Grid Modernization and New Utility Business Model

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Clean Energy Legislative Academy, Breckenridge, Colorado

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About Energy Innovation

• Energy Innovation’s mission is to accelerate progress in clean energy by supporting the policies that most effectively reduce greenhouse gas emissions. Through customized research and analysis for decision makers, we uncover the strategies that will produce the largest results.

• We work closely with other experts, NGOs, the media, and the private sector to ensure that our work complements theirs.
About RAP – US

• RAP provides technical and policy support at the federal, state and regional levels, advising utility and air regulators and their staffs, legislators, governors, other officials and national organizations.

• We help states achieve ambitious energy efficiency and renewable energy targets and we provide tailored analysis and recommendations on topics such as ratemaking, smart grid, decoupling and clean energy resources. RAP publishes papers on emerging regulatory issues and we conduct state-by-state research that tracks policy implementation.
About Your Presenter – Mike O’Boyle

Mike O’Boyle is the Director of Electricity Policy for Energy Innovation, working to uncover policy and technology solutions for a clean, reliable, and affordable U.S. electricity system. He has worked with utility regulators and legislators from states around the U.S. to improve the link between public policy goals and electric utility incentives, update policymakers on technological developments and policy levers to promote investment, and promote clean energy transformation that improves affordability and reliability.

Mike has authored reports for policymakers and other utility stakeholders covering a wide range of power sector topics, including distributed energy resource ownership and operation, mechanisms for adopting performance-based regulation, grid modernization, the economics of coal generation, and more.
About Your Presenter – Janine Migden-Ostrander

- Janine L. Migden-Ostrander advises regulators and advocates on energy efficiency, renewable energy, demand response, distributed generation, and integrated resource planning. Recent projects include working closely with the Puerto Rico Commission, Arkansas Public Service Commission on energy efficiency as part of the Clean Energy Ministerial for the U.S. Department of Energy (DOE), facilitating the Mid-Atlantic Distributed Resources Initiative (MADRI), and providing workshops on power sector transformation for Commissioners. Her projects are predominantly in the U.S., but also overseas.

- Ms. Migden-Ostrander has worked in public utility law for approximately 35 years, most recently as the Ohio Consumers’ Counsel, where she oversaw the state agency that represents the interests of Ohio’s 4.5 million residential households with their investor-owned electric, natural gas, telephone, and water companies.
Grid Modernization

The Next Frontier in Distribution Planning
What do YOU want out of grid modernization?
Issues to be covered

1. Why do grid modernization? Why now?
2. Infrastructure investments
3. Getting the most out of distributed energy resources
4. Guidance for legislation
5. Appendix
   • Additional information on topics covered
   • Regulatory grid modernization proceedings
   • Getting the most out of grid modernization
   • Resources
TECHNOLOGIES THAT CHANGE THE GAME

Source: https://energyinnovation.org/publication/the-coal-cost-crossover/
TECHNOLOGIES THAT CHANGE THE GAME

BATTERY STORAGE
- Modular size
- Renewable integration
- Cheap, dispatchable, clean energy almost anywhere
- Infrastructure, energy, or all of the above?

Global benchmarks - PV, wind and batteries

Source: BloombergNEF. Note: The global benchmark is a country-weighted average using the latest annual capacity additions. The storage LCOE is reflective of a utility-scale Li-Ion battery storage system running at a daily cycle and includes charging costs assumed to be 60% of wholesale base power price in each country.
TECHNOLOGIES THAT CHANGE THE GAME

ELECTRIFICATION

- Renewables integration
- Infrastructure needs
- Demand-side participation, flexibility, elasticity
- Industrial electrification
- Synthetic fuel production

**Figure 6** Incremental Electricity Sales due to Electrification of Heating and Transport

*Source: AEO 2015, NREL 2016, The Brattle Group analysis*
TECHNOLOGIES THAT CHANGE THE GAME

BIG DATA, COMMS, & AI

- Coordinating & predicting customer response
- Targeting high-value customers
- T&D Coordination
- Better outage prediction & coordinated response
- Better measurement of EE/DR programs
THE GRID IS ALREADY BEING REBUILT… WILL IT BE A “MODERN” ONE?
VALUE OF A SMART GRID

DIRECT ECONOMIC BENEFITS

- Reductions in Utility Operating Expenses
- Improvements in Revenue Assurance
- Energy Conservation
- Peak demand reduction
VALUE OF A SMART GRID

INDIRECT ECONOMIC BENEFITS

• Promotes Economic Development
• Improves Reliability and Resilience
• Accommodates customer DER & Electrification
• Encourages Energy Capitalism & Democracy
Discussion: What do your constituents value from grid modernization?
Infrastructure Investments
Cost: Smart Grid Spending

US smart grid spending by segment ($bn)

Source: Sustainable Energy Factbook 2017
Smart Grid Spending: Where do the dollars go?

- Software (ADMS; DERMS; IVVO) -- $
- (Wireless) Communications Networks -- $$
- Field Hardware -- $$$
  - Line Sensors (reliability, data, power quality)
  - Remotely-controlled equipment (reduced opex, reliability)
  - Circuit ties (increase grid configuration flexibility)
  - Smart meters (enable conservation, time-varying rates)

Choosing the Right Technologies

Characteristics of desired technologies

- Two-way communication
- Strengthens the grid/resiliency issues
- Provides data that enables third party provider options
- Enables customer interaction and choice
- Enables multiple value streams like ancillary services and distributed energy resources
- Assists in renewable energy integration
Infrastructure Investment

Characteristics of desired technologies

• Cost-benefit analysis: Long-term benefits outweigh cost through:
  o Reduction in operating costs
  o Cost avoidance, example – reduced storm damage
  o Enables new technologies that can help lower distribution and generation costs such as:
    ▪ Strategically located DER’s
    ▪ Implementation of Time-Varying Rates
    ▪ Facilitates low cost renewable energy and demand response options
Infrastructure Investment

Characteristics of desired technologies

- Interoperablility - ability of system or software to exchange and use information
- Adaptable to upgrades as technology evolves to avoid obsolescence and stranded cost
Technology Spotlight: Smart Meters, a.k.a. Advanced Metering Infrastructure (AMI)
Advanced Metering Infrastructure (AMI)

A **smart meter** is an electronic device that records consumption of electricity in intervals of an hour or less and communicates that information at least daily back to the utility for monitoring and billing. This also provides the customer with more information to control energy consumption and monthly bills.
Facts about Smart Meters

- Approximately half of all electric customers have smart meters.
- Foundational to grid modernization:
  - Allows two-way flows of information between the utility and customer;
  - Permits utilities to offer dynamic rates and demand management programs;
  - Facilitates integration of more distributed renewable resources.
## Traditional vs. Smart Grid Demand Response

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<thead>
<tr>
<th></th>
<th>Conventional DR</th>
<th>Smart Grid DR</th>
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<tbody>
<tr>
<td><strong>Participation</strong></td>
<td>Targeted, Limited to Large C/I &amp; Residential</td>
<td>All Customers</td>
</tr>
<tr>
<td><strong>Who Controls</strong></td>
<td>Utility</td>
<td>Customer</td>
</tr>
<tr>
<td><strong>What is Controlled</strong></td>
<td>- Interruptible Rates</td>
<td>All Loads Available</td>
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<td></td>
<td>- Res. HVAC, Water Heating</td>
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<tr>
<td><strong>Control Equipment</strong></td>
<td>- Utility Provided</td>
<td>- Customer Provided</td>
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<td></td>
<td>- Few Suppliers</td>
<td>- Many Market Suppliers</td>
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<tr>
<td><strong>Incentives</strong></td>
<td>- Fixed / Participation Payments</td>
<td>- Retail Dynamic Prices</td>
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<td></td>
<td>- Baseline metrics</td>
<td>- Reservation payments</td>
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<tr>
<td><strong>DR Products</strong></td>
<td>Generally limited to Reliability</td>
<td>Capacity, Energy, Ancillary Services Markets; Congestion</td>
</tr>
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<td></td>
<td></td>
<td>Management</td>
</tr>
<tr>
<td><strong>DR, EE, Renewable</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Integration</strong></td>
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</table>

*Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project*
Benefits of Smart Meters

Smart metering permits customers to better manage their costs and usage:

• Allows electricity suppliers to offer new pricing options that more closely align actual cost of generating electricity during a given period
• Provides consumers with precise details of their consumption patterns, so that they can better manage their use of electricity
• Uses customer data to target highest energy efficiency opportunities
Benefits of Smart Meters

• Smart Metering enables new capabilities for consumers by:
  • Facilitating use of home energy management systems
  • Enabling remote management of electrical use
  • Accelerating development of microgeneration and embedded storage
  • Assisting in use of electric vehicles
Drawbacks of Smart Meters

- Cost – Average cost is around $150
- Smart grid enables time of use rates but low-income advocates question the elasticity of demand and potential for savings
- Privacy Concerns – data on how and when you use electricity
  - Naperville Smart Meter Awareness v. City of Naperville, 7th Circuit Ct. of Appeals, 8/16/18 – data collection is not unreasonable search. Plaintiffs argued that data could be used to determine when the home is vacant; sleeping and eating routines; what specific appliances are in the home and when they are used; and charging data for plug-in vehicles could identify travel routines and history. Court based its ruling on fact that readings were every 15 minutes and not in real time, the benefits of smart meters and that the data was not available to law enforcement.
Getting the Most out of Distributed Energy Resources
Defining Distributed Energy Resources

- Distributed Generation (PV)
- Energy Storage
- Microgrids
- Cogeneration
- Demand Response (think water heaters, AC units, EVs)
- Energy Efficiency
Discussion: What is the status of distributed energy resources in your state?
Key Challenges

• Utility incentives – build more capital, sell more electricity
• Technological uncertainty & risk
• Information asymmetry
• Regulator hesitancy
Getting the Most out of Distributed Energy Resources

Key legislative measures & authorizations to consider

• Direct the PUC to investigate & quantify value of grid mod (1:1 Topic!)
• Consider performance-based regulation (1:1 Topic!)
• . . . and more in our last 30 minutes!
• Our focus next: Integrated Distribution Planning
Deep Dive: Integrated Distribution Planning

Laying the foundation to make the grid more efficient and dynamic
Prepping the Grid for Distributed Energy Resources (DER)

Integrated Distribution Planning (IDP) answers important questions utilities currently can’t (or won’t) answer:

• **Hosting capacity analysis** – How much distributed solar, storage, and other resources can the grid hold in any given location?

• **Non-wires alternatives** – How can DER help to defer infrastructure upgrades and reduce customer costs?

• **Advanced forecasting** – How much DER can utilities expect, and how can those expectations be better coordinated with planning to avoid unnecessary investments?

• **Improved operations** – How can the utility control the output of distributed energy resources to improve reliability and resilience?
Preparing the Grid for Distributed Energy Resources (DER)

Hosting capacity analysis

Non-wires alternatives

- $121M (-32%)
- $376M
- $185M
- $191M
- $255M
- $205M
- $49M

Wires Alternative

Grid Mod Alternative

Wires-Based Solutions

Advanced Technology Solutions
Why now?

• Proactively addressing changes to planning – not after DER adoption has accelerated

• Ensure infrastructure is truly needed in a rapidly changing technology environment

• No-regrets step to maximizing the value of customer-side resources

• Unpredictable extreme weather events risk reliability
Discussion
Guide for Legislators
Discussion: What are the challenges and opportunities with legislation?
The Role of Good Legislation

- Articulation of a clear vision
- Define public interest and objectives
- Provide guidance to regulators with sufficient direction and authority to carry out the legislative intent
- Provide broad statutory language to enable commission to implement public policies
- Details should be left to regulators
Guidance for Legislation: Smart Grid

- Requiring utilities to demonstrate and the commission to find that the smart meter proposal:
  - Adequately demonstrates significant benefits that exceed costs over long-term
  - Provides a mechanism to net the benefits against costs
  - Provides sufficient detail to demonstrate reasonableness of technology chosen – consider a competitive bid component
  - Allows for periodic audits of costs and implementation of technologies
  - Requires periodic publication of the audit to help hone in on benefits and public objectives
Guidance for Legislation: Smart Meters

• Requiring utilities to demonstrate and the commission to find that the smart meter proposal:
  • Includes a robust program to implement voluntary time-varying rates within a year of the rollout of the first AMI meters
  • Includes a plan to enable DERs
  • Provides accountability for achieving the benefits set forth in its proposals
  • Allows for periodic audits of the costs and the implementation of the technologies
  • Requires periodic publication of the audit to help hone in on the benefits and public objectives
How can a legislator help?

- Provide **guardrails** for grid modernization
- Define goals to be achieved by grid modernization
- Any rate authorization should require demonstration of benefits
- Authorize public utilities commission to hold utilities accountable
- Define utility’s role in grid modernization; is grid modernization meant to create opportunities for third parties?
- Define ownership of data & frameworks for data sharing
How can a legislator help?

Explicitly state goals – what can grid modernization achieve?

- Increase resiliency to routine faults, cyber or physical attacks, & severe weather
- Unlock demand response & reduce system costs
- Support customer adoption of solar & storage
- In-state industry development
- Support renewable energy integration
How can a legislator help?

Define and analyze the benefits and costs of grid modernization

• Require state energy office, public utility commission, or both, to develop a state plan for grid modernization

• Require utilities to modernize planning – integrate distributed energy resources with existing resource planning (made possible in part by grid modernization!)
What can a legislature do on IDP?

• Require a PUC to begin an IDP proceeding
• Authorize PUC to hire consultants to bring regulators, stakeholders up the learning curve. Consider providing a budget for this. (Note that most commissions are funded through utility assessments and not the general revenue fund.)
• Articulate goals of IDP (data access, DER hosting capacity, advanced forecasting, improved operations)
• Require PUC to examine the deployment of DER as a resource
Model Legislation

- Legislative intent and purpose
- Definitions
- Authority of the public utilities commission
- Grid modernization and smart grid
- Smart meters
- Cost recovery for grid modernization and smart meters
Model Legislation

- DERs
- Energy efficiency
- Demand response
- Renewable energy
- Decoupling
- Codes of conduct
Discussion
Examples of State Grid Modernization Proceedings
Ohio Power Forward

- Series of intensive workshops focused on technology and policy
- Undocketed process to allow Commission to hear from all stakeholders
- Commission to evaluate next steps
Maryland Grid Modernization Proceeding

- PC-44 is Maryland Grid Modernization Process opened in late 2016
- Six workgroups: rate design, EVs, storage, competitive supply, interconnection, distribution planning
- Big emphasis on opportunities and impacts for LMI customers
- Good stakeholder participation, including State Consumer Advocate
- All six workgroup chaired by senior MD PSC staff
- Rate design workgroup co-chaired by RAP and RAP advising all six workgroups
Maryland Grid Modernization Proceeding

- MD PSC just approved a TOU pilot rate design with a summer and winter peak at a 4:1 peak to off-peak ratio (summer peak hours 2 p.m. to 7 p.m., winter peak 6 a.m. to 9 a.m.) - Rates are cost-based and consensus agreement from rate design workgroup
- MD PSC is concerned with ratepayer costs and modernizing grid
- Cost of pilots is being carefully scrutinized
- MD utilities are cooperative, engaged, and forward-leaning
- Process is inclusive and seeks input from all parties
Minnesota Proceeding

• Multi-stakeholder workshops
• Culminated in “Minnesota Public Utility Commission Staff Report on Grid Modernization”
• First State with vertically-integrated utilities to tackle this issue
Three Guiding Questions for Minnesota

- Are we planning for and investing in the distribution system that we will need in the future?
- Are the planning processes aligned to ensure future reliability, efficient use of resources, maximize customer benefits and successful implementation of public policy?
- What commission actions would support improved alignment of planning for and investment in the distribution system?

Minnesota Public Utilities Commission Staff Report on Grid Modernization

Credit: Minnesota PUC
Grid Modernization Priorities

1. Maintain and improve the grid’s safety, security, reliability, and resilience at fair and reasonable costs and in accordance with Minnesota’s energy policies;

2. Enable and empower customers and energy options;

3. Move toward efficient, cost-effective, accessible platforms for new products, new services, and new opportunities for distributed technologies;

4. Optimize grid asset use and minimize costs;

5. Open up comprehensive, coordinated, transparent, integrated distribution system planning.
Three Phase Process

1. Definitions and principle
2. Prioritization of potential issues such as: integrated distribution planning; interconnection standards; rate design; new technologies like smart inverters; and new market potentials like third-party aggregation of distributed energy resources
3. Development of a long-term vision of a modern grid that includes new utility business, regulatory paradigms, and advanced rate concepts
Arkansas Legislation on Third-Party Aggregation

Sec. 23-18-1003 of the Arkansas Code, authorizes the Commission to “…establish the terms and conditions for the marketing, selling, or marketing and selling of demand response by electric public utilities or aggregators of retail customers to retail customers or by electric public utilities, aggregators of retail customers, or retail customers into wholesale electricity markets…”
Examples of Aggregation

Rule 24 in California permits third-party aggregators to solicit PG&E customers to participate in their demand response programs and to then "bid in" the electricity reduction into the wholesale electricity market administered by the California Independent System Operator (CAISO). California Public Utilities Commission approved Electric Rule 24 with the goal of promoting demand response participation in CAISO markets.
Getting the Most out of Grid Modernization

Legislative guardrails for utility ratemaking
Five steps to get the most out of grid modernization

1. Assess costs and benefits of a modern grid in the context of existing and planned generation and transmission
2. Clearly define policy goals based on that assessment – focus on desired outcomes
3. Tie quantifiable and independently verifiable metrics closely to those goals and outcomes as feasible
4. Set realistic targets balancing costs and benefits while incorporating stakeholder input
5. Consider tying utility revenue to performance against these targets

Step 1 – Assess the costs and benefits of a modern grid

• Starts with IDP

• Share data about system needs and locational value

• IDP can produce the data that regulators and stakeholders will need to measure and set rational targets for grid modernization performance
Step 2 – **Define goals** of a grid modernization program

- Adaptable for different states & utilities
  1. Affordability
  2. Reliability/resilience
  3. Security
  4. Flexibility, variable resource integration
- Focus on measurable **OUTCOMES** where possible
Step 3 - Measure performance

Key Question:
What are the metrics to achieve new goals for grid modernization?

Key Performance Metrics

The Hawaiian Electric Companies have provided the following key performance metrics to be available for the Hawaii Public Utilities Commission (PUC), our partners, and our customers.

- Service Reliability
- Power Supply & Generation
- Renewable Energy
- Customer Service
- Financial
- Safety
- Rates and Revenues
- Emerging Technologies

https://www.hawaiianelectric.com/about-us/key-performance-metrics
### Scorecard - Toronto Hydro-Electric System Limited

**Performance Outcomes**

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<tr>
<td>Customer Focus</td>
<td>Service Quality</td>
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<td>New Residential/Small Business Services Connected on Time</td>
<td>94.00%</td>
<td>92.50%</td>
<td>94.20%</td>
<td>91.50%</td>
<td>96.90%</td>
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<td>Scheduled Appointments Met On Time</td>
<td>99.60%</td>
<td>99.30%</td>
<td>99.60%</td>
<td>99.80%</td>
<td>99.90%</td>
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<td>Telephone Calls Answered On Time</td>
<td>72.70%</td>
<td>76.90%</td>
<td>82.00%</td>
<td>71.90%</td>
<td>76.80%</td>
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<td>First Contact Resolution</td>
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<td>Customer Satisfaction Survey Results</td>
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<td>Operational Effectiveness</td>
<td>Safety</td>
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<td>Level of Public Awareness</td>
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<td></td>
<td>Level of Compliance with Ontario Regulation 22/04</td>
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<td>Serious Electrical Incident Index</td>
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<td>Rate per 1,000 km of line</td>
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<td></td>
<td>Average Number of Hours that Power to a Customer is Interrupted</td>
<td>1.38</td>
<td>1.46</td>
<td>17.81</td>
<td>1.14</td>
<td>1.35</td>
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<tr>
<td></td>
<td>Average Number of Times that Power to a Customer is Interrupted</td>
<td>1.48</td>
<td>1.47</td>
<td>2.30</td>
<td>1.36</td>
<td>1.40</td>
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<td>System Reliability</td>
<td>Asset Management</td>
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<td>Distribution System Plan Implementation Progress</td>
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</table>
| Cost Control           | Efficiency Assessment |       |      |      |      |      |       |          |            | 5%
|                        | Total Cost per Customer | $951 | $900 | $224 | $967 | $1,000 |       |          |            |
|                        | Total Cost per Km of Line | $67,015 | $65,273 | $66,793 | $70,688 | $73,300 |       |          |            |
| Public Policy Responsiveness | Conservation & Demand Management |       |      |      |      |      |       |          |            | 12.51% |
|                        | Renewable Generation Connection Impact Assessments Completed On Time | 70.11% | 90.70% | 100.00% | 97.12% | 100.00% |       |          |            |
|                        | New Micro-embedded Generation Facilities Connected On Time |       |      |      |      |      |       |          |            | 100.00% |
| Financial Performance  | Financial Ratios |       |      |      |      |      |       |          |            | 90.00% |
|                        | Liquidity: Current Ratio (Current Assets/Current Liabilities) | 1.26 | 0.59 | 0.80 | 0.80 | 0.57 |       |          |            |
|                        | Leverage: Total Debt (Includes short-term and long-term debt) to Equity Ratio | 1.43 | 1.37 | 1.34 | 1.65 | 1.57 |       |          |            |
|                        | Profitability: Regulatory Deemed (included in rates) | 9.58% | 9.58% | 9.58% | 9.58% | 9.58% |       |          |            |
|                        | Return on Equity Achieved | 9.73% | 7.82% | 7.10% | 7.41% | 10.71% |       |          |            |

**Legend:**
- **6-year trend**
  - Up
  - Down
  - Flat
- **Current year**
- **Target met**
- **Target not met**

1. Compliance with Ontario Regulation 22/04 assessed: Compliant (C); Needs Improvement (NI); or Non-Compliant (NC).
2. The trend’s arrow direction is based on the comparison of the current 5-year rolling average to the fixed 5-year (2010 to 2014) average distributor-specific target on the right. An upward arrow indicates decreasing reliability while downward indicates improving reliability.
3. A benchmarking analysis determines the total cost figures from the distributor’s reported information.
4. This CDM measure is based on the new 2015-2020 Conservation First Framework. This measure is under review and subject to change in the future.
Step 4 – Create an open process to set targets

- Transparency
- Time for stakeholder input
- Process for collaboration & periodic revision
- Share data from IDP
- Balance stringency with reality
Step 5 – Consider tying utility revenue to outcomes

Option 1: Cash incentives and penalties
- Require performance as a precondition, scale with performance, or combine both approaches

Option 2: Shared savings
- Identify traditional investments that are ripe for non-wires smart-grid alternatives

Can combine both approaches
How can a legislator help?

• Focus on steps 1, 2, & 3; delegate process to the PUC if possible
  1. Require a thorough & transparent assessment of costs and benefits
  2. Define the value sought – what outcomes would your constituents value from grid modernization?
  3. Require transparent accounting of performance

• Leave the door open for 4 & 5
Resources
Key Resources

Annual Grid Modernization Index

HAWAII ELECTRIC COMPANY
GRID MODERNIZATION PLAN
Key Document


*Integrated Distribution Planning*
August 2016
Prepared for the Minnesota Public Utilities Commission
Key Document

Rhode Island PUC - Initial Considerations on Utility Compensation

Table 4. System Efficiency Metrics

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<thead>
<tr>
<th>Metric</th>
<th>Purpose</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission peak demand</td>
<td>Indicate the extent to which peak demand affects transmission costs</td>
<td>Rhode Island’s monthly contribution to the ISO coincident peak</td>
</tr>
<tr>
<td>Distribution peak demand</td>
<td>Indicate the magnitude of distribution peak demand</td>
<td>Monthly peak distribution demand, by sectors</td>
</tr>
<tr>
<td>Substation peak demand</td>
<td>Indicate the extent to which specific substations are stressed</td>
<td>Percent of capacity utilized on targeted substations, during distribution monthly peaks</td>
</tr>
<tr>
<td>DG-friendly substations</td>
<td>Indicate the portion of substations that are capable of readily installing DG facilities</td>
<td>Ratio of substations that can accept DG without upgrades to all substations</td>
</tr>
<tr>
<td>Distribution load factor</td>
<td>Indicate the portion of distribution sales that occur in peak hours</td>
<td>Ratio of retail sales during peak hours to retail sales in all hours</td>
</tr>
<tr>
<td>Customer load factor</td>
<td>Indicate customer demand relative to energy</td>
<td>Ratio of distribution sales during peak hours to distribution sales in all hours, by customer sector</td>
</tr>
<tr>
<td>Time-varying rates</td>
<td>Indicate penetration of time-varying rates</td>
<td>Percent of customers on time-varying rates, by customer sector</td>
</tr>
<tr>
<td>CO₂ intensity</td>
<td>Indicate intensity of CO₂ emissions from customers</td>
<td>CO₂ emissions per customer, by sector</td>
</tr>
</tbody>
</table>
Example Legislation on IDP

- CA AB 327 (specifically addition of Section 769 to Public Utilities Code)
  https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB327

- NV SB 146

- D.C. DER Authority Act of 2018
  https://legiscan.com/DC/text/B22-0779/id/1779636
RAP Resources

- Beneficial Electrification: Ensuring Electrification in the Public Interest
- Enabling Third-Party Aggregation of Distributed Energy Resources
- Grid-Connected Distributed Generation: Compensation Mechanism Basics
- Regulatory Approaches to Grid Resiliency and Security
- Smart Rate Design for a Smart Future
- Designing Distributed Generation Tariffs Well