White Paper

Date with the Future

Making Plans in a World of Cleaner Energy

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Sharables

- Over the past year, market drivers have driven down expectations of future carbon dioxide emissions from the U.S. power sector by 16%.
- Lower emissions would lower states' hurdles to Clean Power Plan compliance, should it survive legal challenge, but would still leave power sector CO_2 emission reductions well short of long-term "deep decarbonization" goals.
- Gas and renewable resources remain the predominant long-term resource options, but both run the risk of over-investment as market drivers and regulation continue to shift.

Executive Summary

While the future of CO_2 regulation of the power sector remains uncertain as the Clean Power Plan is under legal review, the expectation of future CO_2 emissions from U.S. generation has changed dramatically. Projections show that natural gas prices and renewable technology costs have both come down sharply over the past year, and they have dragged projected CO_2 emissions down with them. These changes have implications for costs of compliance with CO_2 regulation and may start to shape discussion of longer-term CO_2 requirements. With or without CO_2 regulation, however, the rapidly changing market drivers have implications for the timing and reasonableness of long-term resource investments.

States Continue to Pursue Regulatory Paths to Clean Energy

Recent developments show continuing momentum toward incremental renewable capacity additions. Four separate states and Washington D.C. have grown their Renewable Portfolio Standard (RPS) requirements in the past year (see Exhibit 1). Together, these states added between 10 and 16 years to their prior commitments and increased their RPS requirements by an average of 23%.

EXHIBIT 1: RECENT RENEWABLE PORTFOLIO STANDARD REQUIREMENT INCREASES

State/Region	Date	Previous RPS Requirement	Current RPS Requirement
California	Oct. 2015	33% by 2020	50% by 2030
Oregon	Mar. 2016	25% by 2025	50% by 2040
Rhode Island	July 2016	14.5% by 2019	38.5% by 2035
Washington D.C.	July 2016	20% by 2020	50% by 2032
New York	Aug. 2016	30% by 2015	50% by 2030

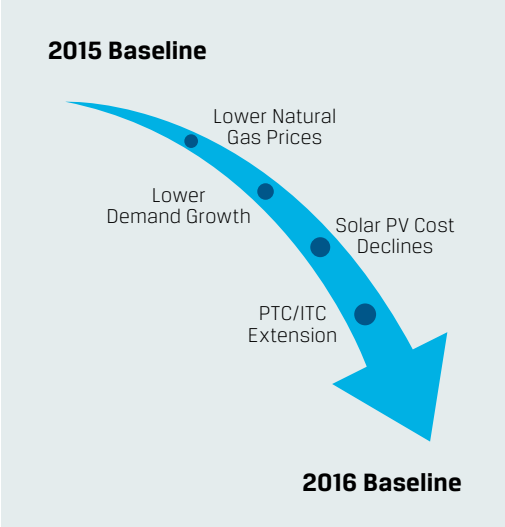
Source: ICF review of state proceedings

Outside of increasing their existing RPS targets, states continue to modify their clean energy goals in other ways. One such change occurred recently in Massachusetts, where Governor Charlie Baker signed House Bill 4568, requiring Massachusetts' distribution companies to contract for offshore wind and other renewable generation. The bill could add nearly 16,500 GWh of new renewable energy by 2027.

Recent federal tax policy changes will also support renewable energy development. The Consolidated Appropriations Act, 2016 (also known as 2016 omnibus spending bill), contained the longest extension of the Production Tax Credit (PTC) for wind since the original PTC created by the Energy Policy Act of 1992, although credit will decrease over time. The same spending bill increased the Investment Tax Credit (ITC) for solar, which was to expire by the end of 2016.

Following Power Sector Trends to a Lower CO_2 Baseline

These regulatory charges around renewable energy have joined regulatory efforts to reduce CO_2 emissions. Emission targets under EPA's Clean Power Plan may be surpassed by more stringent emission targets in California, and recent calls on the Regional Greenhouse Gas Initiative (RGGI) have member states considering deeper reductions there as well. While much focus over the past year has centered on the Clean Power Plan's possible impacts and the legal delays surrounding it, despite the absence of any federal climate regulation, a series of market developments have led to much lower CO_2 emissions' projections from the U.S. power sector.



Source: ICF

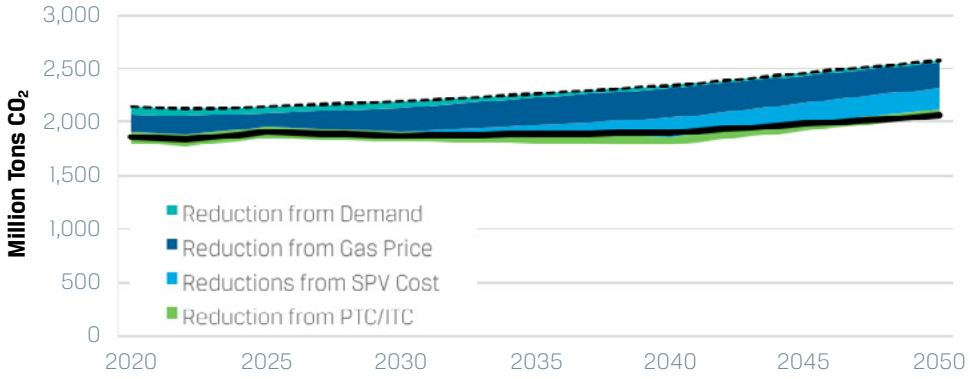
The PTC/ITC and developing views of other key market drivers over the past two years have led to 16% lower (on average) projected CO_2 emissions from the U.S. power sector over the 2020 to 2050 period, absent federal CO_2 regulation (Exhibit 3). ICF's "third party" baseline projections in 2040 fell by more than 400 million tons of CO_2, or 19%, from the projection based on early 2015 assumptions (2015 Baseline) to the more recent 2016 Baseline.[1]

This decline in projected emissions is attributable to many factors:

- Long-term natural gas prices in 2016 Baseline average $1/MMBtu, or 18%, lower at Henry Hub over the period 2020 to 2050.
- U.S. retail sales projections in 2016 Baseline are 2% lower than in 2015 Baseline, reducing the need for generation.
- Assumed costs for new solar photovoltaic (PV) generating capacity (central station) in 2040 are almost 40% lower in 2016 Baseline.
- Extension of the PTC/ITC.

Exhibit 2 shows the contribution of these drivers when looked at in isolation, with each "slice" in the chart reflecting emission reductions associated with moving that assumption alone from 2015 Baseline version to 2016 Baseline version. Lower natural gas prices lead to consistent emission reductions throughout, while the PTC/ITC and solar PV (SPV) costs trade off in importance over the near- to long-term.

EXHIBIT 2: DRIVERS OF LONG-TERM U.S. POWER SECTOR CO_2 EMISSION REDUCTIONS



Source: ICF

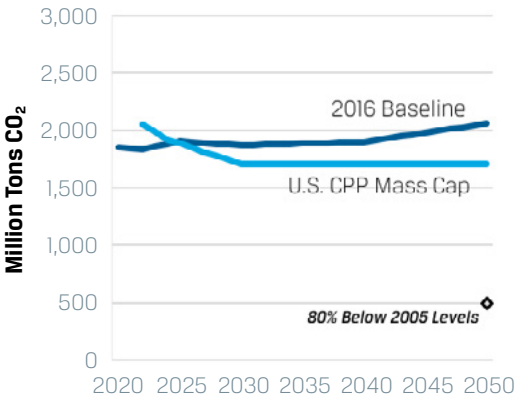
When stacked together, the sum of the parts is somewhat greater, until 2050, than the total reductions realized when they are combined, as reflected by the 2016 Baseline. The difference between the sum of the parts and the 2016 Baseline is due to overlapping impacts of the pieces—some of which drive similar changes, such as the uptake of new solar. Lower gas price environment

[1] ICF often prepares baseline projections based on third-party sources of assumptions, such as the Energy Information Administration (EIA) or EPA, that may differ from ICF's internal views. The 2015 Baseline in this analysis is based on assumptions available from these and other sources in 2015, and the 2016 Baseline is based on assumptions available in early 2016.

tends to worsen the competitive economics of renewable energy relative to gas-fired generation, which suppresses the near-term renewable generation build-out in response to the PTC/ITC extension.

The substantial reduction in emission projections between the 2015 and 2016 Baseline cases brings the United States as a whole into compliance with Clean Power Plan emission targets until around 2025. This change greatly reduces the compliance burden out to 2030 (Exhibit 3) relative to the 2015 Baseline.

EXHIBIT 3: U.S. POWER SECTOR CO_2 EMISSIONS AND THE CLEAN POWER PLAN



Source: ICF

Narrowing of that compliance gap is driving some market participants to look beyond the Clean Power Plan to what levels of CO_2 reductions may come after 2030. For example, the Obama Administration and several states have identified reductions of 80% as long-term goals. So, while current market forces alone are pushing the power sector in the direction of Clean Power Plan compliance, new market drivers—likely paired with more regulation—will be necessary to meet long-term deep decarbonization goals.

Implications for Long-Term Planning

The market drivers, along with state regulatory efforts to increase penetration of renewable generation and reduce CO_2 emissions (as they continue to evolve), will lead to an outcome that will benefit particular types of capacity decisions made in the near-term and will not benefit others. Understanding how robust a particular planning decision may be to these moving targets is essential to developing a creditable resource plan going forward.[2]

Travelling the Gas Bridge

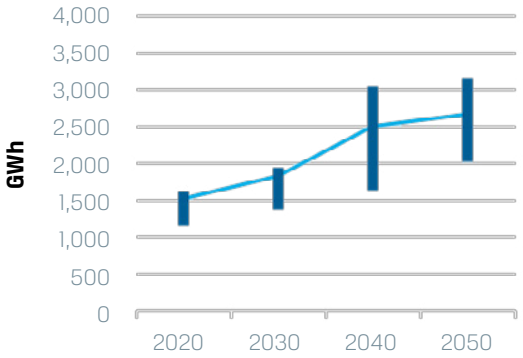
For years, planners and analysts spoke of natural gas as the transition—or bridge—fuel to take the power fleet toward lower CO_2 emission levels under regulation to address climate change. Lower gas prices have already put the sector on that bridge without the need for regulation. Exhibit 4 shows that the bridge has the potential to take the sector well into 2050. The exhibit shows the range of U.S. generation from gas across a range of cases[3] for each year,

[2] This analysis describes national generation trends. Optimizing investments for a particular region or market will require more detailed power and fuel market analysis than is addressed here.

[3] The cases include the market driver cases discussed in the previous section as well as CO_2 regulatory cases.

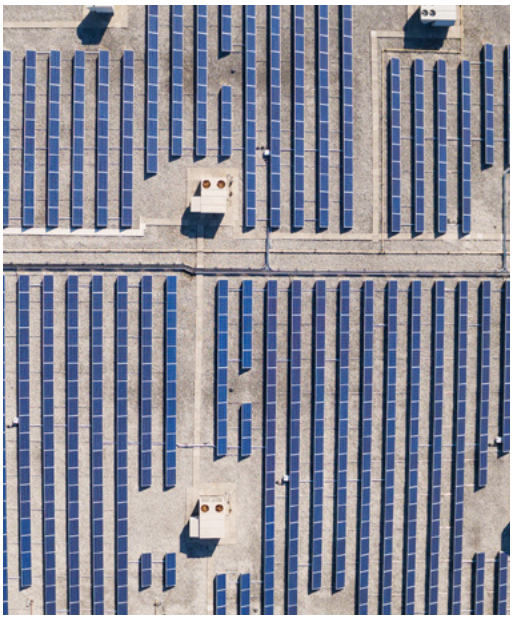
with the top of each bar reflecting the highest generation across the cases and the bottom of each bar reflecting the lowest generation level. The line shows the 2016 Baseline projection.

EXHIBIT 4: GENERATION POTENTIAL, GAS COMBINED CYCLE



Source: ICF

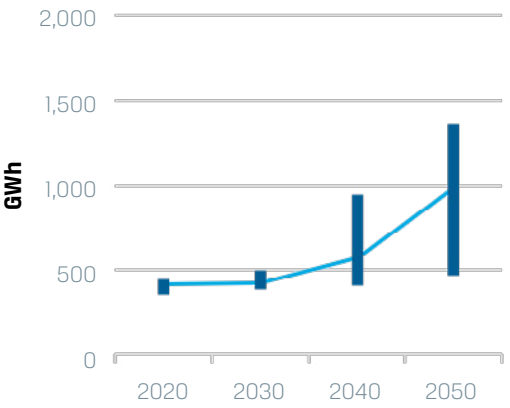
However, potential downsides to that path may outnumber the upsides, especially through 2030, as reflected by the 2016 Baseline projection being at the high end of the range of potential outcomes. Higher gas prices than expected in the 2020 to 2030 period alone or accompanied with lower demand or renewable costs have the potential to reduce the need for gas generation. These downside factors run the risk of stranding new gas investment. Upside potential for gas generation returns post-2040 in response to tighter CO_2 regulation and nuclear retirements, but the downsides also remain through 2050.



Solar on the Launch Pad

The PTC/ITC extensions front load wind and solar expansion through 2020, leaving a narrow range of growth potential between 2020 and 2030 (Exhibit 5). Generation continues to increase in the 2016 Baseline into 2040 and 2050 as solar becomes more competitive with gas and retiring nuclear units drive the need for replacement generation. The upside greatly expands in 2040 as solar costs are assumed to reach new lows and CO_2 regulation increases demand for non-emitting power. However, without sustained lower technology costs, low-price gas remains a potential driver of downside risk, with wind and solar generation potentially only half of what is projected in the 2016 Baseline.

EXHIBIT 5: GENERATION POTENTIAL, WIND AND SOLAR



Source: ICF

Should cost trends continue to advance at the rate of recent change, the bars in Exhibit 5 will likely push left (earlier in time), bringing nearer the potential upside for renewable energy relative to gas and other alternatives. However, grid integration challenges and transmission requirements may offset some of that shift as the market share for renewables increases over time in select regions.

Closing Thoughts

Making these long-term resource planning decisions in the face of uncertainty is not a new challenge, but the rate of change of key drivers will complicate the problem. Gas remains well positioned in a future with the Clean Power Plan and beyond, but advancing renewables may pose risks to gas well before a long-term CO_2 price might. Renewable energy is a robust option in a CO_2-constrained future but faces its own risks from gas and load growth as well as system integration challenges. In considering approvals for new resources, including power purchase contracts and asset investments, utilities and regulators will be increasingly faced with evaluating the reasonableness of costs associated with clean energy alternatives in the face of rapid change while meeting the traditional mandates of safety, reliability, power quality, and, increasingly, resiliency.

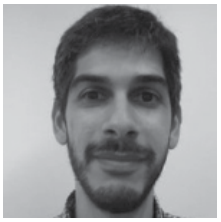
About the Authors

Chris MacCracken has more than 15 years of experience in energy and economic modeling and assessing the potential impacts of environmental policies on the energy sector. He has directed a number of studies examining the impacts of environmental regulation on emission, power and fuel markets, compliance planning, and electric generating unit valuations for electric utilities, independent power producers (IPPs), industry associations, and nonprofit policy organizations. He is lead author of the Emission Markets chapter in ICF's quarterly Integrated Energy Outlook publication.

Prior to joining ICF in 2000, Mr. MacCracken worked with the Global Climate Change Group at Battelle-Pacific Northwest National Laboratory. He modeled the impacts of climate change policy and the role of advanced technologies in mitigating climate change.

Maria Scheller, an expert in long-term planning and forward market modeling, she is experienced in assessing long-term market risks and developing strategies around reducing risks and maintaining operational standards.

She has supported utilities and independent power producers in reviewing plans for development of generation and other resource options for financial soundness under an expected range of conditions. Ms. Scheller has provided due diligence support to individual asset owners and companies holding portfolios of diverse assets and has supported resource procurement exercises for load-serving entities.



Imran Lalani is a Manager at ICF, where he has five years of consulting experience providing project and modeling leadership and support for the Commercial Energy Division. Mr. Lalani's work at ICF focuses on emissions markets, with a particular emphasis on the Clean Power Plan. He has led and supported studies for a variety of clients including Electric

About ICF

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Utilities, Independent Power Producers (IPPs), industry associations, and nonprofit policy organizations aimed at understanding the impact of environmental policy on power and fuel markets, analyzing emissions outcomes and program stringency as well as implications on long term planning and asset valuation.

Mr. Lalani has a B.A. in Economics from Oberlin College and an M.A. in Economics from Johns Hopkins University.

Aaron Geschiere is an associate at ICF, where he has five years of experience providing project and modeling leadership and support for the Commercial Energy Division. Mr. Geschiere's work at ICF focuses on renewable energy fundamentals and project evaluation, with previous experience forecasting Renewable Energy Credit prices in multiple U.S. markets, Power Purchase Agreement evaluation and due diligence, and assessment of market opportunities for renewable project developers. Mr. Geschiere has B.S. degrees in Economics and Environmental Science from the University of Michigan.

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