EBC Energy Resources Program:

Grid Modernization – Many Options
Welcome

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Executive Director & President
Environmental Business Council
Program Introduction & Overview

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Environmental Business Council of New England
Energy Environment Economy
Keynote Presentation: Understanding the Importance & Future of Grid Modernization

Benjamin Davis
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Concentric Energy Advisors
EBC Energy Resources Program: “Grid Modernization – Many Options”

Ben Davis

October 12, 2017
Concentric Energy Advisors: Who We Are & What We Do

- Concentric is a management consulting and financial advisory firm focused on the North American energy industry.

- We offer a broad range of advisory and support services, and our expertise spans all aspects of the natural gas, power, and oil markets.

- Our workforce is comprised of energy industry experts who have held positions with utility companies, state and federal regulatory agencies, energy marketers, and global energy companies.

- Our services span four major practice areas:
Agenda

Part I - Understanding Grid Modernization
- What is Grid Modernization anyway?
- What drives Grid Modernization?
  - Technology
  - Customers
  - Opportunity/ value

Part II - National Landscape - Overview Regulatory/Legislative Initiatives
- Massachusetts
- Examples from other states
Part I

Understanding Grid Modernization
What do we mean by grid modernization?

Some examples:

- New technologies; replacing aging infrastructure
- Grid technologies
  - Advanced distribution automation, monitoring and control, “self-healing grid”
  - Resiliency and Reliability – Reducing outage frequency and duration
  - Greater efficiency (e.g., Volt/Var Optimization) and cost savings
- Distributed energy resources ("DERs")
  - Solar, storage, CHP, energy efficiency
- Integration of large-scale, intermittent renewable generation
- Electric vehicles
- Advanced metering
  - To enable time varying rates/ dynamic pricing, other customer options
  - Other savings and benefits (meter reading costs)
- Big data
- What about creating distribution-level markets?
- What about changing utility business models, including financial incentives?
What is Grid Modernization?

I Spy a...

What is driving Grid Modernization/ the Changing the Energy Landscape?

- Energy technology
- Customer- and Grid-Facing
- Data

- Price + reliability
- More options and expectations

- Clean energy policies
  - Solar/NEM
  - EE/DR
  - EV/storage
  - Comprehensive grid mod/dist. markets

- Fuel prices & generation markets
- System inefficiencies

Stakeholders are key influencers
Thinking more about technology...

Technology Advances Drive Markets:

- Continuous innovation lowers costs with an occasional breakthrough advancement
- As penetration rates go up, costs will go down.
- Customers will quickly reflect changes in products and services into their value and cost expectations
- 3rd party service providers will leverage technology advancements with innovative business models

Three Key Trends to Watch

To what degree are these trends dependent on tax policies and rate subsidies – or will technology advances carry the day?

Evolving Customer Expectations

**Fundamentals of customer satisfaction have not changed:**

- Affordable and reliable service
- Knowledge and effective customer service, with web-based interaction options
- Clear and accurate billing

**But the bar is being raised:**

1) **Reliability**
   - More resilient system with near real-time outage information
   - Increased expectations for reliability and power quality to support electronic devices and the digital economy

2) **Customer Service**
   - Expect energy providers to have the same level of customer service as other providers
Customers Want More (Personalized) Options

New Product and Service Offerings
- Broad range of (non-utility) information sources on energy products and services
- Customized insight and P&S offers based on the customer’s data
- Provide greater control of energy use and costs
- Environmentally sustainable energy options

But keep it simple
- Clarity and simplicity in pricing and value of energy products and services

The Dynamics of Electric Supply and Demand Result in Opportunities for Value

- The “cost” of electricity changes depending the time of day (and year), as shown in the figure on the right.
- Differences in cost can result in opportunities for value for various types of resources and technologies.
- The figure on the left illustrates the “value” of electricity storage.

• Most customers (especially residential and small commercial customers) have “flat rates” which do not reflect the changing “cost” of electricity over the course of a day.
• “Dynamic pricing” or “time varying rates” do reflect that change, thereby providing more efficient price signals.
• The figure below illustrates the difference between real time and fixed rate prices.

How do we compensate DERs? Example: Value of DER (“VDER”) Value Stack as a Successor to Net Energy Metering in NY

**Design Considerations:**

- Elements to include in the value stack
- Valuation of each element, supporting calculations, and timing of updates
- Rate design: who pays?
Part II - Grid Modernization and Related Efforts – National Landscape

Overview Regulatory/Legislative Initiatives
## Future Utility Initiative - State Overview

<table>
<thead>
<tr>
<th></th>
<th>RI</th>
<th>MN</th>
<th>MA</th>
<th>CA</th>
<th>NY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Change Process</strong></td>
<td>Stakeholder Driven with identified future workstreams</td>
<td>Stakeholder Driven (no Staff involvement)</td>
<td>Grid Mod Stakeholder Collaborative + Grid Mod Filings + Additional workstreams</td>
<td>Legislation, 10+ Dockets, “More than Smart” Collaborative, DRPs</td>
<td>Commission-Driven REV Proceeding + Multiple Dockets</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>Reliability Economic Development Sustainability Value for all</td>
<td>Environmental Goals</td>
<td>Optimize grid mod Ensure: Reliability, Efficiency, and Customer Empowerment</td>
<td>Smart Grid, Integrate DERs</td>
<td>Clean Energy Promote DERs Animate market Engage customers Reliability/Resilience</td>
</tr>
<tr>
<td><strong>Current Status</strong></td>
<td>• Stakeholder report filed April 2017 • Initiate 4 related workstreams</td>
<td>• Ongoing – focused on system planning</td>
<td>• GMPs filed; progressing slowly • Briefs in response to utility GMP’s filed Summer 2017</td>
<td>• Focused on new regulatory framework to support increased DG penetrations</td>
<td>• DSP Implementation • BCA Handbook, • Regulatory Policy Matters • Clean Energy</td>
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</table>
Massachusetts Grid Modernization Proceeding

- Massachusetts's Grid Mod DPU proceeding (DPU 12-76) was initiated to:
  - enable utilities and customers to optimize grid mod opportunities.
  - ensure utilities adopt grid mod technologies and practices to enhance reliability, reduce electricity costs, and empower customers to adopt new technologies and better manage usage.
- Intensive stakeholder process – 8 months
  - Process was organized based on customer facing and grid facing
  - Grid Modernization Working Group Report as basis for Grid Modernization Plan (GMP) requirements
- Subsequent Stage Workstreams: Grid Mod Plan, Electric Vehicles, Time Varying Rates
GMP Requirements
- 10-year plans, focus on capital investment for 5 years
- Proposal for “Advanced metering functionality” (“AMF” - a.k.a., AMI?)
- Business case
- Four Objectives:
  - Reduce the effects of outages
  - Optimize demand, including reducing system and customer costs
  - Integrate distributed resources
  - Improve workforce and asset management

Ratemaking
- Capital tracker
- Preapproval
- Funding to encourage innovation

Time Varying Rates
- Shift “basic service” to:
  - Default “time of use” (TOU) with “critical peak pricing” (CPP)
  - Flat rate option with “peak time rebate” (PTR)

GMP Filings
- Range from full AMI deployment to focus on grid automation and grid investments
- National Grid proposed four options, including a comprehensive modernization plan, with full AMI
- Eversource plan focused more on reliability investments (e.g., advanced distribution automation) and linked GM to innovative proposal in rate case
NY’s Reforming the Energy Vision: Comprehensive Effort to Review Utility & Regulatory Models

- NY REV was initiated in April 24, 2014 with the purpose to align utility and regulatory models to achieve policy objectives and to develop a platform to transform NY’s electric industry
- REV goals support increased system efficiency, market animation, customer engagement, reduced carbon emissions, and increased reliability
- NY REV is wide reaching with over 20 related proceedings

### Stakeholder Process
- The NY REV proceeding included extensive stakeholder processes for each stage of the process
- There were over 200 interveners with significant stakeholder influence
- Utilities played a leading role throughout the processes

### Work Streams and Phasing
- NY REV included two tracks focused on the utility and regulatory models.
- Workstreams included customer, platform, market, VDER, incentives, and rate design
- Utilities filed individual and joint implementation plans.

### Utility Role
- Utility as the ‘Distribution System Platform’ including market operations, grid operations and integrated resource planning
Rhode Island: The Changing Electric Distribution System

- RI PUC opened Docket 4600, *Investigation into the Changing Electric Distribution System* (Mar 2016)
- Stakeholder Report made recommendations on a BCA approach, rate design principles (e.g., TVR, location-based strategies, cost recovery, etc.), and future work (April 2017)
- Four workstreams were identified to continue grid mod exploration (Mar 2017)
  - Utility Business Model
  - Distribution System Planning
  - Electrification of Transportation & Heating
  - Grid Connectivity Functionality

- Spring 2017
  - Technical meetings
- Summer 2017
  - Facilitated engagement; draft proposals
- Fall 2017
  - Presentation of regulatory proposals
- January-June 2018
  - Review of proposals through Public Utilities Commission processes
The NextGrid initiative continues the emphasize infrastructure, but expands to include regulatory reform and modernization as well.

• NextGrid originates in the Future Energy Jobs Act
  • 18-month, consumer-focused initiative initiated March 2017

• The final report will outline recommendations to empower customers and communities, optimize utility industry and create new regulatory model
  • Stakeholder process will produce interim and final reports with regulatory reform recommendations

• Will likely involve a reevaluation of the state’s Formula Rate Plan, which provides cost recovery for $3 billion in utility investment from 2012-2023

• Initiative organized into 4 workstreams:
  • Consumers, Communities, and Economic Development
  • Grid Design, Digital Networks and Markets
  • Regulation and Encouraging Innovation
  • Climate Change and the Environment
Minnesota is Approaching Grid Modernization as a Marathon, not a Sprint

MN’s Grid Mod Proceeding (CI-15-556) was initiated in June 2015
- Continuation of MN’s aggressive pursuit of a clean energy agenda
- Many participants had been (and continue to be) involved in the e21 initiative
- The Grid Mod proceeding started with a series of meetings with stakeholders (facilitated by MN PUC Staff) to gather perspectives
- Initial focus on integrated distribution planning; emphasis on acquiring and reporting data to 3rd parties (i.e., locational hosting capacity, etc.)
- Other priorities: Smart Inverters; DG interconnection; AMI; Volt/VAR Optimization; 3rd party aggregation; rate design

**Phased Approach:**

1. Adopt a Definition of Grid Mod.; establish principles, objectives
2. (TODAY) Prioritize potential action items
3. Adopt a long-term vision
## Conclusion: A Wide Range of Issues Being Addressed Across the Jurisdictions

<table>
<thead>
<tr>
<th>DER/Storage ownership</th>
<th>Interconnection</th>
<th>Changing Energy Efficiency</th>
<th>“Value of D” and Distributed Energy Resources (DER)</th>
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<tbody>
<tr>
<td>Rate Design/NEM</td>
<td>3rd party vs utility provision of products and services</td>
<td>Benefit Cost Analysis</td>
<td>Low and Moderate Income Customers</td>
</tr>
<tr>
<td>Rate impacts for grid investments</td>
<td>Data sharing</td>
<td>Innovation</td>
<td>Workforce development</td>
</tr>
<tr>
<td>Foundational Investments</td>
<td>New rate designs</td>
<td>Microgrid Ownership</td>
<td>Hosting Capacity</td>
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What is ISO NE doing to make the grid more modern?

Henry Yoshimura

Director

Demand Resource Strategy

ISO NE

Environmental Business Council of New England
Energy Environment Economy
Electric Grid of the Future Will Look Very Different

We are moving toward a “hybrid” grid with grid-connected and distributed resources, and a continued shift toward natural gas and renewable energy.
In 2010, Behind-the-Meter Demand Resources Were Integrated into the Forward Capacity Market

- Demand Resources are designed to reduce customer demand

**Active Demand Resources:**
- Reducing load for a specific time period
- Starting or incrementing distributed generation; output from electric storage
- Called ‘Active Demand Resources’ or ‘Demand Response’ because they actively respond to ISO dispatch

**Passive Demand Resources:**
- Installing energy efficiency measures
- Installing behind-the-meter solar panels
- Called ‘Passive Demand Resources’ because they do not respond to ISO dispatch
New England’s Demand Resources Have the Largest Peak Demand Impact Among All U.S. ISOs and RTOs

On a percentage basis, across ISOs and RTOs, ISO New England has the greatest ability to reduce peak demand.

FERC has suggested that greater demand-side spending by the New England states has increased the enrollment of passive demand resources.

* Source: FERC 2016 Assessment of Demand Response and Advanced Metering, Table 3-3
ISO New England Forecasts Growth in Distributed Generation Resources

• Since 2013, the ISO has led a regional Distributed Generation Forecast Working Group (DGFWG) to collect data on distributed generation (DG) policies and implementation, and to forecast long-term incremental DG growth in New England

• The DGFWG focuses on the following types of DG resources:
  – Under 5 MW
  – Connected to the distribution system
  – Not visible to the ISO directly
  – Specifically solar photovoltaic (PV) resources, the largest DG component

• The ISO forecasts strong growth in solar PV over the next 10 years
ISO New England Forecasts Strong Growth in Solar PV

December 2016 Solar PV Installed Capacity (MW_{ac})

<table>
<thead>
<tr>
<th>State</th>
<th>Installed Capacity (MW_{ac})</th>
<th>No. of Installations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut</td>
<td>281.55</td>
<td>23,544</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>1,324.77</td>
<td>65,883</td>
</tr>
<tr>
<td>Maine</td>
<td>22.14</td>
<td>2,745</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>54.30</td>
<td>5,873</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>36.81</td>
<td>2,202</td>
</tr>
<tr>
<td>Vermont</td>
<td>198.39</td>
<td>7,612</td>
</tr>
<tr>
<td>New England</td>
<td>1,917.96</td>
<td>107,859</td>
</tr>
</tbody>
</table>

Cumulative Growth in Solar PV through 2026 (MW_{ac})

- December 2016 Solar PV Installed Capacity (MW_{ac})
- New England: 1,917.96
- No. of Installations: 107,859

Note: The bar chart reflects the ISO’s projections for nameplate capacity from PV resources participating in the region’s wholesale electricity markets, as well as those connected “behind the meter.” Source: Final 2017 PV Forecast (April 2017); MW values are AC nameplate.
Energy Efficiency and Behind-the-Meter Solar Impact
Peak Demand and Annual Energy Use

- **Summer Peak Demand (MW)**
  - With and Without EE and PV Savings
- **Annual Energy Use (GWh)**
  - With and Without EE and PV Savings

### Note:
- Summer peak demand is based on the “90/10” forecast, which accounts for the possibility of extreme summer weather (temperatures of about 94°F).

On- and Off-Shore Wind Is Being Proposed

Represent more than half of proposed generation

- **12,000 MW** of onshore and offshore wind potential
- More than 7,300 MW of wind proposed
- Majority of wind development proposals in Maine and northern New England
- Offshore projects proposed in Massachusetts
- Transmission will be required to connect potential wind resources to load centers in New England

Note: Some wind proposals include battery storage.

Source: ISO Generator Interconnection Queue (August 1, 2017)
FERC Jurisdictional Proposals Only; Nameplate Capacity Ratings
Opportunities for Controllable Load and Storage Exist in New England

- Region has added significant amounts of intermittent resources over past few years and more is proposed
- The integration of large amounts of renewables can be aided by flexible resources that can help balance supply and demand
- Paper released in 2016 details how storage (including EVs) can participate in the energy, capacity, reserve, and regulation markets

Storage and other Distributed Energy Resources Can Participate in the Markets in Various Ways

• Participate indirectly in the wholesale markets:
  – On the demand-side as a zonal demand reducing or shifting consumption with a focus on reducing capacity, energy and ancillary service costs

• Participate directly in the wholesale markets:
  – As an Alternative Technology Regulation Resource (ATRR)
  – On the demand-side as an nodal demand being responsive to changes in wholesale energy prices in real-time and potentially providing reserves and regulation and reducing their capacity costs
  – On the supply-side as a generator or demand response being responsive to changes in wholesale energy prices in real-time and potentially providing capacity, reserves and regulation
ISO New England will Fully Integrate Demand Response Into all Wholesale Markets on June 1, 2018

• With full integration, Demand Response Resources will submit demand reduction offers into the Day-Ahead and Real-Time **Energy Markets**, and will be committed and dispatched when economic compared to other resources

• Once Demand Response Resources are integrated into the energy market, they can be co-optimized to provide Energy and Reserves to meet energy and reserve requirements in the most economically-efficient manner

• With the integration of Demand Response Resources into the energy and reserves markets, all dispatchable resources can receive fully-comparable obligations and compensation in the **Forward Capacity Market**
The Fully-Integrated Structure Continues to Permit Aggregation of Individual Assets into Resources

Active Demand Capacity Resource (ADCR)
CSO: 10 MW

Demand Response Resource #1
Energy Offer: 6 MW @ $60

Demand Response Resource #2
Energy Offer: 4 MW @ $600

Demand Response Resource #3
Energy Offer: 7 MW @ $500

Demand Response Resource #4
Energy Offer: 7 MW @ $500

Facility #1: Demand Response Asset #1
3 MW

Facility #2: Demand Response Asset #2
4 MW

Facility #3: Demand Response Asset #3
5 MW

Facility #4: Demand Response Asset #4
7 MW

Can have an energy-only resource not mapped to ADCR

Assets in the same dispatch and reserve zones can be aggregated into resources
Remaining Challenges with Distributed Energy Resource (DER) Integration

• Presently, most generation and some demand response is dispatched by the ISO to meet price-inelastic demand

• As DERs increase, power flows become more variable, potentially bi-directional, and less predictable

• With more time-varying retail rates, net demand could become more price responsive and less predictable

• Wholesale/retail market design, regional planning and real-time operations become more complex
Challenges with DER Integration into Markets

• **Long-Term Resource Adequacy:** Integrating DERs into markets by reducing the demand forecast could expose the region to risk as DERs are not financially accountable to perform when needed.

• **Real-Time Operations:**
  – If DERs do not participate in wholesale markets, the ISO has little visibility and no control over their production in real-time, but must account for them when committing and dispatching bulk-power resources.
  – If DERs participate in wholesale markets, DERs would be subject to ISO dispatch, but the ISO is generally unaware of local distribution constraints; these constraints could affect DER deliverability and impact the wider grid.

• **Measurement and Verification:** More robust telemetry/metering solutions, such as advanced metering infrastructure, is needed to achieve visibility and to properly settle wholesale and retail markets.

• **Jurisdiction:** Metering infrastructure is largely subject to state jurisdiction; state and Federal policy objectives concerning DER integration into markets may conflict.
Questions
What are utilities doing to modernize the grid?

Bill Jones

Director

Solutions Delivery

National Grid, USA
What are utilities doing to modernize the grid?

Bill Jones – October 12, 2017
An industry in transition

The energy world needs to adapt and evolve to deliver a clean, sustainable future

Traditional energy market

- Large centralised generation
- Nuclear power station
- Hydro-electric power
- Coal/gas fired power station
- Gas production
- Small range of conventional technologies
- Static infrastructure

Energy flows to users

Trade-offs

- Energy volume drives energy company revenue
- Price and reliability are main determinants of customer choice

Today’s evolving market

- DR
- EV
- Storage
- Solar
- EE
- Smart Grid

- Advanced Distribution
- Advanced Communications
- Data and Analytics
A lot of things coming together that we need to connect and optimize use

Seamless connectivity is assumed

50 Billion Things

Utility-Scale Solar PV
Utility-Scale Wind
Solar Rooftops
Non-Intermittent Generation
Demand Response
Therms/year Energy Efficiency
Energy Efficiency (200 MW)
Utility-Scale Battery Storage
Smart Meters
EVs
Grid Modernization

- Advanced Metering Infrastructure
- Advanced Communications
- Advanced Distribution Management System
- Marketing, Education and Outreach
- Advanced Distribution Automation
- Volt VAR Optimization (VVO)
- Conservation Voltage Reduction (CVR)
- Distributed Generation
- Customer Load Management
New Energy Solutions and Services

**DG AND STORAGE**
Equitable access to clean generation; resiliency and optimization couple with storage solutions for greater value

**CLEAN TRANSPORTATION**
Developing an infrastructure to facilitate the expansion of vehicles and fleets with electricity and natural gas

**GRID MODERNIZATION**
Advancing and integrating technologies to enable a more efficient and effective grid to support the new customer needs

**NEXT GEN EE, DR AND NWAs**
Enabling the value of distributed resources to help reduce electricity usage in constrained areas
The energy landscape is changing

- Smart technologies
- Real-time data
- Prosumers
- New partnerships
- Competitive intensity
- Bill pressure
- Decarbonization
- Internet of things
- Uncertain load growth
- Big data
- DER penetration
- Sharing economy
- Automation & AI
- Changing demographics
Electric vehicles will represent a significant aspect in the energy space in the future.

Customer Outreach and Education

Targeted Charging Station Expansion

Looking to enable the entire chain for EV infrastructure.
Utility scale solar and other DER systems generate value to customers

National Grid has been active in the solar market since 2009…

- Received approval from Department of Public Utilities (DPU) in 2009 to own and operate Solar
- We have completed two solar deployments already (23 sites in total and 21 MW) in MA
- Building upon learnings from PH I/II, the filing includes plans to implement new technology:
  - Integrated inverters
  - Panel positioning for optimized output
  - Canopy solar
  - Sun tracking systems
Thank You

Questions?
Institutional Approaches

Stephen Troio

Eaton
Panel Discussion

Moderator:
• Mary Smith, Harvard University

Panelists:
• Benjamin Davis, Concentric Energy Advisors
• Stephen Troio, Eaton
• Bill Jones, National Grid
• Henry Yoshimura, ISO NE
EBC Energy Resources Program:

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