Regional System Security in New England

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Presentation to IEA Electricity Security Advisory Panel

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New England's Electric Power Grid at a Glance

- 6.5 million households and businesses; population 14 million
- 350+ generators
- 8,000+ miles of high-voltage transmission lines (115 kV and above)
- 13 interconnections to electricity systems in New York and Canada
- 32,000 megawatts (MW) of supply
  - About 2,000+ MW are demand resources
- 28,130 MW all-time peak demand, on August 2, 2006
- Over 400 participants in the marketplace
- $5-11 billion annual wholesale electricity market value

Background on New England Market

ISO New England - Not-for-profit corporation Created in 1997 to oversee New England's restructured electric power system; regulated by Federal Energy Regulatory Commission

Core Responsibilities:

- **Operating the Power System**
  Minute-to-minute reliable operation of region's generation and transmission system
- **Administering Wholesale Electric Markets**
  Oversee region's wholesale marketplace for energy, capacity and reserve supplies
- **Power System Planning**
  Ensure reliable and efficient power system to meet current and future power needs

Six New England States (Maine, Vermont, New Hampshire, Connecticut, Rhode Island, Massachusetts)

- **Different policy goals**
- **Different state needs/resources**
- **Try to coordinate where possible (multi-state procurement, regional coordinator through the NEPOOL process)**

Grid in Transition:

Opportunities and Challenges in New England

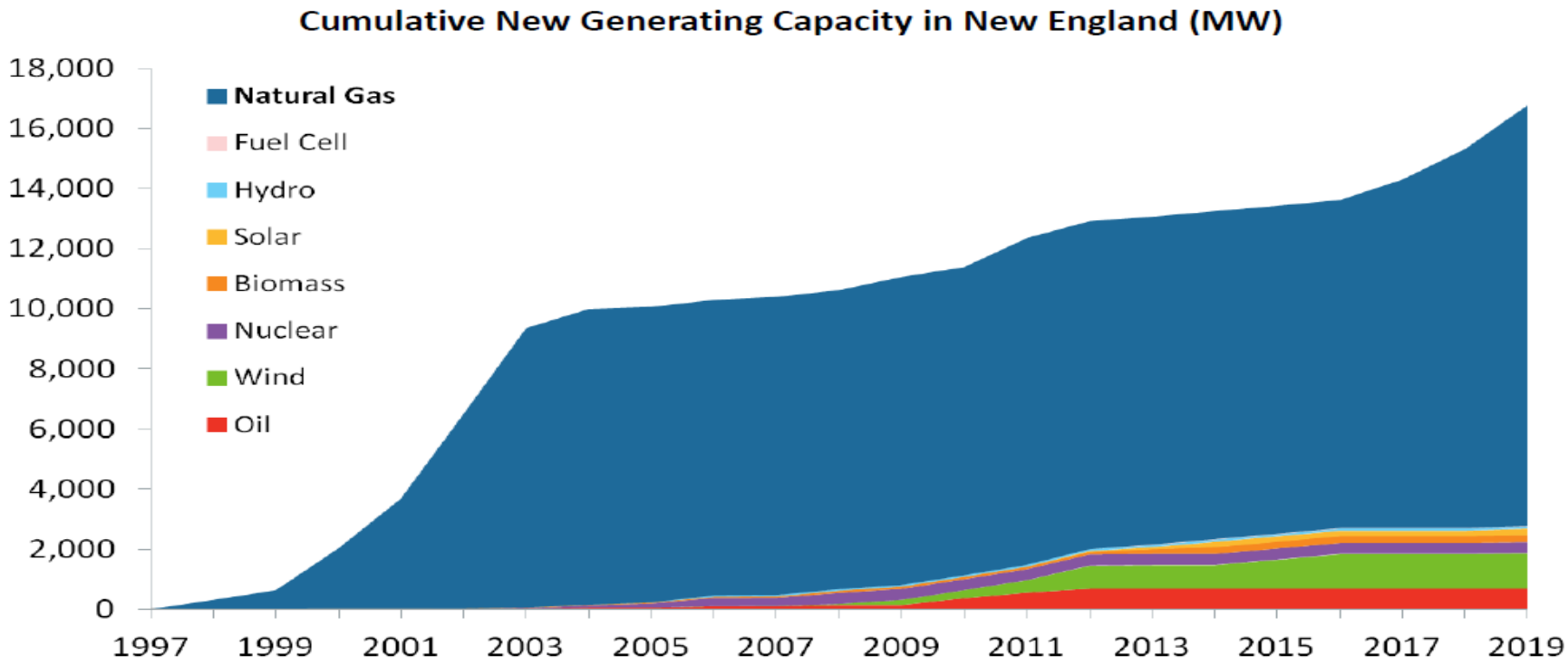
Ongoing industry transformation is redefining electricity production—and the very nature of the regional power system.

Drivers of Change:

- Innovation
- Public policies and programs
- Economics
- Consumer Choices

Grid in Transition:

Natural Gas Is the Dominant Fuel Source for New Generating Capacity in New England



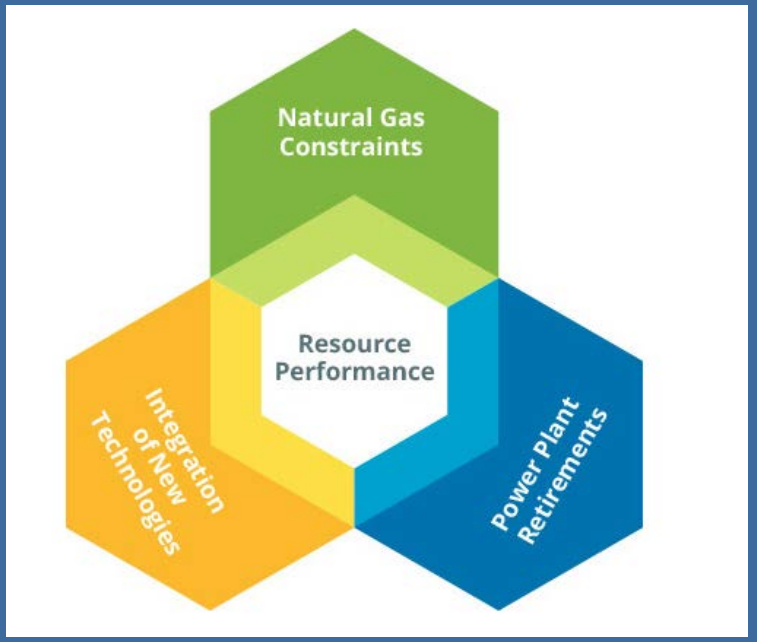
Note: New generating capacity for years 2016 – 2019 includes resources clearing in recent Forward Capacity Auctions

Grid in Transition: Opportunities and Challenges

Waves of Change Bring Opportunities….

Opportunities

- Natural gas resources and renewables are displacing less economic and higher-emitting resources in New England.
- The ability of many natural-gas-fired plants to change output quickly helps to balance an increasing amount of intermittent generation.
- Wholesale electricity prices are being driven down—except when natural gas prices spike (often in the winter months).
- Distributed generation may be able to help lessen the impact of local power outages.
- Smart-grid technology and retail rate design changes will empower consumers to use electricity more efficiently and reduce their energy bills.



Source: ISO New England, *2016 Regional Electricity Outlook*

Grid in Transition: Opportunities and Challenges

….but Also Pose Challenges

Challenges

- Inadequate natural gas pipeline infrastructure is limiting the performance of gas-fired resources, which is creating reliability concerns and price volatility, and contributing to air emissions increases in winter.
- Substantial non-gas generating capacity is retiring, limiting the options for reliable grid operation when natural gas infrastructure is constrained.
- The weather-dependent output from wind and solar resources and the increase in DG adds complexity to how ISO-NE must operate the power system to maintain reliability.
- Expensive transmission infrastructure upgrades are needed to connect more wind and hydro resources.
- State efforts to inject more green energy into the system outside of the markets may undermine confidence in the markets and future investment in competitive power resources.

Source: ISO New England, *2016 Regional Electricity Outlook*

Integration of Renewable Resources / DG

Balancing new technologies with reliability is requiring changes in ISO system operations, planning, and market design

Solar Power

- Photovoltaic
- Solar-thermal

Biofuels

- Agricultural crops (1st Gen)
- Cellulosic feedstock (2nd Gen)
- New feedstock such as Algae (3rd Gen)

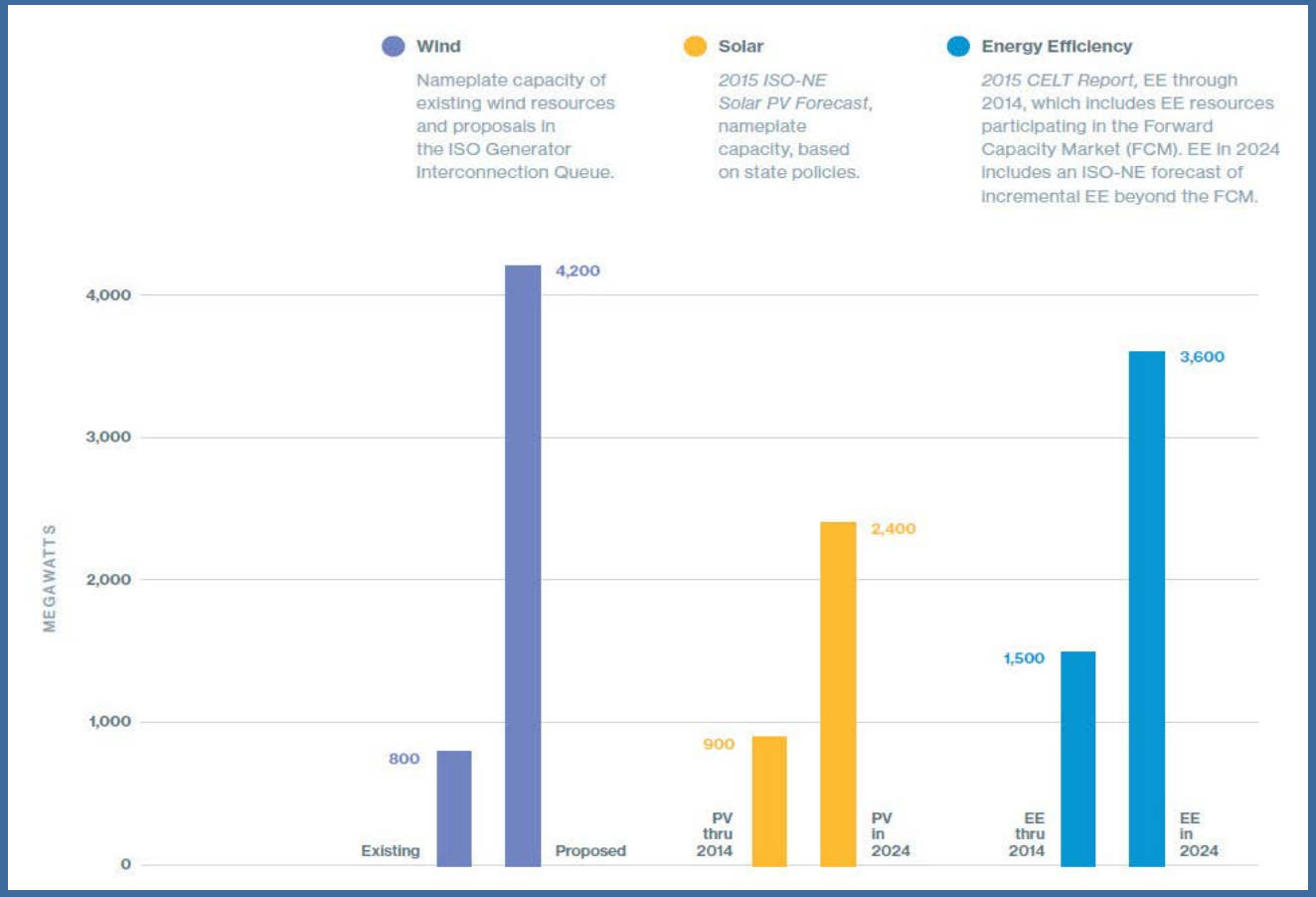
Wind Power

- Onshore
- Offshore

Hydro Power

Integration of Renewable Resources / DG

State policies, as well as state and federal support and tax credits, are having a clear effect on the growth of renewable resources and energy efficiency in New England.



Source: ISO New England, *2016 Regional Electricity Outlook*

Market Challenges

Energy and Capacity Markets are interrelated

- Renewable resources with low to no fuel costs will put downward pressure on energy market prices, adding to existing financial pressure on conventional generation.
- To remain economically viable, these conventional resources will increasingly rely on Forward Capacity Market revenue and will require higher capacity prices.

Achieving Environmental Objectives in a Way that Maintains a Competitive Wholesale Electricity Marketplace

- In the late 1990s, the region adopted wholesale electricity markets based on broad principles of competition, transparency, and resource-neutrality.
- Most renewable resources are relatively expensive to build and are, therefore, not competitive in the wholesale marketplace.
- The ISO's current practice prevents non competitive offers from compromising accurate price formation.
- The states are working with the ISO and stakeholders to balance public policy objectives with the wholesale markets.

Source: ISO New England, *2016 Regional Electricity Outlook*

Integration of Renewable Resources / DG

Tomorrow's "Hybrid Grid"

Renewables and other new technologies hold much promise for New England. For example: zero emissions, widespread residential solar-power and storage systems, smart grid technology, and distributed generation may be able to help lessen the impact of local power outages.

The expansion of technologies also brings challenges and costs. For example: Intermittent output, transmission investment needed, lack of visibility, and less stable interconnection methods.

Source: ISO New England, *2016 Regional Electricity Outlook*

Modernizing the Electric Power Grid

Modernizing the electric power grid is also a priority in New England and across the country.

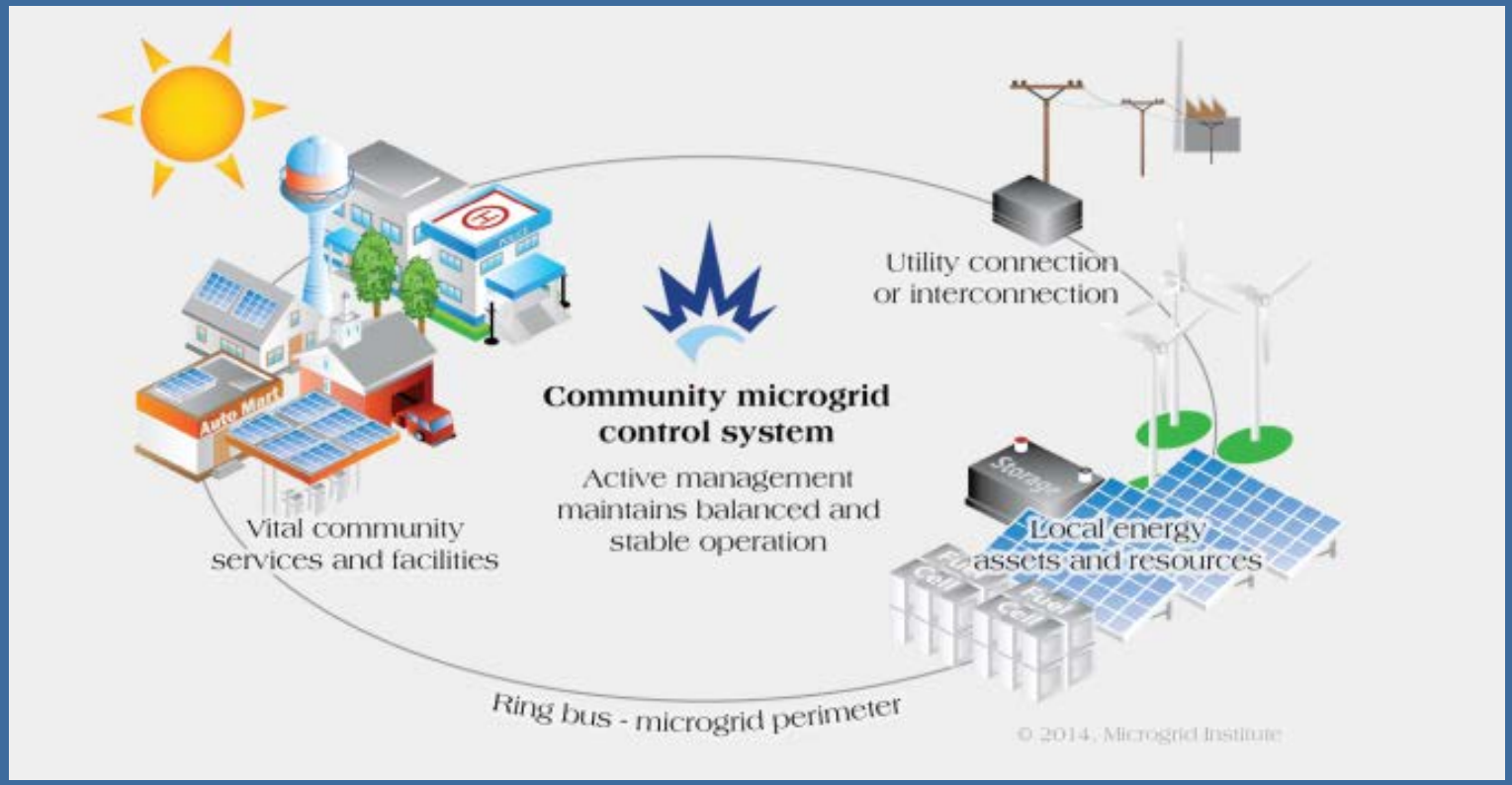
State efforts to modernize the grid also open up new approaches to demand resources. But as customer power consumption becomes more price-responsive and in some case self-supplied, demand becomes less predictable, supply less controllable, and operations more complex.

ISO Efforts

- Forecasting and Dispatch
- Market Participation
- Interconnection and Other Standards

Modernizing the Electric Power Grid

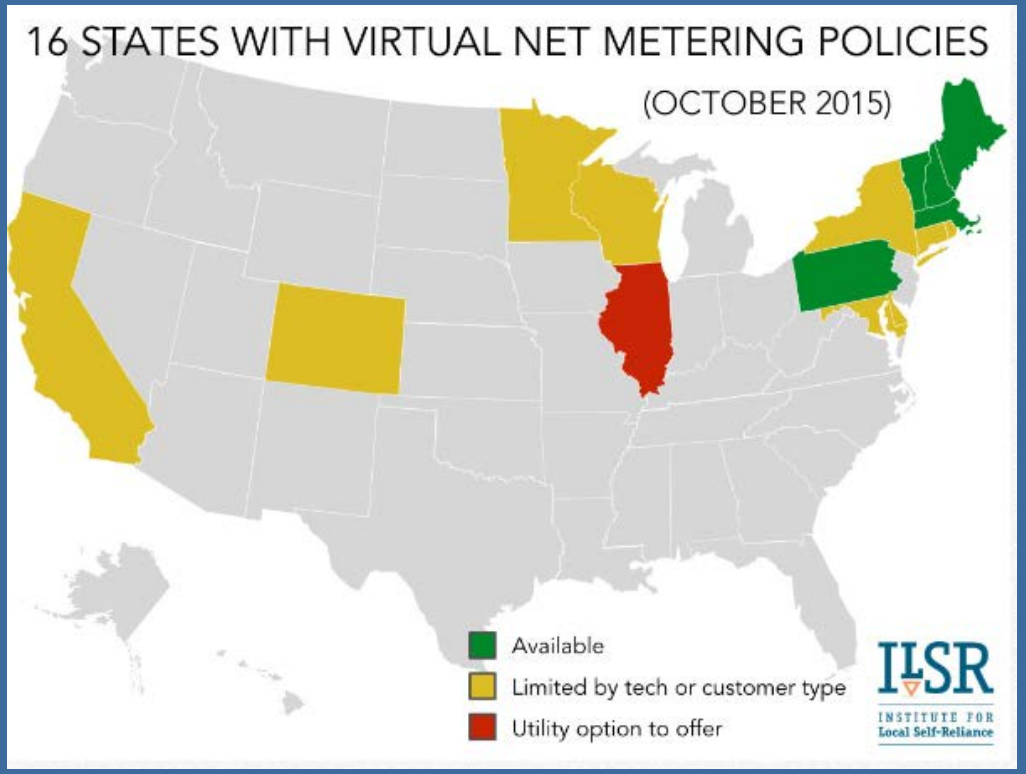
A microgrid is a small energy system capable of balancing captive supply and demand resources to maintain stable service within a defined boundary.



Source: ISO New England, *2016 Regional Electricity Outlook and Entergy: The Opportunity Before Us, April 2016*

Modernizing the Electric Power Grid

Virtual (or group or neighborhood) net metering (now also called "shared renewables") allows utility customers to share the electricity output from a single power project, typically in proportion to their ownership of the shared system. The following map illustrates which states (as of October 2015) support virtual net metering.



CT = Municipal, state, or ag. customers only

Source: ISO New England, *2016 Regional Electricity Outlook and Entergy: The Opportunity Before Us, April 2016*

Cybersecurity Initiatives

Cyber Threats

- Public utilities in Connecticut and throughout the United States face the credible danger of cyber penetration, compromise and disruption.
- Federal officials admit that many U.S. public utilities have been penetrated and do not know that they have been penetrated.
- Foreign actors have the ability to "pull the trigger" to knock out utility services extensively in the United States.
- Given the motivations and capabilities of those who seek to damage the United States, the increasingly accessible means for committing cyber crime and the difficulty of thwarting attacks with hidden attribution, Connecticut regulators recognize that there will likely be a utility cyber disruption at some point.

Cybersecurity plan

ISO-NE put in place comprehensive, round-the-clock protection against cyber threats designed to detect, withstand, and recover from cyberattacks.

ISO-NE has participated in NERC's exercise on cybersecurity and physical security

Connecticut looks to our national government for cyber security, as we do for other kinds of security.
The main defense has to be national, but the points of infrastructure penetration are local.

Connecticut PURA works closely with the governor, legislature, Division of Emergency Management and Homeland Security, and its utilities to address cyber threats.

Source: ISO New England, *2016 Regional Electricity Outlook*