Integrated Resource & Resilience Planning (IRRP) for the Power Sector

USAID Training – March 6, 2017
Session 2: What Planning Looks Like

Part One – Components & Process

Presenters: Maria Scheller, Sanjay Chandra, Ken Collison, Bill Prindle, Molly Hellmuth
What Components and Factors are Considered within an IRRP?
Key Elements of Integrated Resource Planning

- Integrate resources and people across departments
  - Supply, demand, transmission, distribution, and pricing
  - Cooperation, coordination, and communication

- Treat uncertainty explicitly
  - Alternative resource portfolios
  - Factors external to the utility
  - Collect and analyze additional data

- Continue planning process
  - Feedback from implementation to planning
  - Develop new plans

- Involve the public in the planning process
  - Customers, nonutility experts, Independent power producers, and regulator

- Consider environmental factors

- Implement plan
  - Acquire demand and supply resources

Source: Adopted from “Technical competence of integrated resource plans prepared by electric utilities”, Eric Hirst and Martin Schweitzer, March 1990.
Components of IRRP Analysis

- Demand Analysis & Forecast
- Distribution System Analysis
- Supply-side Resource Analysis
- Transmission Network Analysis
- Demand-side Resource Analysis

Integrated Resource and Resilience Analysis
Factors Influencing an IRRP Analysis

Integrated Resource and Resilience Analysis

- Economy
- Environment / Climate Goals
- Political Motivations
- Consumer Willingness to Pay
- Regulatory Structure
- Technological Progress
Sample IRRP Analytical Phasing Structure

- **Determine Input Data**
  - Supply resources
  - Demand levels
  - Demand resources
  - Fuels
  - Transmission
  - Capital limits
  - Environmental limits

- **Design Decision Criteria**

- **Optimize Resource Mix**
  - Economic criteria
  - Consider alternate resource portfolios

- **Consider Risks through Scenario Review**
  - Fuel
  - Load Unit Performance
  - Transmission
  - Environmental
  - Build Exuberance
  - Demand
  - Response
  - Climate

- **Evaluate Options based on Criteria**
  - Best Portfolio(s) selected on the basis of commercial reality, balance of objectives, and perspective of risk
# Possible Objectives and Metrics to Use for Portfolio Evaluation

<table>
<thead>
<tr>
<th>Objective</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize cost</td>
<td>Levelized NPV ($/MWh) or $/MWh of generation portfolio costs; total Revenue Requirements ($)</td>
</tr>
<tr>
<td>Rate stability / Ratepayer risk</td>
<td>Annual volatility of $/MWh associated with portfolio options across scenarios</td>
</tr>
<tr>
<td>Resource Adequacy</td>
<td>Level of reserves maintained (%); Frequency (# of events) and level (MWh) of loss of load events associated with portfolios across scenarios</td>
</tr>
<tr>
<td>Environmental Stewardship</td>
<td>Tonnage emissions for criteria pollutants; Cost of meeting air quality objectives; External health impact (indirect costs)</td>
</tr>
<tr>
<td>Diversity</td>
<td>% concentration on one type of asset or fuel, % of concentration on one generating unit</td>
</tr>
<tr>
<td>Land Use</td>
<td>Acres of land required</td>
</tr>
</tbody>
</table>
Interrelationships of Components in the IRRP Process

Supply-side Resource Analysis

Demand Analysis & Forecast

Transmission Network Analysis

Distribution System Analysis

Distributed Energy Resource Analysis

Supply-side planning

DSR

Network planning and design

System planning and design

Locational Value

Hosting Capacity

Dispatch Schedule/Day-ahead Planning
How can IRRP Manage Climate Risk?

Presenters: Molly Hellmuth
Climate Resilient Power Planning

Rationale

- Reliable and cost-efficient energy services are critical;
- Emphasis on renewable energy and investment in infrastructure;
- Climate change is beginning to have significant impacts;
- Due diligence, e.g., USAID ADS 201: requires climate risk screening and management in new strategies and plans, including power sector investments

Degree to which hydropower utilities believe climate change is already influencing their engineering and structural design measures. Source: IHA, 2015.
Climate Resilient Power Planning

Building power planners capacity and understanding of:

- The types of climate risks and potential impacts to power system resilience
- The types of climate risk management options
- The implications for power systems planning (IRRP)
Direct Climate Change Impacts

- **Operational and Financial:**
  - Resource availability: e.g., changes in quantity or distribution of flow into hydropower reservoirs
  - Efficiency: e.g., increased temperatures reduce transmission and distribution efficiency
  - Structural damage: e.g., exposure of infrastructure to flooding
  - Resource demand: e.g., increased energy for cooling
Indirect Impacts of Climate Change

- **Strategic and Planning Risks:**
  - Risk management in the investment behavior of energy institutions
  - Energy technology R&D investments
  - Energy resource and technology choices
  - Energy Prices

- **Financial:**
  - Adaptation costs (e.g., raising vulnerable assets to higher levels, building future energy projects further inland)
Integration of Risks and Resilience into IRRP

- Step 1: Risk and Resiliency Assessment:
  - Sub-national
  - Climate change
  - Potential impacts by power system component
  - Potential adaptation measures by component
  - Recommended climate scenarios
Integration of Risks and Resilience into IRRP

- **Step 2: Participatory Risk and Resiliency Workshop:**
  - Present the results of the risk and resiliency analysis
  - Identify priority risks and risk management responses
  - Develop climate scenarios

<table>
<thead>
<tr>
<th>Climate Stressor</th>
<th>Hydro</th>
<th>Thermal</th>
<th>Renewables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought</td>
<td>High</td>
<td>Med</td>
<td>Low**</td>
</tr>
<tr>
<td>Temperature</td>
<td>Med</td>
<td>Med</td>
<td>Med**</td>
</tr>
<tr>
<td>Extreme Rainfall &amp; Flooding</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Sea Level Rise</td>
<td>Low</td>
<td>Med</td>
<td>Med</td>
</tr>
<tr>
<td>Rainfall, flow variability &amp; timing</td>
<td>High</td>
<td>Med</td>
<td>Low</td>
</tr>
<tr>
<td>Erosion and Sedimentation</td>
<td>High</td>
<td>Low</td>
<td>Med</td>
</tr>
</tbody>
</table>

*Biomass is highly sensitive to drought, while solar and wind have lower sensitivity
**Biomass has a higher level of sensitivity to temperature than solar and wind
Integration of Risks and Resilience into IRRP

- Step 3: Power System Performance Evaluation:
  - Evaluate hydropower performance in WEAP
  - Evaluate power system performance (given different investment choices) in IPM
  - Given different climate scenarios
Integration of Risks and Resilience into IRRP

- **Step 4: Integrate Results into Power System Master Plan:**

  - Incorporation of risks and resilience measures based on participatory review of quantitative, qualitative assessments

<table>
<thead>
<tr>
<th>Justification</th>
<th>Type</th>
<th>Adaptation Strategy</th>
<th>Already Pursuing?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No-regrets</strong></td>
<td>Policy and Planning</td>
<td>Establish public education programs to promote lifestyles that are less energy-dependent</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Policy and Planning</td>
<td>Explore energy market mechanisms to meet demand. Consider power exchange agreements, purchasing from the spot market, and options purchasing.</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Establish or expand demand-response programs which encourage consumers to voluntarily reduce power consumption during peak demand events</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time of Use Tariffs to encourage consumers to reduce power consumption during peak hours</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve and enforce energy efficient building codes</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adopt mandatory minimum energy performance standards for buildings and appliances</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Policy and Planning, Structural</strong></td>
<td>Install smart meters and grids to reduce power consumption during peak demand events</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td><strong>Structural</strong></td>
<td></td>
<td>Employ passive building design strategies to maintain minimum comfort or lighting levels even in situations where energy system losses occur</td>
<td>N</td>
</tr>
</tbody>
</table>
How is Demand Growth Projected?
Demand Analysis and Forecast Approach

- Weather
- Economy
- Rates
- Time of Day
- Off system load
- Time of Year

Steps:
1. Electrification
2. Time Series
3. Econometric
4. End-use
5. Learning Algorithms
Risk and Resiliency: Load Forecasting

- **Temperature Increase**
  - Net demand for electricity will increase (cooling driven)
  - Higher peak demands can be particularly challenging

- **Extreme Events**
  - Extremes increase the peak demand to cool and heat buildings.

- **Adaptation Measures:**
  - Developing demand-side/conservation management – Time of Use Tariff
  - Green buildings, energy efficient measures
  - Smart meters, grids
How are Supply Side Resources Considered?

Presenter: Maria Scheller
Supply-Side Resource Analysis

- **Central Generation**
  - Natural gas
  - Hydro
  - Fossil
  - Renewables
  - Other

- **Analysis Components**
  - Available capacity
  - Fuel price
  - Performance expectations
  - Capital and operating costs
  - Environmental impacts

To what extent should repair and refurbishment costs of current sources be analyzed?
Generation Technology Assessment and Inventory

Renewable Resource Potential is High?

- Raw potential for renewable resources is a strength in many developing countries.
- However, limited information on the total potential for resources, the impact of those resources to land and other competing uses, or the interconnection capability tends to be available.
Risk and Resiliency: Generation

- **Changing flow**
  - Changed hydropower generation

- **Extreme Events**
  - Direct flood damage
  - Increase/decrease hydropower generation
  - Increase competing water demands

- **Adaptation Measures:**
  - Hardening, building redundancy into facilities, relocating vulnerable facilities
  - Reducing water consumption, increasing water supply, adding peak generation, power storage capacity
How are Distributed Energy Resources Considered?

Presenter: Sanjay Chandra
What are Distributed Energy Resources (DER)?

- Distributed energy resources (DER) are smaller power sources that can be aggregated to provide power necessary to meet regular demand.

- Planning is now more complex as increases in DER deployments are occurring on the system whether through organic adoption or policy driven.

- Lack of information on the type of DER, amount, and speed of deployment creates a challenge to the traditional long term planning process

- Analysis not just focused on planning, but on the impacts as well
  - Impact intermittent generation from technologies such as solar, small wind
  - Loading on a feeder, potential of two-way power flows for safety and reliability
DER is Changing Today’s Planning Processes

- Traditional Grid Planning typically focuses on generation, transmission, and distribution segments, ignoring activities at the “edge of the grid”
- Today, rapidly increasing deployments of “DER” technologies such as solar, storage, advanced communications and controls are causing planners to re-think this approach
  - DER is now beginning to be viewed as a grid asset and part of planning processes
- DER planning can help developing countries leapfrog the traditional distribution and IRP planning processes and move to the next level
Why is Change Occurring?
Convergence of a Number of Factors!

- Drivers such as emissions, environmental, and siting concerns are making traditional solutions more difficult to implement and increasing the deployment timeline as well.

- Decreasing cost of advanced technologies are making distributed resources more accessible to commercial and residential customers.
  - Solar PV, Energy Efficiency, CHP

- Coupling DER with advanced controls, communications, and additional technologies can “firm” and “control” technologies – transforming them into reliable, grid assets.
  - Solar PV + storage
  - “Targeted” Energy Efficiency and Demand Response
  - Microgrids

- Incorporation of DER enhances planning solutions and complements traditional approaches.
  - ICF incorporates its DER capabilities into our IRRP approach, maximizing options with Energy Ministries and Utilities.
  - Integrated approach accelerates solution deployment by utilizing all potential grid assets.
How do we Approach DER Analysis?

Scenario based distribution planning
- Uncertainty of the types, amount and pace of DER make singular forecasts ineffective. Inputs from ICF’s DEEP tools provide an accurate, data-based range of geo-specific forecasts of DER penetration.

Hosting capacity
- ICF works with utility feeder data to determine the amount of DER a feeder can accommodate within three principal constraints: thermal, voltage/power quality and relay protection limits.

Locational value of DER
- Sourcing locational infrastructure or operational requirements from DER may result in positive or negative costs and benefits. ICF has developed frameworks with utility clients to capture and optimize them.

Probabilistic-based engineering analysis
- Issues from increased DER penetration – variability of loading, voltage — require probabilistic analysis. ICF models these probabilities.

Integrated T&D planning
- At high DER, net load characteristics have impacts on transmission system / bulk power system operation, requiring transmission-distribution interaction analysis. ICF is helping to write the book on these issues in California.
How do we Approach DER Analysis?

- Deploying DER in a widespread, efficient and cost-effective manner requires complex integration with the existing electricity grid.

- ICF models and analysis drive the new distribution planning framework.
  - Basic building blocks of a “distribution” planning framework.
  - Individual Blocks can be initiated to simply understand the potential of DER on an electricity system.

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DER Analysis Should be Integrated in Planning Decisions

- Approach leverages the current trends of the movement and migration of generation assets to the edge of the grid
- Incorporates the DER assets as tools for grid operations, leading to advantages of:
  - Leveraging deployments that may already be occurring by commercial and residential customers
  - Potentially avoiding large capital cost of deploying a centralized solution, shifting to a more local solution for specific area
  - Potentially avoiding environmental hurdles increasingly seen in traditional approaches
  - Adding additional options to consider in addressing IRRP needs; IRRP assessed the ability to solve locational problems quickly with DER versus potentially longer term ability to better manage load growth centrally
How is the Transmission System Analyzed?

Presenter: Ken Collison
Transmission Network Analysis

Power System Reliability & Planning

- **Resource Adequacy**: Maintaining sufficient capacity to meet customer needs in spite of scheduled and unscheduled outages

- **Transmission Security**: The ability to continue operating reliably following sudden and unexpected contingencies

- **Transmission Adequacy**: Having sufficient transmission capacity to move power across key interfaces and corridors in the system

*Primary focus of Transmission Assessment*
Transmission Network Analysis

Assess capability of existing system
- Transmission security analysis
- Transfer capabilities between zones
- System improvements to meet reliability and performance criteria

Perform current (today) and long-term (5-year) system capability assessments
- Include expected resource and infrastructure additions
- Adequacy and security analysis
- System improvements to meet reliability and performance criteria

Use scenario analysis to assess resiliency of T&D infrastructure
- Determine incremental system improvements for a resilient system

Incorporate into Least Cost Modeling

Develop Master Plan
Transfer Capability Analysis

Having sufficient transmission capacity to move power across key interfaces and corridors

1. Establish the zones based on geography, generation resources, and load demand
2. Establish the interface as defined by the combination of lines connecting two zones
3. Determine transfer capability by adjusting generation and load between the zones
4. Repeat this for all identified combination of zones
Case Study: Transfer Capability Assessment for Tanzania Grid
Transmission Security Violations and Affected Equipment
Transmission Security Violations – Summary

43 transmission lines at or above Long Term Emergency (LTE) ratings—should be addressed

12 loaded over 120% of their LTE ratings—a more significant reliability concern
Case Study: Transformer Overloads in Tanzania: Dar es Salaam, Tanga, Kilimanjaro and Morogoro

<table>
<thead>
<tr>
<th>From Bus Name</th>
<th>From Nom kV</th>
<th>To Bus Name</th>
<th>To Nom kV</th>
<th>Area</th>
<th>pu Loading</th>
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<tr>
<td>UBU132MB</td>
<td>132</td>
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<td>11</td>
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<td>0.93</td>
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<td>33</td>
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<td>KID011G3</td>
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<td>KID220MB</td>
<td>220</td>
<td>Morogoro</td>
<td>1.41</td>
</tr>
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</table>

Case Study: Voltage Violations in Tanzania

- Base Case has a few voltage violations at 33 kV and below.
- These violations are also seen in the N-1 contingency analysis.

<table>
<thead>
<tr>
<th>Areas</th>
<th>Nom kV</th>
<th>Per Unit</th>
<th>Substation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dar Es Salaam</td>
<td>11</td>
<td>0.89</td>
<td>Jacobsen</td>
</tr>
<tr>
<td>Iringa</td>
<td>11</td>
<td>0.87</td>
<td>Mufindi</td>
</tr>
<tr>
<td>Kilimanjaro</td>
<td>11</td>
<td>1.08</td>
<td>Nyumba</td>
</tr>
<tr>
<td>Manyara/Dodoma</td>
<td>33</td>
<td>1.08</td>
<td>Kondoa</td>
</tr>
<tr>
<td>Morogoro</td>
<td>33</td>
<td>0.94</td>
<td>Morogoro</td>
</tr>
</tbody>
</table>
Risks and Resiliency: T&D

- **Temperature Increase**
  - Decreases the efficiency of electrical transmission

- **Extreme Events**
  - Line sag and power disruption
  - Structural damage
  - Tree-on-line damage

- **Sea Level Rise & Storm Surge**
  - Scouring of transmission tower bases
  - Corrosion of electrical components

- **Adaptation Measures**
  - Back-up power supply, intelligent controls, and distributed generation
  - Insulating equipment
How is the Distribution System Analyzed?

Presenter: Ken Collison
Distribution System Analysis

Assess capability of existing system
- Perform distribution load flow and capacity expansion analysis
- Determine system improvements to meet load growth and reliability

Perform long-term (5-year) system capability assessments
- Include expected resource and infrastructure
- Perform capacity expansion
- System improvements to meet load growth and reliability

Use scenario analysis to assess resiliency of Distribution system
- Determine incremental system improvements for a resilient system.

Distribution Expansion Plan

Training and Knowledge Transfer
Case Study: Distribution System Analysis for Tanzania

- Assess development plans of TANESCO and REA
- Perform distribution expansion planning to accommodate load growth and grid connectivity
- Assess the effect of loss reduction programs and advanced metering
- Training on best practices and knowledge transfer
What are the Methods and Tools for DSM?

Presenter: Bill Prindle
1. Develop customer load data, EE measure data, and program designs

2. Calculate program energy and capacity savings and cost-effectiveness

3. Assess programs’ wider benefits, challenges and solutions

4. Finalize DSM program designs for regulatory approval and implementation
Step 1: Develop load data by customer class

<table>
<thead>
<tr>
<th>Tariff Class</th>
<th>Customers in Tariff Class</th>
<th>% Total Cust.</th>
<th>Total Sales (GWh)</th>
<th>% Sales</th>
<th>Average Annual Sales per Customer (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1—Domestic Low Usage</td>
<td>613,618</td>
<td>47%</td>
<td>515</td>
<td>10%</td>
<td>839</td>
</tr>
<tr>
<td>T1—General Usage</td>
<td>699,287</td>
<td>53%</td>
<td>2,203</td>
<td>43%</td>
<td>3,150</td>
</tr>
<tr>
<td>T2—Low Voltage Supply</td>
<td>2,483</td>
<td>0.2%</td>
<td>634</td>
<td>12%</td>
<td>255,336</td>
</tr>
<tr>
<td>T3—High Voltage Supply</td>
<td>461</td>
<td>&lt;0.1%</td>
<td>1,804</td>
<td>35%</td>
<td>3,913,232</td>
</tr>
<tr>
<td>Total</td>
<td>1,315,849</td>
<td></td>
<td>5,156</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **D1-dominestic**: Refrigerators & Freezers 68%, Lighting 15%, Fans 4%, TV & Radio 6%, Other 7%
- **T1--Residential**: Refrigerators & Freezers 44%, Lighting 15%, Other 14%, AC 17%, Fans 7%
- **T1--Commercial**: Refrigerators & Freezers 34%, Lighting 36%, Other 21%, AC 9%
Step 1: Develop customer load profiles by type (Example: retail store)
Customer Load Profile: Medium Office

- **Time of Day**
  - 12:00 AM
  - 4:48 AM
  - 9:36 AM
  - 2:24 PM
  - 7:12 PM
  - 12:00 AM

- **kVAh**

- **Outside Air Temperature**
  - R² = 0.6901

- **Graphs and Pie Chart**
  - Cooling 26%
  - Interior Equipment 26%
  - Interior Lighting 23%
  - Exterior Lighting 7%
  - Fans 18%
Customer Load Profile: Cement Plant

- **Kiln** - Electricity MWh 27%
- **Finish Grinding** - Electricity MWh 38%
- **Fuel handling** - Electricity MWh 2%
- **Raw Materials preparation** - Electricity MWh 27%
- **Other** - Electricity MWh 6%

**Graphs:**
- **Time of Day**
- **Outside Air Temperature**

- **$R^2 = 0.0116$**

- **Pie Chart:**
  - Kiln - Electricity MWh 27%
  - Finish Grinding - Electricity MWh 38%
  - Fuel handling - Electricity MWh 2%
  - Raw Materials preparation - Electricity MWh 27%
  - Other - Electricity MWh 6%
## Develop DSM Measures

<table>
<thead>
<tr>
<th>Tariff Class</th>
<th>End Use</th>
<th>Measure Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Lighting</td>
<td>CFL</td>
</tr>
<tr>
<td></td>
<td>Refrigeration</td>
<td>Efficient Refrigerator</td>
</tr>
<tr>
<td>T1</td>
<td>Cooling</td>
<td>Efficient AC</td>
</tr>
<tr>
<td></td>
<td>Envelope</td>
<td>Air Sealing</td>
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<tr>
<td></td>
<td>Lighting</td>
<td>CFL</td>
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<td>Refrigeration</td>
<td>Efficient Refrigerator</td>
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### Residential

<table>
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<tr>
<th>Measure Category</th>
<th>End Use</th>
<th>Measure Type</th>
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<tbody>
<tr>
<td>Energy Efficiency</td>
<td>Cooling</td>
<td>Efficient Split AC</td>
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<tr>
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<td>Air Sealing</td>
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<td></td>
<td>Lighting</td>
<td>CFL</td>
</tr>
<tr>
<td></td>
<td>Refrigeration</td>
<td>LED Reflector Lamps</td>
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<tr>
<td></td>
<td></td>
<td>Lighting Occupancy Sensor</td>
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<td></td>
<td></td>
<td>Linear LED Lamps</td>
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<td>T8/T5 Linear Florescent</td>
</tr>
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<td>Demand Response</td>
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<td>AC Direct Load Control</td>
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### Commercial

<table>
<thead>
<tr>
<th>Measure Category</th>
<th>End Use</th>
<th>Measure Type</th>
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<tbody>
<tr>
<td>Energy Efficiency</td>
<td>Cooling</td>
<td>Efficient Refrigerated Case Display</td>
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<tr>
<td></td>
<td>Refrigeration</td>
<td>Efficient Refrigerator</td>
</tr>
<tr>
<td>Lighting</td>
<td>CFL</td>
<td>LED Reflector Lamps</td>
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<td>Lighting Occupancy Sensor</td>
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<td></td>
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<tbody>
<tr>
<td>Energy Efficiency</td>
<td>Compressed Air Upgrades</td>
</tr>
<tr>
<td></td>
<td>Custom Project</td>
</tr>
<tr>
<td></td>
<td>Lighting Upgrades</td>
</tr>
<tr>
<td></td>
<td>Motor Upgrades</td>
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<tr>
<td></td>
<td>Process Cooling Upgrades</td>
</tr>
<tr>
<td></td>
<td>Process Heating Upgrades</td>
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</table>
Step 1: Compile EE measures into programs

- **Data gathering**
  - Compile list of available measures, impacts and costs

- **Program build-up**
  - Package multiple energy efficiency measures into programs

<table>
<thead>
<tr>
<th>Residential Water Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Hot Water Heater with controller - Res</td>
</tr>
<tr>
<td>Heat Pump Hot Water Heater</td>
</tr>
<tr>
<td>Tankless Water Heater (in-line electric)</td>
</tr>
<tr>
<td>Low Flow Showerhead</td>
</tr>
<tr>
<td>Tank Insulation</td>
</tr>
</tbody>
</table>
Step 2: Calculate impacts and cost-effectiveness

- Measure Cost
- Energy Savings
- Cost Effectiveness
- Program Design
- DSM Potential

Country-specific data
Step 2: Calculate demand impacts (MW)
Step 2: Calculate energy impacts (GWh)

Graph showing energy impacts from various solutions over the years 2014 to 2018:
- Residential Lighting
- Refrigerator Recycling & Replacement
- Energy Solutions for Industrial
- Energy Solutions for Commercial
- Commercial Refrigerated Vending
Step 2: Calculate cost-effectiveness

Cost of Energy Savings (cents/kWh)

Technical Potential Savings (GWh) / GHG Emissions Reduction (mtCO₂e)
Step 3: Estimate overall benefits vs. likelihood of success

<table>
<thead>
<tr>
<th>Indicator</th>
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</thead>
<tbody>
<tr>
<td><strong>Market Transformation Potential</strong></td>
<td>The potential for programs to influence their relevant market channels over the long run (e.g., the extent to which the program may change retailer stocking practices over time) and the likelihood of changing purchasing decisions (e.g., the probability that consumers would use energy-efficiency products once a financial incentive is no longer available).</td>
</tr>
<tr>
<td><strong>Political Feasibility</strong></td>
<td>How likely local utility and government stakeholders are to accept and support the program. Without buy in from key stakeholders, a program is likely to never make it out of the planning stage. This may be affected by key stakeholders having backed a similar program in the past that did not have positive results.</td>
</tr>
<tr>
<td><strong>Program Complexity</strong></td>
<td>Marketing, administration, and evaluation burden all add to the complexity of implementing programs. This factor is evaluated based on available resources, experience, and expertise in these areas. The score could be high if a particular country has implemented similar programs recently that can be leveraged when implementing a new activity.</td>
</tr>
<tr>
<td><strong>Environmental Aspects</strong></td>
<td>The lifecycle impact of the program on waste, water use, and emissions. For example, if facilities and infrastructure for recycling CFL lamps are not present in the country, a CFL lighting program may score poorly in that country.</td>
</tr>
<tr>
<td><strong>Economic Aspects</strong></td>
<td>The potential to increase jobs and development of the local manufacturing industry. If, as a part of the program, manufacturing demand is increased or jobs are created as people are needed for energy audits or installations, this score will be high.</td>
</tr>
<tr>
<td><strong>Equity / Affordability</strong></td>
<td>How a program would perform in providing DSM options to customer class within each of its target sectors. The score relates to the relative benefit to one particular market segment over another.</td>
</tr>
</tbody>
</table>
Step 4: Identify top programs for implementation

Figure 1: Top 10 Energy Efficiency Opportunities
Steps 2-4: EE Opportunity Study Tool

Energy Efficiency Opportunity Assessment

Country
Uganda ← Select Country

Countries currently available in this tool

Calculator Version: A3