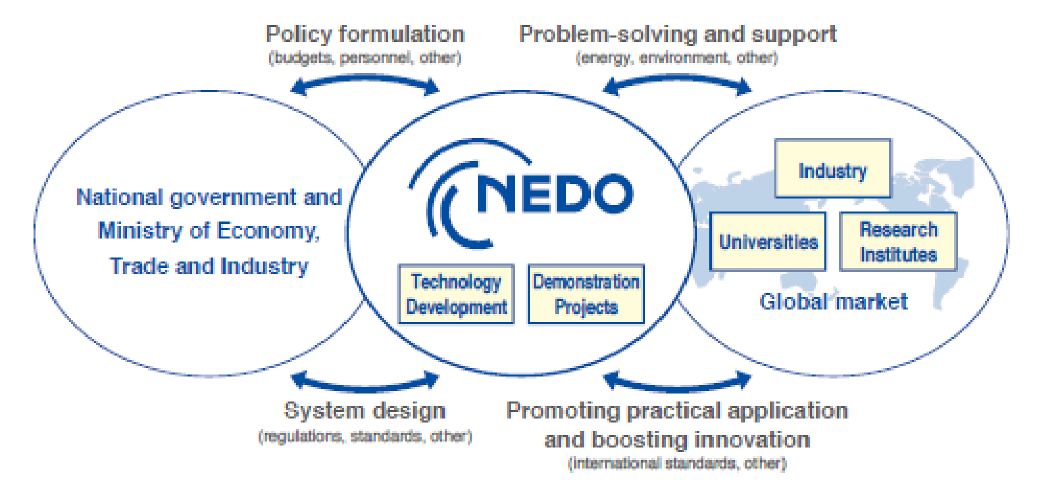
[596] http://www.nedo.go.jp/english/news/AA5en_100001.html

government as well as national laboratories affiliated with DOE[597] (total NEDO funding for both sites amounted to €56 million).

- Smart Community demonstration projects in Lyon, France and Malaga, Spain.

ICF assessment of appropriateness for financing SET projects

By carrying out international demonstration projects, NEDO aims to make innovative Japanese technologies available to countries and regions around the world with diverse needs and infrastructure. In support of that, NEDO has developed Roadmaps for 21 key technologies which are of a high priority to Japanese industry and its research base, as outlined in the "Cool Earth-Innovative Energy Technology Programme"[598]



The scale of public sector investment which Japan is able to commit to strategic SET areas[599], backed by private investment from large industrials with formidable technological capabilities and global sales track record, gives NEDO a clear advantage in the global FOAK market. Together with a strategic intent to align FOAK project demonstration with clearly targeted international market opportunities provides a potent reminder of how quickly technological development and leadership can be achieved with a well designed programme.

Due to NEDO (and METI) being unwilling to being consulted, we are unable to confirm the precise nature of the investments made and the type of financial support, although we assume them to be grant funded. What is a clear learning point from this scheme, however, is the ability of NEDO to create channels to market for Japanese technologies, especially in Europe.

[597] http://www.narucmeetings.org/Presentations/NEDO%20and%20International%20Activities.pdf

[598] http://www.meti.go.jp/english/newtopics/data/pdf/031320CoolEarth.pdf

[599] Funding provided by NEDO aligns with efforts made by other governmental bodies such as MOE and METI.

Name	Callaghan Innovation – Project and Growth Grants (also known as R&D grants)	
Geographical area	New Zealand	
Year started	1 February 2013	
Status	Open – rolling applications	
Type of instrument	Grants-based mechanisms divided into: 1. Project grants (for a specific development activity with a defined scope of work) 2. Growth grants (a tax-break for large established companies with established R&D programmes that spend at least €183,000 on R&D in each of the last 2 years and spend at least 1.5% of its revenue on R&D)	
Annual budget [600]	€97.5 million for grants mechanism (along with €48.8 million as operational funding)	
Project funding amount	Both project and growth grants can receive up to €3 million funding but: 1. For project grants, intervention rates vary between 30-50%, based on parameters such as spillover benefits outside the business and impacts of the grant regarding the commercial success of the project. 2. For growth grants, intervention is up to 20% of eligible R&D costs.	
TRL focus	TRL 4 – 8	https://www.callaghaninnovation.govt.nz/
Technology coverage	Broad coverage of sectors depending on which businesses apply for funding. Therefore no grants are allocated specifically to clean technologies although they could cover anything from energy generation to transmission, distribution energy efficiency and consumer products.	**Contact details:** Chris Thomson National network manager for energy Chris.Thomson@callaghaninnovation.govt.nz

Instrument objective

With current business expenditure on R&D at a very low level[601], the New Zealand government has a broad policy called the Business Growth Agenda which focuses on growing high value exports backed by technology companies and high value manufacturing. The policy was established by the Ministry of Business, Innovation and Employment (MBIE). Callaghan Innovation was formed two years ago as an operational agency with the aim to accelerate the commercialisation of innovation by New Zealand businesses and, in particular, to grow the high value manufacturing technology sector and increase its export revenues. Callaghan Innovation's activities will contribute to achieving the Government's target of increasing business expenditure on R&D (BERD) to 1% of GDP by 2018 and increasing exports to 40% of GDP by 2025.

Target beneficiaries

Callaghan Innovation provides funding solely to businesses incorporated in New Zealand and not science or

[600] Note that all values have been converted into euro using an exchange rate of 0.6091 EUR/NZD as of 05/11/2015 obtained from www.xe.com

[601] Fewer than 5% of New Zealand businesses with more than six employees do R&D, amounting to €0.76 billion spending on R&D in 2014 http://www.callaghaninnovation.govt.nz/sites/all/files/callaghan-innovation-soi-june-2019-web.pdf

research groups. Their primary focus is on businesses within the high-value manufacturing and services sector as these businesses are export and R&D intensive and are more likely to innovate than other sectors.

Eligibility criteria and specific contractual conditions

Based on the eligibility criteria for the R&D grants, applicants should:

1. have at least one director who is a New Zealand resident, and are incorporated in New Zealand, or have a centre of management or head office in New Zealand; and,
2. meet financial and due diligence requirements.

For project grants additional eligibility criteria apply such as potential commercial returns to the business, ability to monetize results, ability to successfully deliver on the technical aspects and whether there is a technology stretch[602]. For growth grants, businesses should spend at least €183,000 on eligible R&D in each of the last two years and at least 1.5% of its revenue on R&D in each of the last two years, or plan to increase R&D spending over the next two years[603].

Market acceptance and relevance

Based on information provided by Callaghan Innovation, during the period of July 2014 to June 2015 (FY 2015) 165 applications for project grants were examined of which 144 were approved and 21 were declined leading to a success rate of 87% of total applications received for project grants.

Support provided by the Callaghan Innovation team is instrumental in securing successful applications. A good network of client-facing staff comprises business managers working closely with businesses from the outset.

However, one of the challenges faced by applicants in terms of meeting their eligibility criteria is the assessment of the return on investment. This is especially the case when there is uncertainty about what the market potential could be and consequently there is low confidence in the estimates provided.

Effectiveness and efficiency

In the 2015 annual report[604], key performance indicators of Callaghan Innovation are described and assessed against targets. In particular, a biennial business R&D survey is carried out to assess business expenditure on R&D (BERD). The target to increase business expenditure on R&D (BERD) above previously surveyed levels was not met according to the 2014 New Zealand Biennial R&D survey. BERD represented 0.54% of GDP in 2014, down from 0.58% in 2012. This is a result of any increase in BERD being outpaced by GDP growth.

In terms of private sector leverage, Callaghan Innovation funding achieved a roughly 1:1 ratio, although the 52% private funding intervention for commercial projects exceeded the 40% target.

ICF assessment of appropriateness for financing SET projects

Based on insights gained during the interview with a Callaghan Innovation representative, 83% of the electricity in New Zealand is generated from renewables (hydro, wind and geothermal). Consequently, due to having an already mature renewables market and no immediate security of supply issues, there has been no government pressure to push innovation or reduce emissions in the energy generation market. Furthermore, no formal mechanism exists in New Zealand for first-of-a-kind projects with high funding needs (for example of over €3.5 million) especially given the size of the country. However, interested investors with large-scale projects that have aligned goals with the Business Growth Agenda can be facilitated through the energy policy team within the Ministry of Business, Innovation and Employment. Therefore potential large-scale FOAK projects are not ruled out. Although the fundamentals of the specific scheme do not offer any obvious learning for FOAK project funding, feedback on the scheme does highlight the benefit of applicants being supported closely by scheme experts. It also illustrates the challenges of providing realistic market forecasts for innovative new technologies which might help sway an independent evaluator of a proposal. Intervention rates are also no larger than 50%.

[602] http://www.callaghaninnovation.govt.nz/sites/all/files/rd-grants-brochure-07-2015.pdf

[603] http://www.callaghaninnovation.govt.nz/grants/growth-grants

[604] http://www.callaghaninnovation.govt.nz/sites/all/files/callaghan-innovation-annual-report-2015.pdf

6 Market Participants Survey

The following document consists of a concise report of the survey by interview of market participants from the four groups described in Market Participant Description Sheets using the questionnaire approved for that purpose. The template of that questionnaire is included in this report as Annex 1. The four groups are:

- Banks (public, commercial, investment, universal);
- General investors (asset managers, pension funds, insurance companies, and foundations);
- Specialised investors (venture capital, private equity firms);
- Producers (utility and energy companies, industrial firms)

Interviews were undertaken in the period 30 July to 3 November 2015. In total, 25 interviews were undertaken with market participants drawn, with one exception[605], the Consolidated List of Market Participants. Interviews were conducted on a confidential basis.

Of the 25 market participants interviewed, seven are banks (mainly universal but some commercial, investment or public), six are general investors (i.e., asset managers, foundations, insurance companies and pension funds), seven are specialised investors (i.e., venture capital firms and private equity firms), and five are producers (i.e., energy companies, industrial firms and utility companies).

6.1 Approach

The ICF Team identified suitable persons within each of the eighty market participant organisations on the Consolidated List who could act as interviewees and invited them to interview via email. Suitable persons included senior bankers, managing directors of investor firms, and division heads of industrial conglomerates. (In most cases, reminder emails and phone calls proved necessary for the interview to be secured. Even so, only a minority of market participants agreed to be interviewed.)

Through the interviews, the ICF Team sought information on the following areas:

1. Risks and obstacles to financing Strategic Energy Technology (SET) opportunities[606]
2. Market participants' SET financing strategies, in particular:
   - In which SET sectors is the market participant active in making deals?
   - At what Technology Readiness Levels (TRLs)?
   - In which regions of the world and countries?
   - What volume[607] of financing does the market participant disburse into SET?
   - What forms of finance underpin its SET deals?
   - What are the typical financial parameters of those deals?
3. Market participants' FOAK[608] financing strategies, in particular:
   a. For market participants who do pursue FOAK opportunities:
   - In which SET sectors does the market participant pursue FOAK opportunities?
   - How many opportunities does it consider annually?
   - What is the typical pipeline of lookalike transactions sought?
   - What kinds of partners are sought?
   - At what stage does the market participant first become involved?

[605] An asset manager active in SET who had heard of the Study and volunteered to be interviewed.

[606] An opportunity to finance a project (e.g., through a loan) or a company undertaking such a project (e.g., through equity)

[607] Significance of market participant's overall financing volume into SET opportunities: High means > €100m, Medium means between €50m and €100m, Low means < €50m

[608] First-of-a-kind as in "first-of-a-kind commercial scale energy demonstration project" and companies undertaking such projects

- Has the market participant achieved any successful FOAK exits (in the case of equity) or been successfully repaid (in the case of loans)?

b. For market participants who do NOT pursue FOAK opportunities:

- What are their reasons for not doing so?
- What factors and framework conditions might persuade them to do so?

4. The market participant's reaction to the project investment sheets
5. What European Union and Member State support schemes has the market participant explored?
6. What recommendations does the market participant have (mainly with respect to a publicly funded financing instrument for lowering risks and improving market engagement)?

Sections 6.2 to 6.5 provide an overview of responses from each of the four market participant groups. Section 6.6 gives an overview of key findings from the interviews.

6.2 Responses from Specialised Investors

Interviews were conducted with four Venture Capital firms (VC 1 – 4) and three Private Equity firms (PE 1 – 3).

6.2.1 Specialised Investors' perception of key Risks and Obstacles to financing SET

Specialised Investors set out their perception of key risks and obstacles for SET financing in more detail than other types of market participant.

6.2.1.1 Technology risk

A MAJORITY of Private Equity firms and Venture Capital firms cited **technology risk**. In particular:

- Technology risks, including scale-up risks and risks of suppliers' technology not working are very high (particularly for Ocean energy) and **can be borne only by big players**. Small technology developers therefore need to be working with large industrial companies who can guarantee performance. (PE-1);
- Project developers need to have successfully piloted their technology (PE-2);
- Because of technology risks, projects in SET are inherently risky (VC-2);
- There is a risk associated with fitting new technology into existing infrastructure (VC-4).

6.2.1.2 Regulatory risk

ALL Private Equity firms and a MAJORITY of Venture Capital firms cited **regulatory risk**. In particular:

- **Feed-in tariffs**:
  - Reductions in feed-in tariffs are a big risk for solar PV (PE-1);
  - PE-2 sees feed-in tariffs as a regulatory risk because they may be withdrawn, and so avoids investments into companies whose projects would rely on them;
  - Risks have arisen from feed-in tariffs being reduced (VC-2)
  - Changes to feed-in tariffs bring huge instability (VC-3)
- **Grants[609] and subsidies[610]**:

[609] We note that the withdrawal of grants or grant schemes is not a regulatory risk; however, some market participants defined it as such.

[610] We note that feed-in tariffs may sometimes be classed as subsidies.

- PE-1 avoids SET opportunities that involve long-term grants as these grants may be withdrawn;
- High subsidies create artificially high process for biomass, making it very difficult to hedge prices (VC-1);
- The biggest and ongoing risk is that of the withdrawal by government of grants and subsidies on which clean-energy companies depend (PE-3)

- **Lack of harmonisation between regulatory regimes**
  - Regulatory risks arise from the lack of harmonisation of regulatory regimes for energy in Europe. This means that, for example, technologies that are commercially viable in Czech Republic may not be 'investable' in Germany because of the different regulatory regime (VC-1).

6.2.1.3 *Financial obstacles*

One Private Equity firm and a MAJORITY of Venture Capital firms cited financial obstacles. In particular:

- **Scale of costs/ capital intensity**:
  - The sheer cost of new technologies, extending to tens of millions, in ocean energy, biomass conversion and offshore wind is a huge obstacle to investment (PE-1);
  - Relatively large costs and lengthy time horizons make SET less attractive than software or IT-based technologies (VC-2);
  - Coastal (i.e., lagoon) energy storage is too expensive and innovation in solar PV manufacturing is capital intensive (VC-1)
  - The amount of money required to get these projects to commercial scale is enormous (VC-4)

6.2.1.4 *Commercial risks*

One Private Equity firm and a MAJORITY of Venture Capital firms cited commercial risks. In particular:

- High cost per MWh of generation (VC-4);
- Re. biomass opportunities: Are there supply and offtake agreements in place? (PE-2);
- Unfair competition from outside Europe in relation to solar PV manufacturing (VC-2);
- Re. large-scale energy storage: the lack of a commercial structure for revenue generation (VC-4) and the lack of secure revenue streams (VC-3).

6.2.1.5 *Other risks*

Other risks mentioned by at least one Specialised Investor include feedstock quality risks, sovereign risks in emerging markets, intellectual property risks, risks associated with management in new companies, and risks associated with commercial adoption of new products.

6.2.2 SET Financing Strategies of the Specialised Investors

All Specialised Investors interviewed **have been active in the financing of SET opportunities** (i.e., projects or the companies undertaking them) although there is **change in strategy for two** – PE-3 and VC-2 have moved out of SET financing to other sectors that have, according to them, less risk and better returns, such as energy efficiency and digital media.

6.2.2.1 *SET sectors and TRLs*

Unlike the Banks and General Investors, the Specialised Investors collectively cover a wider range of SET sectors and TRLs as shown in Table 6.1 below.

Table 6.1 Coverage by Specialised Investors of SET sectors and Technology Readiness Levels

AEN: advanced electricity networks; BIO: biomass conversion; CCS: carbon capture & storage; CSP: concentrating solar power; GEO: geothermal; LES: large-scale energy storage; SPV: solar photovoltaics; WIN: wind energy; ● = currently active; O = historically active

Specialised Investor	AEN	BIO	CCS	CSP	GEO	LES	OCN	SPV	WIN	Technology Readiness Levels
PE-1	●	●			●		o	●	●	6 – 8
PE-2		●	o					●		6 – 8
PE-3	o				o			o		9
VC-1	●	●							●	6 – 8
VC-2				o		o	o	o	o	5 – 9
VC-3		●				●		●		7 – 9
VC-4	●		●			●		●		5 – 9

6.2.2.2 Geographical remit

Among the currently active Specialised Investors, geographical remit consists of a handful of countries in two or three global regions: Europe, Africa, the Americas and Asia. **No region dominates**.

6.2.2.3 Volume and form of financing

Of the currently active Specialised Investors, **three disburse less than €10m annually** into SET opportunities, and **two disburse more than €10m but less than €50m annually**. Considering the forms of financing provided for SET opportunities:

- ALL active Specialised Investors provide **Equity**;
- ONE active Specialised Investor (VC-4) also provides "convertible Grants" and Debt in the form of mezzanine loans.

6.2.2.4 Financing criteria and parameters

Among the factors that the Specialised Investors interviewed consider when making an investment or lending decision in SET are:

- Investee company's **technology** – is it **unique, robust, scalable, proprietary?** Is the **concept proven?** Has it been **piloted**? Is there a working prototype?
- The state of and **trends in the market** for the technology
- Strength, expertise and credibility of the investee company's **management team** – have they done more than one deal? Do they have an attractive business plan?
- Investee company's size (preferably small; for VC-1, be too small to raise money in the capital markets) and age (at least 5 years)
- What are the opportunities for deal **syndication**? Co-investors might be high-net worth individuals, family offices, companies upstream or downstream of the investee company.
- Is the investee company **partnering with a large manufacturer**?

The Specialised Investors interviewed declined to specify in full the financial parameters of their SET deals, with many saying that the parameters of a deal were unique to that deal. The information gathered is summarised here:

- <u>Deal size</u>:
  - For equity deals, deal size range is **€0.5m** to **€4m** (VC-1), **€1m to €3m** (PE-1)

- Debt/equity ratios:
  - 60/40 for high-risk opportunities; 80/20 for low-risk solar PV opportunities (VC-3, the only specialised investor to provide loans)
- Debt-service coverage ratio:
  - Not specified
- Time horizons for return or exposure:
  - Notional time horizon is 3 – 8 years (PE-1)
  - 5 – 8 years (PE-2)
  - Investee company must become profitable within 8 – 9 years (VC-1)
  - "We aim to get our money back within 7 – 10 years" (VC-2)
  - Target time horizon for return: 3 – 5 years; in reality more like 5 – 7 years (VC-4)
- Target rates of return:
  - Cash-in: cash-out ratio of 1:3, achieved by 40-50% of investments (PE-1)
  - Indicative IRR rates: for solar, 7%; for onshore wind, 8%; offshore wind, 9%; biomass conversion, 15%. "The IRR goes up as the feedstock risk goes up." No IRR for energy storage (PE-1);
  - Internal rate of return of 20% per year unlevered over 5 – 8 years, meaning return of 2.5 – 3X investment (PE-2);
  - Aim to make 3 – 5 times return on investment (VC-4);
  - Returns on equity vary from 15 and 25% (VC-3);
  - If the return on mezzanine loan "goes above a certain threshold", some of the return is shared with mezzanine lenders. Interest rates vary from 8% for low risk projects to 14% for high-risk projects (VC-4)
- Dividend policy:
  - Not specified

6.2.3 FOAK Financing Strategies of the Specialised Investors

PE-3 and VC-2 are not active in the financing of SET opportunities and hence are not active in the financing of FOAK opportunities. VC-2 nonetheless provided information regarding historical activity. All other Specialised Investors are currently active but generally not to the same extent as a few years ago. PE-1 summed up the problems with respect to FOAK opportunities as follows:

- The depth of funding is thin as the risk appetite has gone out of the market;
- Market participants have stopped investing in FOAK because they have lost money;
- Selling something new (i.e., FOAK) into the market is incredibly difficult: durability and reliability are key, not just an efficiency gain;
- It is now impossible to finance ocean energy or innovative offshore wind opportunities.

6.2.3.1 SET sectors targeted for FOAK opportunities

The Specialised Investors cover the range of SET sectors shown in Table 6.2 below.

Table 6.2 SET sectors targeted for FOAK opportunities by Specialised Investors

AEN: advanced electricity networks; BIO: biomass conversion; CCS: carbon capture & storage; CSP: concentrating solar power; GEO: geothermal; LES: large-scale energy storage; SPV: solar photovoltaics; WIN: wind energy; ● = currently active; O = historically active

Specialised Investor	AEN	BIO	CCS	CSP	GEO	LES	OCN	SPV	WIN
PE-1	●	●			●		O	●	●
PE-2		●							
VC-1	●	●							●
VC-2				o		o		o	o
VC-3		o				●			
VC-4						●			

6.2.3.2 Number of FOAK opportunities considered, pipeline of lookalike transactions

The **number of FOAK opportunities considered annually ranges from "several" to "hundreds".** There is no obvious correlation with the volume of funds disbursed into SET. Only PE-2 and VC-4 were willing to discuss the pipeline of lookalike transactions. However, PE-2 would only say that it looks for the investee company to have a pipeline of projects that will enable it to grow to be a business over USD 100 million in size. VC-4 does not consider this an important criterion.

6.2.3.3 Partners sought

Similarly to when making a financing decision in SET, the Specialised Investors look for the following features in partners in FOAK opportunities:

- Strength, expertise and credibility of the investee company's **management team** – have they done more than one deal? Do they have an attractive business plan?
- Investee company's size (preferably small) and age (at least 5 years)
- What are the opportunities for deal **syndication**? Co-investors might be high-net worth individuals, family offices, companies upstream or downstream of the investee company.

According to PE-1, **there are very few institutional funds still around who are investing in demonstration-stage opportunities** and it is a struggle to find co-investors.

6.2.3.4 Stage at which involved

The Specialised Investors gave few and conflicting details in this respect:

- PE-2 does not get involved earlier than the time required to build the demonstration plant (i.e., 6 to 18 months);
- PE-1 does not consider this to be important;
- VC-1 simply says that the investee company must be profitable within 8 – 9 years.

6.2.4 Successful exits

The Specialised Investors were reluctant to answer this question. However:

- PE-1 stated that it has made two successful exits and two partially successful exits that together have "delivered 1.5 times the amount of money invested". Another exit is planned for next year;
- VC-1 has achieved a successful exit from a supplier of novel batteries

- All six of VC-2's investments into FOAK solar PV manufacturing opportunities failed (due to dumping by Chinese manufacturers).

6.2.5 Specialised Investors' reactions to investment sheets

All the Specialised Investors interviewed **declined to comment in detail on the investment sheets**. At most, they restricted themselves to making some general remarks about risks, which have been integrated into previous sub-sections.

6.2.6 EU and MS support schemes explored by the Specialised Investors

Horizon 2020 was mentioned by three Specialised Investors. PE-1 arranges assistance for investee companies in applying for EU grants, particularly from Horizon 2020. VC-1 considers that Horizon 2020 has a set of requirements that are impossible for start-up companies to meet, in particular the requirement to demonstrate that they have a partner in a different Member State from themselves. VC-3 stated that the problem with Horizon 2020 is its requirement that applicants should obtain 60% co-financing from other sources.

VC-1 has explored a **venture capital facility managed by the European Investment Bank** that supports venture capital and private equity fund managers, SMEs and early stage companies developing or using advanced technologies. Unfortunately, it could not meet the facility's requirement of raising 80% funds to match the 20% funding provided by the EIB.

Without giving any specifics, VC-2 stated that it has explored a number of German and Swedish publicly funded support schemes as well as an EIB scheme for clean-tech companies and the European Investment Fund. It considers the **European Investment Fund could be a good vehicle for equity for FOAK opportunities**.

PE-1 has used monies received from Member State and EU funds to make investments in FOAK opportunities. It would be interested in doing so again even though it believes the application processes would be difficult.

6.2.7 Recommendations for the Commission from the Specialised Investors

Between them, the Specialised Investors made several recommendations, not all of which are compatible with each other. They are summarised below, elaborating on those involving financial instruments and continuing with those that do not involve financial instruments but other measures.

6.2.7.1 Provide support for only the construction phase, use grants and subsidies to do so

PE-2 does not approve of any form of ongoing publicly funded support (and will avoid FOAK or SET opportunities in which there is such kind of support, including feed-in tariffs) except for "one-off" grants or subsidies to assist with construction. PE-2 believes there could be role for the EC to provide such assistance in the construction phase.

6.2.7.2 Create a new expert-led equity-based support scheme

VC-1 observed that EU monies are currently "spread too thinly to too little effect" across various Support schemes. It recommends, for reasons of efficiency, that EU monies be put into one fund supervised by a few experts. When establishing this fund, the EU could encourage other investors to contribute monies.

Similarly, VC-4 recommends that the EC establish a fund with an investment committee setting investment targets, making investment decisions, and having a right of first refusal in subsequent projects of the investee company.

In a more detailed suggestion, PE-3 recommends that the EC establish a "commission" comprising 20 to 30 private-sector market participants such as venture capital firms, private equity firms and pension funds as well as public officials. Investments could be on a volume discount basis and have a hurdle rate of 6 – 8 %. Funds would come from emitter companies on a "polluter pays" principle. PE-3 put forward this idea in relation to infrastructure resilience and climate adaptation but ICF mentions it here as the idea could be used to support FOAK project as well.

6.2.7.3 Use existing vehicles to provide equity

Though not necessarily arguing against the creation of a new publicly funded support scheme, two Specialised Investors pointed out that vehicles already exist. VC-3 suggested that "the EU could channel financing through existing venture capital funds, as the EIB does in Africa." VC-2 observed that the European Investment Fund could be a good vehicle for equity for FOAK opportunities.

6.2.7.4 Provide financing in forms other than equity but take the upside

VC-3 proposes that the EU should provide 70 – 80% of financing in several tranches of different types: e.g., convertible grants, low-interest loans, mezzanine loans. "If the investee company's project fails, everyone loses money. If the project is semi-successful, the loan is repaid but not the grant. If it is successful, the loan is repaid, the grant is repaid, and a share of the returns is paid out."

6.2.7.5 Provide insurance against technical risks

VC-3 proposes that the EU could provide "some kind of re-insurance" against the technology risks of the first project of the investee company. PE-1 makes a similar recommendation specifically for geothermal opportunities, which should be supported through establishing an EU-wide insurance policy, as happens in France and the Netherlands. The basis of this recommendation is that the risk is due to "the geology failing 5% of the time", which is too often for investors when drilling costs may be €7 million. Hot-rock geothermal should not be eligible, according to VC-1, as the risks are higher.

6.2.7.6 Incentivise large industrial companies to invest in FOAK

VC-1 makes this recommendation on the basis that the large balance sheets of industrial companies make them more readily able than other market participants to invest in riskier ventures, such as FOAK opportunities.

6.2.7.7 Collaborate with partners who actually operate near the "Valley of Death"

VC-3 stated that the only types of market participant who operate near "the Valley of Death" and recommended that the EC collaborate with them. On the one side of the Valley of Death are venture capital firms who are willing to finance early stage projects, and on the other side are private equity firms who are willing to finance opportunities related to proven technology with a track record.

PE-3 was similarly keen that the EC should work with venture capitalists and private equity firms.

6.2.7.8 Support technology developers from the early stages of their projects

VC-2 stated that not just publicly-funded financing instruments are needed but "other carefully planned policies that would allow European technology developers to grow into sustainable businesses". The US ARPA-E scheme would be a good model to follow. (This scheme is described in the Regional Analysis and does deliberately support technology developers from the early stages of the project development cycle through to commercialisation.)

6.2.7.9 Utilise monies from existing R&D budgets

According to VC-2, a percentage of MS/EU R&D budgets should be used for commercialisation of R&D through soft funding. "There is a huge amount of R&D funding available but only a pittance available for funding the commercialisation of R&D."

6.2.7.10 Recommendations that do not involve financial instruments

These include recommendations that the EC should:

- Publish reports on successful FOAK demonstration case studies as they would show that clean technologies are investible and so attract investment (VC-1)
- Play a role in developing a consistent energy policy across all Member States (VC-1)

- Regulate the European energy market to enable a framework for secure revenue streams from energy storage (VC-3)
- Protect European businesses from unfair competition and ensure that European taxpayers' money is used to support European businesses and not disguised non-European businesses (VC-2)
- Play a role in getting governments to put a real cost on carbon emissions (VC-4)

6.3 Responses from General Investors

Interviews with six General Investors (GI 1 – 6).

6.3.1 General Investors' perception of key Risks and Obstacles to financing SET

As regards General Investors' perception of the key risks and obstacles for SET in general:

- A MAJORITY mentioned **regulatory instability**;
- HALF mentioned **unproven technology** (incl. scale-up) risks;
- Other risks and obstacles mentioned by at least one General Investor are:
  - Large volumes of financing required;
  - Low return on investment and long horizons for those returns;
  - Risk of price instability due to regulatory changes, especially to feed-in tariffs;
  - Lack of a stable price framework for biomass (i.e., no fixed feedstock or off-take prices);
  - Low prices for electricity from solar PV;
  - Risks surrounding the enforceability of owner and lender rights (especially in Southern Europe);
  - Risk of lack of acceptance of a SET project by local stakeholders.

6.3.2 SET Financing Strategies of the General Investors

All General Investors interviewed **have been active in the financing of SET opportunities** (i.e., projects or the companies undertaking them) although there is **change in strategy for two** – GI-4 has moved out of SET, while another GI-3 is moving away from SET financing to other high tech sectors that have, according to them, less risk and better returns.

6.3.2.1 SET sectors and TRLs

The SET sectors and TRLs in which General Investors pursue opportunities are shown in Table 6.3 below.

Table 6.3 Coverage by General Investors of SET sectors and Technology Readiness Levels

AEN: advanced electricity networks; BIO: biomass conversion; CCS: carbon capture & storage; CSP: concentrating solar power; GEO: geothermal; LES: large-scale energy storage; SPV: solar photovoltaics; WIN: wind energy; ● = currently active; O = historically active

General Investor	AEN	BIO	CCS	CSP	GEO	LES	OCN	SPV	WIN	Technology Readiness Levels
GI-1		●		●				●	●	TRL 9
GI-2								●	●	TRL 9
GI-3	o				o	o		o		TRL-6
GI-4								o	o	TRL 9
GI-5									●	TRL 9
GI-6								●	●	TRL 9

6.3.2.2 Geographical remit

Among the currently active General Investors, geographical remit varies from Worldwide to a handful of European countries, but for all **Europe is the most important region**.

6.3.2.3 Volume and form of financing

Of the currently active General Investors, GI-3 disburses less than €10m annually into SET opportunities, and **the rest each disburse over €100m annually**. Considering the forms of financing provided for SET opportunities:

- ALL active General Investors provide **Equity**;
- A MAJORITY of active General Investors provide **Debt**
  - GI-1 provides senior and junior debt;
  - GI-4, which has withdrawn from SET, provided amortised debt[611].

6.3.2.4 Financing criteria and parameters

Among the factors that the General Investors interviewed consider when making an investment or lending decision are:

- **Is the technology proven**? Is it certified by a quality assurance organisation?
- Is the project developer **partnering with a large industrial or utility company** with a strong balance sheets who can **guarantee construction and operation**?
- Does the project developer have a **strong management team** and good **potential for growth and profit**?
- Does the project developer enjoy a **monopolistic position** by virtue of an exclusive contract or concession?
- Is the project developer intending to **undertake at least 10 projects**?

[611] i.e. where interest and principal is paid down over the loan lifetime, as opposed to a large proportion of the loan being paid off at the final maturity date

- Could the deal lead to a **pipeline of projects or new relationships** with other market participants?
- What are the opportunities for deal **syndication**?

The General Investors interviewed declined to specify in full the financial parameters of their SET deals. The information gathered is summarised here:

- Deal size:
  - For debt deals, typical deal size is **€30 million** (TRL9)
  - For equity deals, deal size range is **€1m to €20m**, corresponding to equity shares typically of 15% - 20% and maximum 50% (TRL6) or €100m to €150m (TRL9)
- Debt/equity ratios:
  - No information provided regarding current deals; for historic deals: 70/30 (TRL9)
- Debt-service coverage ratio:
  - “There is no minimum annual average debt service coverage ratio as that depends on the project” (TRL9)
- Time horizons for return or exposure:
  - 5 years but can be as long as 15 years (TRL6)
  - 10 years “to be the same duration as the fixed-tariff period” (TRL9)
  - Notional repayment of the loan within 15-20 years (TRL9)
- Target rates of return:
  - Between 9 and 12% (TRL9);
  - Between 8 and 10% if there is a strong industrial partner who can de-risk the construction phase, otherwise between 6 and 8% (TRL9);
  - Return of 5x investment before exit (TRL9)

- Dividend policy:
  - Dividends could be paid if covenants and ratio tests had been satisfied (TRL9)
  - Depends on returns but assuming that the investment is recouped within ten years, then dividends should be 10% annually (TRL9)

6.3.3 FOAK Financing Strategies of the General Investors

The General Investors interviewed **all avoid FOAK opportunities** for a variety of reasons. For the most part, these consist of many of the same risks and obstacles as those they cited for SET opportunities, with particular emphasis on the following:

- **Unproven technology** (ALL except GI-3, which does only TRL6);
- A **preference for low-risk/low-return investments** either on the part of the General Investor or its clients, which in the case of GI-2 includes pension funds (GI-2, GI-6);
- A **lack of confidence in technology developers** or their partners (GI-1, GI-5);
- Very large **volumes of financing required** (“greater than €100m” – GI-3);
- **Low return** on investment and **long horizons** for those returns (GI-3).

Three of the General Investors interviewed qualified their rejection of FOAK, albeit hypothetically, by stating that they might re-consider their stance if the FOAK opportunity were to be “de-risked” by either an industrial partner or by a public sector entity, such as the EC through the use of guarantees. GI-6 considered the possibility of investing in hybrid projects with a FOAK element, e.g., proven solar PV plus FOAK storage, as there the innovation would be incremental. Incremental innovation and quality certification are, for GI-6, key to overcoming the technical risks whereas a support framework is key to overcoming non-technical risks.

6.3.4 General Investors' reactions to investment sheets

All the General Investors interviewed **declined to comment on the investment sheets since they are not pursuing any FOAK opportunities**.

6.3.5 EU and Member State support schemes explored by the General Investors

The General Investors interviewed gave few details about EU or Member State support schemes that they had explored. GI-3 mentioned Horizon 2020, but said that it would not be able to make the commitments necessary for FOAK projects and that the fact that Horizon 2020 loans affect investee companies' balance sheets is unhelpful. GI-5 mentioned that EIB and the Danish Export Credit Agency had provided "attractive loans" to a wind project in which it had taken an equity stake.

6.3.6 Recommendations for the Commission from the General Investors

Between them, the General Investors made several recommendations, not all of which are compatible with each other. They are summarised below, elaborating on those involving financial instruments and continuing with those that do not involve financial instruments but other measures.

6.3.6.1 Provide guarantees

This is recommended by GI-1 and GI-4 as an effective way for the EC to de-risk FOAK opportunities, with GI-4 emphasising risks relating to enforceability of contracts, performance default or payment default.

6.3.6.2 Provide support or subsidies on a First Loss basis

This is recommended by GI-5 as an effective way for the EC to lower the risk of FOAK opportunities "which is more important than raising the return".

6.3.6.3 Do NOT provide guarantees or subsidies

GI-2 disapproves of guarantees (by public bodies rather than, say, equipment suppliers) because the very presence of such a guarantee raises suspicions that the technology is not ready. GI-2 similarly disapproves of subsidies on the grounds that they "distort the market" without resulting in lower prices for the consumer.

6.3.6.4 Reduce risk through Contracts for Difference

This is recommended as a course of action for the EC by GI-2 who (similarly to Bank-1) also recommended the financing structure of the Hinkley Point nuclear power station in the UK as a good model to follow.

6.3.6.5 Provide equity

GI-4 recommended this as a course of action for the EC but declined to give details.

6.3.6.6 Provide finance but accept the main share of the risk and a minor share of returns

GI-3 recommended this as a course of action for "public bodies" but gave no details other than to justify this distribution of risk and return by saying that the public bodies would enjoy other benefits such as increased tax revenues, job creation and progress towards environmental targets.

6.3.6.7 Establish "technology-specific feed-in tariffs"

GI-6 recommended "technology-specific feed-in tariffs", for biomass especially, but acknowledged that they would be impossible for advanced electricity network projects or storage projects and politically unrealistic for the other SET sectors.

6.3.6.8 Support technology developers from the early stages of their projects

GI-2 recommended that the EC supports technology developers from the early stages of the project development cycle through to commercialisation. GI-2 was not clear on what this would involve, although this idea was expressed in greater detail by the manager of the ARPA-E support mechanism in the US (see the Regional Analysis).

6.3.6.9 *Collaborate with partners who have the "risk profile" appropriate for FOAK*

GI-6 stated that the types of market participant who have the right "risk profile" for pursuing FOAK opportunities are venture capital firms and private equity firms, and so the EC should partner with them rather than with other types of market participant, all of whom are too risk averse.

6.3.6.10 *Recommendations that do not involve financial instruments*

GI-5 recommended that the EC "play a role in developing pricing frameworks, which would be of great benefit as it is the take-off price/ tariff that provides revenue certainty" (GI-5).

There was also a recommendation by GI-3 under which "a public authority or agency would own and operate" a demonstration project, and market participants would arrange to provide the technology and know-how.

6.4 Responses from Banks

Interviews were conducted with eight Banks.

6.4.1 Banks' perception of key Risks and Obstacles to financing SET

Of the Banks interviewed, all but two gave their opinion as to what the key risks and obstacles are with financing SET. Among those who replied with respect to key risks/obstacles for SET in general:

- ALL mentioned **unproven technology** (incl. scale-up) and **project completion** risks;
- a MAJORITY mentioned **regulatory instability**;
- a MINORITY mentioned large upfront costs, lengthy time periods required for commercialisation (up to 30 years), complicated permitting regimes, and unstable electricity prices.

6.4.2 SET Financing Strategies of the Banks

All Banks interviewed are active in the financing of SET opportunities (i.e., projects or the companies undertaking them).

6.4.2.1 *SET sectors and TRLs*

The SET sectors and TRLs in which Banks pursue opportunities are shown in Table 6.4. Bank 8[612] declined to specify any sectors or TRLs, on the basis that it does not engage in project finance as such but instead provides large-scale corporate financing services to large customers.

[612] Bank 8 is not among the market participants identified by ICF. It is one of six banks with whom RTD/EIB asked ICF to seek an interview owing to their issuance of a press release ahead of COP 21. The services that Bank 8 provides in relation to SET include capital raising activities such as underwriting IPOs, follow-on offerings, bond offerings and other activities pertaining to raising and providing corporate finance

Table 6.4 Coverage by General Investors of SET sectors and Technology Readiness Levels

AEN: advanced electricity networks; BIO: biomass conversion; CCS: carbon capture & storage; CSP: concentrating solar power; GEO: geothermal; LES: large-scale energy storage; SPV: solar photovoltaics; WIN: wind energy; ● = currently active; O = historically active

Banks	AEN	BIO	CCS	CSP	GEO	LES	OCN	SPV	WIN	Technology Readiness Levels
Bank-1		●							●	TRL 9
Bank-2		●							●	TRL 9
Bank-3		●		●	●				●	TRL-9
Bank-4		●		●				●	●	TRL 9
Bank-5		●						●	●	TRL 9
Bank-6					●			●	●	TRL 9
Bank-7		o		o				●	●	TRL 9

6.4.2.2 Geographical remit

All Banks have a worldwide remit for SET financing, except for one which is restricted to Europe. Among those with a worldwide remit, **Europe is the most important region**, followed by North America.

6.4.2.3 Volume and form of financing

Aside from Bank 8, which does not provide project finance, each one of the Banks interviewed disburses over €100m annually into SET opportunities. Considering the forms of financing provided for SET opportunities,

- ALL Banks provide **Debt**;
- ONE Bank provides Equity;
- ONE Bank manages Bond issues.

Debt is the main form of finance provided for SET – not just by the commercial Banks but also the investment Banks. Of the Banks who mention seniority of debt, most state that they provide **senior debt**[613] only, although one is also prepared to provide sub-debt. The loans themselves are generally **corporate loans**, although one Bank also provides mezzanine loans[614].

Bank-6 spelled out clearly its approach as consisting of, "*Debt, usually short to medium-term bridging finance to a clearly defined exit, preferably a capital market solution such as a private or public placement lead managed by the MP alone or in a syndicate. Occasionally, funding commitments in excess of 15 years but rarely with intention of holding to final maturity.*"

Bank-7 also clearly spelled out its approach as providing "*Long-term loans to special purpose vehicles involving developers who are medium-sized companies (or larger) with whom the market participant has a long-standing relationship for wind or solar projects using established technology (i.e., TRL 9) certified by a quality assurance organisation such as the TÜV and produced by a credible manufacturer who can provide a guarantee*."

[613] i.e. secured against assets

[614] i.e. unsecured and based on a project's ability to repay debt from free cash flow

6.4.2.4 *Financing criteria and parameters*

Among the factors that the Banks interviewed consider when making a lending decision are:

- **Is the technology proven**? Is it certified by a quality assurance organisation?
- Is the project developer partnering (in a Special Purpose Vehicle or otherwise) with a medium-sized or **large industrial sponsor**, preferably with whom the Bank has a pre-existing relationship?
- How much **corporate support** is being provided by essential stakeholders such as suppliers and manufacturers? Are there equipment guarantees?
- **How much equity** and other forms of commitment (such as equity 'kickers' or conversion rights) are the project developer and its partners providing? Do they have **sufficient cash to service debt/equity**?
- What kind and what level of **government support** is being provided?
- What are the opportunities for **syndication**?

When asked about the financial parameters of their SET deals, the Banks interviewed declined to provide full and detailed answers. The information gathered is summarised here:

- Deal size:
  - Varies from **€10 million to €30 million** depending on location and consequent due diligence costs
- Debt/equity ratios:
  - "Ratio is within market and sector norms"
  - "Maximum offered is 70/30"
- Debt-service coverage ratio:
  - "Ratio is within market and sector norms"
  - Debt-service coverage ratio of 1.3-1.4
- Time horizons for return or exposure:
  - Not usually in excess of 15 years
- Interest rates:
  - For corporate loans 1-3%, for mezzanine loans 5-15%
- Dividend policy:
  - Dividends have to be specified in the loan agreement

6.4.3 FOAK Financing Strategies of the Banks

All bar one of the Banks interviewed **avoid FOAK opportunities on principle** because the technology is unproven and because of completion risks. Bank-7 added the observation that "*Other kinds of investor do not want to invest in FOAK technologies either. Venture capitalists would be an option but for the fact that returns will take longer than 6 years to materialise since the gestation period for FOAK technologies is so long.*" Although it does not engage in project finance, Bank-8 stated that the main obstacle is the long period of time that it takes to commercialise those technologies, "which can be up to 30 years and is too long for most investors".

Two Banks qualified their wholesale rejection of FOAK, albeit hypothetically. Bank-2 said that a FOAK project might be of interest if it looked like a stepping stone to future markets in floating wind, CCS and battery storage. Bank-5 said that the reputation of project sponsors, if particularly strong, could cause its credit committee to offer "a degree of flexibility" towards the idea of backing FOAK projects.

Bank-1 is exploring the possibility of pursuing FOAK opportunities. To date, it has considered 3 to 5 FOAK opportunities in CCS and 3 to 8 FOAK opportunities in floating offshore wind, but **it has decided not to pursue any of these FOAK opportunities**. According to Bank-1, the problem is not the availability of finance but the "lack of a balanced risk allocation structure" to take care of risks that the private sector cannot carry, particularly regulatory risks. Assuming that such a risk allocation structure could be put in place, the partners that Bank-1 would seek are large industrials, developers with equity, and other key corporate partners with which it has a pre-existing relationship.

6.4.4 Banks' reactions to investment sheets

All the Banks interviewed **declined to comment on the investment sheets since they are not pursuing any FOAK opportunities**.

6.4.5 EU and Member State support schemes explored by the Banks

No Banks reported exploring any EU or MS support schemes. Bank-1, which has considered FOAK CCS opportunities, observed that the financing structure of the Hinkley Point nuclear power plant in the UK is a model that CCS projects in the UK are following, The financing structure is underpinned by the new contract for difference (CfD) regime, plus either loan guarantees or grants. The grants would be considered "equity equivalent" and repaid when private-sector investors had achieved defined threshold equity rates of return.

6.4.6 Recommendations for the Commission from the Banks

Between them, the Banks made several recommendations, not all of which are compatible with each other. They are summarised below, elaborating on those involving financial instruments and continuing with those that do not involve financial instruments but other measures.

6.4.6.1 Do Nothing

Bank-6 declared its hostility to any form of risk sharing with (or risk transferring to) public-sector guarantors or partners, including first-loss instruments. Firstly, because it leads to a crowding out of commercial finance and private-sector funding opportunities. Secondly, because it creates an element of moral hazard, i.e., a lowering of credit standards resulting in support being given to projects and technologies that would not have received support if commercial market criteria had been allowed to prevail. According to this Bank, "commercial market criteria" should be allowed to prevail even if this means delaying or postponing the adoption of new technologies.

6.4.6.2 Deploy a "First Loss"-type facility

Bank-4 recommends an "EIB First Loss"-type facility on the basis of an experience in which this type of facility improved the credit rating of a proposed wind project's bonds to "investment grade" thereby allowing access to cheaper funding.

6.4.6.3 Do NOT deploy a "First Loss"-type facility

Bank-2 and Bank-3 counsel against a First Loss-type facility, arguing respectively that:

- Equity-based instruments provide better value and transparency;
- The risks faced by the project remain the same with or without First-Loss participation.

6.4.6.4 Provide equity

Bank-1 recommended this as a course of action for the EC but declined to give details.

6.4.6.5 Provide "equity equivalent" grants

Bank-1 recommended this as a course of action for the EC, specifying that there should be claw-backs based on pre-defined performance or rate-of-return criteria, i.e., when private-sector investors had achieved defined threshold equity rates of return.

6.4.6.6 Provide grants for pre-feasibility studies

Bank-1 recommended this as a course of action for the EC but declined to give details.

6.4.6.7 *Provide bridge financing for the construction period*

Bank-1 recommended this as a course of action for the EC but declined to give any details, including specifying any exit.

6.4.6.8 *Underwrite key risks and provide guarantees*

Bank-1 recommended underwriting as a course of action for the EC, having defined the key risks as being those concerning project completion, technology design and regulatory instability. In a similar vein, Bank-1 recommended that the EU, as "an entity of high credit standing", should provide performance and integration guarantees (which it admitted could also come from corporate sponsors).

6.4.6.9 *Recommendations that do not involve financial instruments*

These include generally rather vague recommendations that the EC should:

- "Provide support for a policy framework that allows **CfD-type contracts**" (Bank-1)
- "Establish a **framework for power purchase agreements** and **stable tariffs**, which would provide some stability to prices" (Bank-7)
- "Provide **regulatory stability** – a clear EU CCS policy is needed" (Bank-1)
- "**Harmonise the EU and MS innovation support schemes** available to the large corporate manufacturers" (Bank-7)

There is also a recommendation by Bank-7 that the EC and MS governments should "establish FOAK energy demonstration projects themselves, as has been done with wind, using their research budgets".

6.5 Responses from Producers

Interviews with eight Producers. Producers 3 and 4 are the investment arms of their respective organisations.

6.5.1 Producers' perception of key Risks and Obstacles to financing SET

Producers were on the whole reluctant to discuss key risks and obstacles for SET financing. The insights they gave are summarised below:

- Long design cycles and capital intensiveness are obstacles (Producer-3, Prodcuer-7, Producer-8)
- Unproven technology is a risk (Producer-4, Producer-8)
- Regulatory instability is a risk, especially with respect to feed-in tariffs (Producer-4)
- The chief deal-breaker for FOAK projects is that they are insufficiently remunerative (Producer-4)

6.5.2 SET Financing Strategies of the Producers

All Producers interviewed **have been active in the financing of SET opportunities** (i.e., projects or the companies undertaking them) but were on the whole reluctant to give details.

6.5.2.1 SET sectors and TRLs

Unlike the Banks and General Investors, the Producers Investors collectively cover a wider range of SET sectors and TRLs as shown in Table 6.5 below.

Table 6.5 Coverage by Producers of SET sectors and Technology Readiness Levels

AEN: advanced electricity networks; BIO: biomass conversion; CCS: carbon capture & storage; CSP: concentrating solar power; GEO: geothermal; LES: large-scale energy storage; SPV: solar photovoltaics; WIN: wind energy; ● = currently active; O = historically active

Producer	AEN	BIO	CCS	CSP	GEO	LES	OCN	SPV	WIN	Technology Readiness Levels
Producer-1		●							●	Not specified but research indicates TRLs 7-9 at least
Producer-2									●	As above
Producer-3	●	●			o	●	o	o	●	As above
Producer-4		●		●	●	●		●	●	TRL 9
Producer-5						●			●	LES: 6; WIN: 9
Producer-6									●	TRL 9
Producer-7		●					●	●	●	BIO, SPV, WIN: 9; OCN: research indicates 6 or 7
Producer-8	●	●		●	●	●	●	●	●	BIO, SPV, WIN: 9, Others: research indicates TRLs 7-9 at least

6.5.2.2 Geographical remit

Among the Producers, geographical remit varies from Worldwide to a handful of European countries; however, for all except Producer-6, **Europe is the most important region**.

6.5.2.3 Volume and form of financing

No Producer was willing to specify its annual disbursement into SET opportunities. Research indicates all but one **disburse more than €100m annually** into SET opportunities, and the last one **disburses between €50m and €100m annually**.

Considering the forms of financing provided for SET opportunities:

- **On balance sheet**: Producer-1 (for Wind with subsequent re-financing), Producer-5 (in majority of cases), Producer-6 (for Wind), Producer 7 (in all cases), Producer-8
- **Equity**: Producer-4 provides equity only; Producer-3 provides minority equity; Producer-5 provides equity in minority of cases; Producer-8
- **Convertible loans or options**: Producer-3 sometimes provides these in conjunction with equity
- **Joint venture**: Producer-1 for Biomass conversion.

6.5.2.4 Financing criteria and parameters

Only Producer-1, Producer-4 and Producer-5 were prepared to give details of the criteria and parameters for financing a SET opportunity. For Producer-1 these include:

- What are the market opportunities in the short and longer term?

- How will the project help develop our business?
- What are the expected deliverables from the project?
- Is the complexity and efficiency of the project and the project organisation satisfactory?
- Can the potential projects partners be expected to deliver on their tasks?

For Producer-4:

- Projects are often in-house. Projects that Producer-4 participates in as an external investor must be bankable;
- Partners include equipment manufacturers and financial institutions but no start-ups;
- Offshore wind turbines have been produced through a joint venture with a manufacturer
- Deal size ranges from €10 million to €200 million
- Time horizon for returns: 15 – 25 years
- Target return on investment should be "at least double digit"

For Producer 5:

- In-house projects have budgets over €10 million;
- External investments are made for strategic reasons. For example, to bring a supplier company's production facilities into Producer 5's own supply chain; to ensure that a wind farm that uses Producer 5's turbines is built or to prevent competitors from taking an equity stake in that wind farm

6.5.3 FOAK Financing Strategies of the Producers

Producer-1 and Producer-3 claim to be active in the financing of FOAK opportunities but would not give details of their strategies. Producer-7 and Producer-8 gave details of the sectors in which they have had FOAK projects (floating wind, ocean energy, and, for Producer-8, advanced electricity networks and large-scale energy storage). Producer-4 stated that it avoids FOAK because of the technology risk. Producer-5 and Producer-6 stated that, in accordance with their business strategies, they focus on onshore wind, which it considers to be essentially proven technology. Producer-2 made no comment at all.

6.5.4 Producers' reactions to investment sheets

All the Producers interviewed **declined to comment in detail on the investment sheets**. At most, they restricted themselves to making some general remarks about risks, which have been integrated into previous sub-sections.

6.5.5 EU and MS support schemes explored by the Producers

Producer-7 has explored NER300 and the "*Investissements d'Avenir*" programme of the French ADEME agency. It finds NER300 unsuitable for financing innovative (and hence risky) projects since by withholding funding until the project has succeeded, it places all the risk on the project developer. Prodcuer-8 has also explored the "*Investissements d'Avenir*" programme and considers that it targets funds well. Other producers gave no details of any support schemes that they might have explored. Producer-5 believes that exploring support schemes is something for the investee company to do.

6.5.6 Recommendations for the Commission from the Producers

Between them, the Producers made a few general recommendations. They are summarised below.

6.5.6.1 Ensure that the support scheme is user-friendly, additional and properly focused

Producer-1 stated that any publicly funded support scheme should be as "agile and easy to work with as possible", and funding should be "additional", in order to be most effective in removing barriers to achieving the maturity and market-introduction of new technologies.

Producer-8 urged that any support scheme intended to support innovative technology should truly do so and not provide unnecessary support to mature technologies.

6.5.6.2 Provide grants or debt

Producer-3 stated that the EC providing grants or debt "would be welcome" as there is a lack of equity and debt in the market for start-ups, due to long design cycles, capital intensive, and many investors seek out existing operational projects. Producer-7 and Producer-8 are supportive of convertible grants.

6.5.6.3 Lower the level of non-technological risks

Producer-4 stated that it might be prepared to bear technological risks if the EU and EIB were prepared to bear other risks through a publicly-funded support scheme.

6.5.6.4 Prioritise sectors

Producer-1 stated SET sectors should be prioritised according to:

- Market size on a European scale and a global scale
- Technology challenges
- Technology Readiness Level
- Expected time to market
- Current price per MWh and expected price per MWh when mature

6.6 Summary of findings

6.6.1.1 Overview

Section 6.6 summarises the key findings from interviews with market participants set out in Sections 6.2 to 6.5.

6.6.1.1 Key risks and showstoppers

All four groups of market participants cite **technology risks** and **risks due to regulatory instability** as key. Among other risks and obstacles, the **high volume of costs for SET** is cited as an obstacle by Producers and Specialised Investors; **project completion risk** is cited by Banks; and **commercial risks** are cited by Specialised Investors.

Of these risks and obstacles, only risks due to **unproven technology** or to regulatory instability are ever cited as being **showstoppers**. Unproven technology is cited as a showstopper by **Banks** and **General Investors**. Potential regulatory instability (in particular, the risk of withdrawal of feed-in tariffs or other subsidies) is the reason why one Specialised Investor will not touch an opportunity (whether FOAK or not) involving subsidies after the construction phase.

6.6.1.2 SET sectors and technology readiness levels

Unsurprisingly, in view of their general attitude towards unproven technology, all Banks and almost all General Investors[615] restrict themselves to opportunities involving SET projects at TRL9, mostly involving wind energy, biomass conversion and solar photovoltaics.

Specialised Investors and Producers operate across a wider range of TRLs, namely 5 – 9. They also operate across all sectors to a greater or lesser extent. Nonetheless, considering SET opportunities generally, wind energy, biomass conversion and solar photovoltaics are the most popular SET sectors among these groups as well. Considering FOAK opportunities, advanced electricity networks and large-scale energy storage take on more prominence.

[615] The exception is GI-3, which invests in opportunities involving SET projects at TRL6 and no higher; but this is an exception that proves the rule as GI-3 described its strategy as being more like that of a venture capital firm

Across the four groups of market participant, wind energy, solar photovoltaics and biomass conversion are the most popular sectors, with 50% or more of individual market participants being active in each; advanced electricity networks, concentrated solar power, geothermal and large-scale energy storage are less popular, with around 25% of individual market participants being active in each; and ocean energy and carbon capture and storage are the least popular, with less than 10% of individual market participants being active in ocean energy and less than 5% in CCS.

6.6.1.3 Financing decision criteria

Market participants were reluctant to divulge the criteria that they use, so much so that no market participant answered all the questions put to it on the subject. With that caveat, we nonetheless summarise the information received. The criteria reported through the interviews can be grouped into four categories (Technology, Developer, Developer's Partners, and Commercial) and clear parallels can be seen with the risks and obstacles reported.

As regards **Technology**, the criteria stated were:

- Is the technology proven? (BANKS) Is the technology proven and certified? (GENERAL INVESTORS)
- Is the concept proven? Is it unique, robust, scalable, and proprietary? Has it been piloted? (SPECIALISED INVESTORS)
- How complex is the project and what are the expected deliverables? (PRODUCERS)

As regards the **Developer**, the criteria stated were:

- Does the developer have a strong management team? (SPECIALISED INVESTORS, GENERAL INVESTORS)
- How efficient is the developer organisation? (PRODUCERS)
- Is the developer small but bigger than start-up and has it been around for at least 5 years? (SPECIALISED INVESTORS)
- Does the developer enjoy a near-monopolistic position through exclusive contracts or a concession? (GENERAL INVESTORS)
- What level of equity, cash (to service debt/equity), and government support does the developer bring? (BANKS)

As regards the **Developer's Partners**, the criteria stated were:

- Does the developer have a large industrial partner? (SPECIALISED INVESTORS, GENERAL INVESTORS and BANKS)
- Do the developer's partners bring guarantees? (GENERAL INVESTORS, BANKS)
- How reliable are the (developer and its) partners? (PRODUCERS)

As regards **Commercial**, the criteria stated were:

- What are the market trends for the technology? (SPECIALISED INVESTORS)
- What are the pipeline of opportunities and prospects for new relationships with other market participants? (GENERAL INVESTORS)
- What are the market opportunities in the short and long-term and how will this project help develop our business? (PRODUCERS)
- What are the opportunities for deal syndication? (SPECIALISED INVESTORS, GENERAL INVESTORS and BANKS)

6.6.1.4 Volumes and forms of finance, typical deal parameters

Banks and General Investors have the greatest volumes of finance to disburse, with each individual member of those groups disbursing over €100 million per year into SET opportunities. By contrast, Specialised Investors each disburse less than €50 million per year into SET opportunities, with some disbursing less than €10 million. Producers did not disclose the volume that they each disburse, but ICF research for the Market Participant Description Sheets indicates over €100 million annually for most.

Market participants were reluctant to divulge the deal parameters that they use, so much so that no market participant answered all the questions put to it on the subject. With that caveat, we nonetheless summarise the information received.

Debt is provided by Banks (which is the only form of SET finance that Banks provide[616]) and General Investors only. From the evidence received, debt is NOT used as a form of finance for FOAK opportunities.

Equity is provided by Specialised Investors, General Investors and Producers. Specialised Investors provide between €0.5m and €4m per deal, including for FOAK opportunities. General Investors provide between €100m and €150m per TRL9 deal; the sole General Investor who provides equity for TRL 6 deals provides between €1m and €20m per deal. For Producers, the situation is less clear since only one Producer responded in relation to external investments; the answer given was between €10m and €200m.

Producers also finance SET opportunities on balance sheet, but the only information received about this was from one Producer who stated that the cost of in-house projects started at €10 million.

6.6.1.5 *Attitudes towards FOAK*

The market participants who have a positive attitude towards FOAK are some (but not all) Specialised Investors and Producers. Owing to bad experiences with FOAK deals, and also SET deals, and the competing attraction of opportunities in other fields, fewer Specialised Investors are active and those that are though not to the same extent as in previous years.

The market participants who have a negative attitude towards FOAK consist of the Specialised Investors who have left SET entirely, all Banks and General Investors, and the Producers whose innovation strategy consists of continuous improvement of proven technology. For Banks and General Investors, the levels of technical risk are too high. Most cited unproven technology as a showstopper. The others considered the circumstances under which they might reconsider their attitude as hypothetical.

[616] Among the Banks interviewed, debt is the only form of SET finance even among those who provide equity for deals involving other industries.

6.6.1.6 Recommendations from Market Participants

Market participants from all four groups made recommendations for the EC and EIB regarding publicly funded support schemes, regardless of whether they themselves were interested, or could be persuaded to be interested, in FOAK opportunities. The most popular of these recommendations to the EC and EIB may be summarised as follows:

- Financial support should be provided, mainly as equity and guarantees, but with some involvement for subsidies and debt;
- Collaborate with market participants with the most appropriate risk profile and who operate near the “Valley of Death”, i.e., venture capital firms and private equity firms;
- Incentivise large industrial firms to invest in FOAK;
- Support technology developers from early stages of project development (i.e., not just from when their projects reach TRL 7 and the ‘Valley of Death’);
- Harmonise policy and policy frameworks for energy across Europe, which would help to provide some price stability and revenue certainty.

6.7 Summary tables

Table 6.6 gives an overview of the four market participant groups’ financing strategies and (informing those strategies) perceptions of risks and obstacles with respect to SET.

Table 6.7 gives an overview of the four market participant groups’ attitudes towards FOAK, the circumstances that they state might change their attitude from negative to positive (if applicable), and their FOAK financing strategies (if applicable).

Table 6.8 gives an overview of the EU and Member State support schemes explored by market participants and of their recommendations to the EC and EIB with respect to support schemes as well as to SET-related policies and policy frameworks.

Table 6.6 Overview of market participants' perceptions of risks and obstacles with respect to SET and of their SET financing strategies

AEN: advanced electricity networks; BIO: biomass conversion; CCS: carbon capture & storage; CSP: concentrating solar power; GEO: geothermal; LES: large-scale energy storage; SPV: solar photovoltaics; WIN: wind energy

	Specialised Investors	General Investors	Banks	Producers
Main risks and obstacles to SET financing perceived by market participants	■ Technology risks, including scale-up and risk associated with fitting new technology into existing infrastructure ■ Regulatory risks, especially as regards changes in feed-in tariffs and (other) subsidies ■ High volume of costs ■ Commercial risks, e.g. – High cost per MWh of generation – Need for supply agreements (for biomass) and offtake agreements – Unfair competition from outside Europe – Lack of commercial structure for revenue generation for energy storage	■ Unproven Technology ■ Regulatory Instability	■ Unproven Technology ■ Project Completion ■ Regulatory Instability ■ Length of design cycles	■ Unproven Technology (particularly in relation to external investments) ■ Regulatory instability, especially as regards changes in feed-in tariffs ■ Length of design cycles ■ High volume of costs
SET sectors of interest	Major: BIO, SPV; Medium: AEN, LES, WIN; Minor: CCS, GEO; Historic only: CSP, OCN	Major: WIN, SPV; Minor: BIO, CSP; Historic only: AEN, GEO, LES	Major: WIN, BIO, SPV; Minor: CSP, GEO	Major: WIN; Medium: BIO, LES, SPV; Minor: AEN, CSP, GEO, OCN
Technology readiness level range	TRLs 5 – 9	TRL 9 (all bar one), TRL 6 (one)	TRL 9	TRLs 5 – 9
Geographical remit	Each operates in a few countries on two or three continents: Europe, Americas, Africa, Asia	Varies from Europe to Worldwide	Worldwide, mainly Europe	Varies from Europe to Worldwide
Volume disbursed annually into SET	Up to €50 million by some Specialised Investors; up to €10 million by others	Over €100 million by each General Investor	Over €100 million by each Bank	Over €100 million by most Producers; €50m – €100m by one Producer
Main form of SET financing	Equity	Equity (all), Debt (most)	Debt	On balance sheet, Equity
Financing decision criteria *(NB. Market participants were most reluctant to give specific details. Each of the criteria listed was specified by at least one market participant but by no means all in the group)*	■ Technology: – Is the concept proven? – Is it unique, robust, scalable, and proprietary? – Has it been piloted? ■ Trends in the market for the technology ■ Is the company small but bigger than start-up and at least 5 years old? ■ Strength of developer's management team ■ Large industrial partner? ■ Opportunities for deal syndication	■ Proven, certified technology? ■ Large industrial partner? ■ Guarantees from suppliers? ■ Strength of developer's management team ■ Potential for growth, profitability of developer ■ Does developer have exclusive contracts or concession? ■ Pipeline of opportunities? ■ Prospect of new relationships with other market participants? ■ Opportunities for deal syndication	■ Proven technology? ■ Large industrial partner? ■ Guarantees from suppliers? ■ Level of equity from developer ■ Level of cash from developer to service debt ■ Type and level of government support ■ Opportunities for deal syndication	■ How will the project help develop our business? ■ What are the expected deliverables from the project? ■ How complex is the project and how efficient the organisation? ■ What are the market opportunities in short and long term? ■ Reliability of prospective partners (NB these are criteria relating to external investments, not in-house projects)
Financing parameters *(NB. Market participants were most reluctant to give specific details. Each of the criteria listed was specified by at least one market participant but by no means all in the group)*	■ Deal size range: €0.5m - €4m ■ Time horizon for return: 3 - 10 years ■ Target rates of return: – 2.5 – 5 times investment before exit – Indicative internal rates of return: solar, onshore wind 7%; offshore wind 8%; biomass conversion 15%.	■ Typical deal size: – Equity for TRL9: €100m - €150m – Debt for TRL9: €30m – Equity for TRL6: €1m - €20m ■ Debt/equity ratio: 70/30 ■ Debt-service coverage: "depends on project" ■ Time horizon for return: 5 - 20 years ■ Target rates of return: – 6 - 12% depending on strength of industrial partner – 5 times investment before exit	■ Min. deal size: €10m - €30m ■ Debt/equity ratio: 70/30 ■ Debt-service coverage: 1.3-1.4 ■ Time horizon for return: less than 15 years ■ Dividend policy must be specified in loan agreement ■ Interest rates: 1 - 3% for corporate loans 5 - 15% for mezzanine	■ Deal size range: €10m - €200m ■ Time horizon for returns: 15 – 25 years ■ Target return on investment: "at least double digit" (NB these are criteria relating to external investments, not in-house projects.)

Table 6.7 Overview of market participants' attitudes towards FOAK, the circumstances that they state might change their attitude from negative to positive (if applicable), and their FOAK financing strategies (if applicable)

	Specialised Investors	General Investors	Banks	Producers
Attitude towards FOAK.	**Positive**, mainly, but not to the same extent as historically because of problems encountered.	**Negative**, for one or more of the following reasons: ■ TRL 9 investors: – Unproven technology – Preference for low-risk/low-return investments – Lack of confidence in technology developers or their partners ■ TRL 6 investor: – Large volumes of finance required – Low return on investment and lengthy time horizons for those returns.	**Negative.** For most Banks, unproven technology is a showstopper. For the rest, the overall high level of risk rules FOAK out.	**Positive**, mainly.
If negative towards FOAK, what might change their mind?	■ For those who are against, nothing: they no longer invest in SET opportunities, let alone FOAK.	■ For some General Investors: sufficient de-risking by guarantees from industrial partners and publicly funded support schemes, but this was mentioned as a hypothetical possibility. ■ For one General Investor, hybrid projects in which FOAK storage were combined with non-FOAK other sectors might be a possibility. ■ For other General Investors: nothing in practice.	■ For most Banks, nothing. ■ One Bank might re-consider if risks were shouldered by other partners, who would have to include large industrials, developers with equity, and other key partners with whom it already has a relationship.	Of the two Producers who are negative towards FOAK, one was speaking in relation to external investments, and the other's involvement with innovation consists only of continuous improvement of proven technology.
If positive towards FOAK, financing strategy decision criteria and parameters	As those listed in Table 6.6 above for SET opportunities.	Not applicable	Not applicable	As those listed in Table 6.6 for SET opportunities, noting that they relate to external investments rather than in-house projects.
If positive towards FOAK, stage of initial involvement	■ Generally not specified. ■ One Specialised Investor does not become involved earlier than the time to build the demonstration plant (i.e., in construction phase, which may last 6 to 18 months). ■ Another Specialised Investor may become involved 8 to 9 years before expected profitability.	Not applicable	Not applicable	Not specified.
If positive towards FOAK, any successful exits?	A minority (two) of Specialised Investors reported making successful exits.	Not applicable	Not applicable	Not specified.

Table 6.8 EU and Member State publicly funded support schemes explored by market participants, and market participants' recommendations to the EC and EIB with respect to support schemes as well as to SET-related policies and policy frameworks

	Specialised Investors	General Investors	Banks	Producers
EU and Member State Schemes explored	■ Horizon 2020 ■ European Investment Fund	■ Horizon 2020 ■ Danish Export Credit Agency (in conjunction with EIB)	None	■ Horizon 2020 ■ "Investissements d'Avenir" programme of French ADEME Agency
Market Participants' recommendations about the TYPES of FINANCING that the EC/EIB should provide.				
Recommendation for EC/EIB to provide DEBT?	YES – As low-interest loans, mezzanine loans	no recommendation made	YES – bridging finance for construction	YES
Recommendation for EC/EIB to provide EQUITY?	YES	YES	YES	no recommendation made
Recommendation for EC/EIB to provide GRANTS?	YES – For the construction phase; or – As convertible grants	NO	YES – For feasibility studies; or – As equity-equivalent grants	YES – Especially as convertible grants
Recommendation for EC/EIB to provide GUARANTEES/ INSURANCE/ UNDERWRITING?	YES	Some say YES; others say NO	YES (mixed opinions about First Loss facilities)	no recommendation made
Recommendation for EC/EIB to provide SUBSIDIES?	Some say YES (for construction phase); others say NO	YES – on a First-Loss basis	no recommendation made	no recommendation made
Other actions for EC/EIB to take, as recommended by Market Participants				
Actions relative to SUPPORT SCHEMES	■ Collaborate with Venture Capital & Private Equity Firms ■ Support technology developers from the early stages of their projects ■ Incentivise large industrial companies to invest in FOAK ■ Utilise monies from existing R&D budgets for commercialisation ■ Ensure that European taxpayers' money is used to support European businesses and not disguised non-European businesses	■ Collaborate with Venture Capital & Private Equity Firms ■ Support technology developers from the early stages of their projects ■ Accept major share of risk and minor share of returns	■ Harmonise EU and Member State innovation support schemes ■ Do not provide support as this would distort the market (NB this is a solitary opinion)	■ Ensure that the support scheme is user friendly and its financing "additional" (i.e., not displacing other financing) and focused on truly innovative technology ■ Lower the level of non-technical risks ■ Prioritise SET sectors according to – Market size (Europe, worldwide) – Technological challenges – Technology Readiness Level – Expected time to market – Current price per MWh and expected price per MWh at maturity
Actions relative to POLICIES and POLICY FRAMEWORKS	■ Play a role in developing a consistent energy policy across all Member States ■ Regulate the European energy market to enable a framework for secure revenue streams from energy storage ■ Protect European businesses from unfair competition ■ Play a role in getting governments to put a real cost on carbon emissions	■ Play a role in developing pricing frameworks in order to provide revenue certainty through a stable off-take price or tariff ■ Encourage use of technology-specific feed-in tariffs ■ Encourage use of Contracts for Difference	■ Establish a framework for power purchase agreements and stable tariffs ■ Provide support for a framework that would allow Contracts for Difference - type contracts ■ Provide a clear EU CCS policy	no other recommendations made
MISCELLANEOUS Actions	■ Publish reports on successful FOAK demonstration case studies as they would show that clean technologies are investible and so attract investment	■ Own and operate a demonstration project (General Investor would arrange to provide technology and know-how)	no other recommendations made	no other recommendations made

Annex 1 Topic guide for consultations with market participants

Interviewer:
Date:
Market participant name:
Interviewee & Job title:
Telephone:
Email:
Brief overview of role of interviewee:

A1.1 Key findings

[Please summarise key findings under each heading – 1 page max]

Significance[617] of market participant in supporting FOAK projects in Europe / globally and in which sectors

Summary of the investment structures deployed by market participant for FOAK projects and potential mechanisms which they would consider using

Key risks for FOAK project financing, including dealbreakers

Key motivating factors & framework conditions which might attract market participants to back FOAK projects

Suggestions for future EC mechanisms to support the sector

[617] With respect to overall financing/investment volume for FOAK projects: high >€100m, medium €50-100m, low <€50m, zero)

A1.2 Section A: Investment strategy of market participant (allow 15-20 minutes)

The purpose of this initial part of the interview is to quickly establish the current investment focus/strategy of the market participant and their attitude towards FOAK project financing

The data sheet on each market participant, together with a quick review of their website and the interviewer's knowledge, should provide sufficient insights and potential project examples to allow the interviewer to 'hit the ground' running

The data sheet can also serve as a checklist to edit during/after the interview1.

A1. What is your institution's geographical remit for SET funding?

Probe: relative distribution of funding for institution. How important is EU – now/future?

A2. What is your institution's total volume of funds disbursed into SET in the EU annually (€m/€bn)?

Probe: largest SET sectors (% of total); main Member States in which money spent; percentage of total EMEA funding if relevant

A3. What types of SET deals have you executed in the past 2-3 years?

Probe SET deal type: equity/debt/subordinated debt/hybrid; split between types

Probe geographical differences in deals: Europe, N.Am, SE Asia, BRICs, etc.

Probe sector coverage: 1-2 main sectors / niche, broad coverage

Probe deal focus: projects, companies (e.g. start-ups, late stage, manufacturing), mix

Probe favoured TRL[618]*/stage of technology development:*. Lowest acceptable TRL; **establish their understanding of FOAKs vis-à-vis fully commercial technologies to see if there is common acceptance or a definitional problem?***

[618] Technology Readiness Level: early demonstration (TRL 5)/ prototype/pilot plant (TRL 6) / **commercial scale FOAKs** (TRL 7-8) / deployed and proven technology (TRL 9) / fully commercial technologies (TRL 10)

A4. What are the significant financial parameters for SET deals[619] that you typically work to?

Probe financial structure: deal sizes (min/max €); currency of deal; debt/equity ratios; time horizons for return or exposure; targeted rate of return on investment (%); minimum annual average debt service cover ratios; dividend policy.

A5. What are the key obstacles to investment in SET?

Probe risks: business risks (e.g. regulatory uncertainty); financial risks; technical risks; revenue and environmental risks.

If the market participant DOES target FOAK projects, go to Question A6 and seek to understand the market participants' reasons for being involved, the objectives they pursue, and the nature of the deals / technology developer they prefer to work with, as well as key financials/exits.

If the market participant does NOT target FOAK projects, go to Question A7

---

[619] The intention is to understand something of the current modus operandi of the market participant rather than specific deal structures for FOAK projects which is asked later

A6. Questions for current FOAK investors/financiers

A6 (a) In which SET sectors are you backing FOAK projects?

A6 (b) How many FOAK project opportunities would you typically evaluate per year?

Probe levels of syndication: typical number / type of co-investors/financiers; **ask for key names so we can cross check with our lists and build up a picture of major players***

Probe public financing mechanisms used in deals: support type; EU / MS / non-EU.

Probe: differences in financial parameters across SET sectors.

A6 (c) Can you name some typical characteristics of the technology developers you feel most able to work with?

Probe: size; track record; financial commitment to projects; corporate affiliations or not;

Probe technology source/IP protection: (a) is the technology their own? (b) has that technology been protected, e.g. patented? (c) is the patent at risk?

Probe: favoured approaches and business models used by technology developers*

A6 (d) How close to the operational start of the project (e.g. commissioning) does the project need to be for it to receive the attention of your institution?

Probe: any differences between debt and equity

A6 (e) How close to the date of expected first revenue generation/or EBITDA positive does the project need to be for it to receive the attention of your institution?

A6 (f) What is the minimum number or overall value of look-alike transactions which you typically seek from FOAK projects/propositions?

Probe: size of deemed pipeline; how developed and defined; critically, over what time frame should the pipeline be defined for; and over which jurisdictions

A6 (g) Are there any prominent European or Member State funding schemes which you have explored and/or used to help support your investment in FOAK projects?

Probe: scheme names, type of support scheme (grant, loan, subordinate debt, equity); any feedback on their effectiveness/efficiency

A6 (h) Is there any form of publicly-funded financing instrument[620] which you think could provide better market engagement and lower risks at an EU level for the sector?

Probe: desirable features of such an instrument; examples of where such an instrument might already be available (i.e. sector which may not be SET; country, including outside EU)

A6 (i) Have you achieved any successful FOAK exits [equity] and/or successful repayment of loans? *[if not, probe the wider SET area]*

Probe: value, ROI, investment multiple, other known outcomes which indicate success/impact (e.g. M&A/IPO, no of units sold, markets into which innovation sold, jobs created); future attitude/strategy to FOAK based on these historical precedents?

Now move on to Section B: Investment Sheet discussion

----

[620] An important question for providing insights for a future financial instrument which can help bridge a funding gap

A7. Questions for investors/financiers who have yet to invest in FOAK projects

A7 (a) What is your main rationale for not getting involved with FOAK projects?

Probe: key risks, level of expertise within firm, differences in these issues between SET sectors

A7 (b) Under what circumstances might you be persuaded to invest in FOAK projects?

Probe: which financial and other framework conditions including role of public support

A7 (c) Are there any prominent European or Member State funding schemes which you have explored and/or used to help support your investment in FOAK projects?

Probe: scheme names, EC/MS, type of support scheme (grant, loan, equity); feedback on their effectiveness

A7 (d) Is there any form of publically-funded financing instrument which you think could provide better market engagement and lower risks at an EU level for the sector?

Probe: desirable features of such an instrument; examples of where such an instrument might already be available (i.e. sector which may not be SET; country, including outside EU)

Move on to Section B

A1.3 Section B: Feedback on Project Investment Sheets (allow 30 minutes min)

The interviewer should seek feedback on a number of Investment Sheets which will have previously been sent to the interviewee for review. These will be based on SET sectors identified through notable deals made by the market participant.

The purpose of this part of the consultation is to obtain insights into the key financial parameters which will encourage the market participant to finance/invest in the exemplar projects set out in the Investment Sheets. It is also to test consistency of responses and actual readiness to commit funding and to substantiate the findings.

The interviewer should only prompt the market participant with financial ratios gathered from technology developers ***when it proves difficult to elicit a response****.*

Ask the interviewee whether they have had the opportunity to review the Investment Sheets sent to them?

NB for face-to-face interviews it would be sensible to take copies of each Investment Sheet so that they can be handed over and talked through, in case they have not been received or if the market participant shows interest in a SET sector which has not been identified

----

If the market participant responds **positively** to an Investment Sheet, ask questions B1 to B17 **for each Sheet**

If the market participant responds *negatively* to an Investment Sheet, ask questions B18 to B21 *for each Sheet*

Positively received Investment Sheets

SET Investment Sheet name: ……………………………

B1. With reference to the Risks Table, are there any risks which you perceive to be too high?

Probe: potential deal breaker risks; mitigating approaches which might alleviate such risks

B2. With reference to table on the last page of the investment sheet, what would be your preferred investment structure for this sort of project?

Probe: on balance sheet, off-balance sheet / Special Purpose Vehicle (SPV), other

B3. How much funding would you expect a developer to commit to this sort of project?

Probe: % of deal/total assets; type of developer that could provide this level of funding

B4. What sort of capital structure would you expect to see from such a project?

Probe: approximate debt/equity and/or debt/EBITDA and/or debt/total assets ratios expected at financial close or after some time (please provide a time indication)

B5. What would be the maximum debt maturity period[621] you would accept for this project and/or the maximum acceptable equity holding period?

Probe: years/months

[621] By which time the debt repayment should have been made

B6. Would you seek to <u>syndicate</u> this type of project investment/finance to equity or debt co-investors?

Probe: no of co-investors/financiers; level of funding from each in deal

B7. What kind of funding instruments would you expect for this investment?

Probe: e.g. debt (bank loans, bonds, private placement), equity; hybrid instruments; grants?

B8. In case of debt funding, would you expect collateral, e.g. asset pledges, guarantees, etc.?

B9. What sort of <u>return on investment</u>[622] (ROI) would you hope to see at 3 and 7-10 years?

Probe: sensitivities around this and risks

B10. Would you expect such a project to generate <u>positive operating cash-flow</u> from the start of operations? If not, when?* Are there any specific ratios (operating cf/debt or free cash flow/debt etc.) which are important for you and if yes what are the acceptable levels for you?

Probe: differences between project types (e.g. energy generation vs fuel production vs smart grid vs CCS, for example)

[622] Benefit (return) of an investment divided by the investment cost, expressed as percentage

B11. **What average annual debt service cover ratio (DSCR[623]) would you wish to see in Years 1, 3, 5 for this project?**

Probe: sensitivities around this and risks

B12. **Would you envisage agreeing to forecast / anticipated a dividend payments being made in such a project?**

B13. **What are your expectations regarding liquidity? How many months at a minimum of cash outflow (e.g. dividend, capex, debt service etc.) would you expect to be covered by liquidity sources (e.g. cash reserves, committed bank-lines, positive operating cash flow etc.)?**

B14. **Would you expect to see secured offtake agreements[624] in place for this type of project?**

B15. **Are there any contingent liabilities which might arise from such a project which you would consider as a potential deal breaker?**

Probe: environmental/decommissioning liabilities; pensions; hedging; leasing

B16. **Do you perceive there to be any challenges in achieving a refinancing or market exit for this type of project?**

[623] DSCR = Net Operating Income / Total Debt Service. DSCR of less than 1 = negative cash flow. DSCR of 0.95 means only enough net operating income to cover 95% of annual debt payments.

[624] For energy generation / fuel production (for manufacturing, discuss forward orders for resulting sales)

B17. **What <u>new approaches at EU / Member State level</u> might help to alleviate risks in such a project?**[625]

Probe: public sector support mechanisms and the appropriate type of funding provided

----

[625] This may already have been covered under either A6(g) or A7(d) – if not probe any mechanism which might support deal

Negatively received Investment Sheets

SET Investment Sheet name: ……………………………

B18. With reference to the Risks Table, are there any risks which you perceive to be too high?

Probe: whether the risk profile overall is too high?; which risks are most critical?; can any risks be mitigated? potential dealbreaker risks?

B19. What market barriers in this sector create the most risk for you as an investor/lender?

B20. What conditions would be necessary to encourage you to become involved with FOAK project financing?

Probe financial / structuring areas of the Investment Sheet and unpick key aspects which the market participant is willing to shed light on (i.e. what would work): deal structure; returns.

Probe: would you be motivated to engage in the transaction if another fund provider found a specific business risk (e.g. technology) acceptable?

B21. What new approaches at EU / Member State level might help to alleviate risks?

Probe: public sector support mechanisms and the appropriate type of funding provided

CLOSE

Thank for their time and ask whether they would be happy to be contacted again to provide further information and / or clarify any issues. Mention that the study will be running through to 2016 although early insights are expected in late 2015 at which point engagement with the market is likely to take place. ICF may be in touch in due course to provide advance notice of any further engagement with the study.

How to obtain EU publications

Free publications:

- one copy:
  via EU Bookshop (http://bookshop.europa.eu);
- more than one copy or posters/maps:
  from the European Union's representations (http://ec.europa.eu/represent_en.htm);
  from the delegations in non-EU countries (http://eeas.europa.eu/delegations/index_en.htm);
  by contacting the Europe Direct service (http://europa.eu/europedirect/index_en.htm) or
  calling 00 800 6 7 8 9 10 11 (freephone number from anywhere in the EU) (*).

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).

Priced publications:

- via EU Bookshop (http://bookshop.europa.eu).

This study, commissioned by DG Research & Innovation, examined the role of financial instruments in the support of commercial-scale, first-of-a-kind (FOAK) energy demonstration projects focused on Sustainable Energy Technology (SET) sectors in Europe. FOAK projects are highly risky and the supply of equity and debt is at much lower levels than the financing of proven low carbon technologies. Market participants have very different appetites for risk, which in turn leads to complex financial structures being required to enable such projects to achieve financial close. Consequently, there is high demand for a suite of public sector funding mechanisms to be made available to fill the commercialisation, 'Valley of Death', funding gap. Two EU financial instruments have been identified as being needed: equity provision and specialist loans (as the latter already being offered by the Energy Demo Projects (EDP) facility), both at a scale of around at least €250 million and ideally €500 million.

Studies and reports

Publications Office

ISBN 978-92-79-62115-4