
ISO on Background

Gordon van Welie

President & CEO, ISO New England Inc.
About the ISO on Background Series

• Informal opportunity for media to learn more about trends affecting New England’s electricity industry

• Hosted by ISO New England senior management

• **Content is on the record**

• Please hold questions until the Q&A session at the end of the presentation

• Presentation and remarks will be posted at [www.iso-ne.com](http://www.iso-ne.com)>About Us>News and Media>Press Releases
Agenda

• 10:30 -10:40 a.m. **Welcome and Introductions**
  Ellen Foley, director, Corporate Communications

• 10:40 a.m. -11:30 a.m. **State of the Grid: 2016**
  Gordon van Welie, president and CEO

• 11:30 a.m. – 12:00 p.m. **Question-and-Answer Session**
Overview of Presentation

• About ISO New England
• State of the Grid
  – Setting the Stage
  – 2015 Highlights
  – Preparing for the Hybrid Grid
  – Conclusions
• Questions and Answers
ABOUT ISO NEW ENGLAND
Two Decades of Experience Overseeing the Region’s Restructured Electric Power System

• ISO New England’s three core responsibilities include:
  – Operating the regional power system
  – Administering the region’s competitive wholesale electricity markets
  – Planning for the regional power system

• Regulated by the Federal Energy Regulatory Commission (FERC)

• Independent of companies in the marketplace

• ISO-NE does not:
  – Buy or sell power
  – Own generation or transmission equipment
  – Have any involvement in the natural gas industry
  – Take any position on any pipeline or elective transmission project proposal
Snapshot of New England’s Power System and Wholesale Electricity Markets

- **Resources & consumer demand:**
  - 350 generators; 31,000 MW of generating capacity
  - 600 MW of demand response & 1,700 MW of energy efficiency
  - 15,000 MW of new generation since 1997
  - All-time peak demand: 28,130 MW on August 2, 2006

- **Transmission system:**
  - 8,600 miles of high-voltage transmission lines
  - $7.4 billion invested since 2002 to improve reliability
  - 13 transmission ties to neighboring power systems (NY & Canada)

- **Markets:**
  - Energy: daily market for electricity
  - Capacity: annual forward auction for long-term resource availability; obligation for one year or seven years for new resources
  - Ancillary services: daily market for real-time reliability services
STATE OF THE GRID: SETTING THE STAGE
Transformation of Region’s Resource Mix Continues

- **Low natural gas prices**
  - Gas is the most economic fuel for new, conventional resources
    - 80% of new capacity since 1997 runs on natural gas
    - Nearly 65% of all proposed new generation would use natural gas
  - Demand for natural gas is rising
  - Gas pipelines are constrained during high demand periods, particularly winter
    - Creates grid reliability concerns and price volatility

- **Low prices are putting financial pressure** on coal, oil and nuclear baseload generators; some are retiring

![Cumulative New Generating Capacity in New England (MW) 1997-2018](chart)
Shift to Cleaner Energy Sources Continues

• **State policies drive renewable resource development**
  – Mostly large-scale wind and behind-the-meter solar
  – Other, fast & flexible resources will be needed to balance intermittent resources’ variable output
  – New transmission needed to bring wind farms’ energy from their remote locations to population centers

• **Distributed generation and the “hybrid” grid**
  – A significant portion of New England’s future grid could be “behind-the-meter” (solar facilities on distribution system)
  – That will change how much and when power is used by consumers
Electric Grid Will Look Very Different in the Near Future

“Hybrid” grid with grid-connected and distributed resources, and a continued shift toward natural gas and renewable energy
STATE OF THE GRID: 2015 HIGHLIGHTS
Natural Gas Used Most Often to Generate Region’s Power

The fuels used to produce the region’s electric energy have shifted as a result of economic and environmental factors

Percent of Total **Electric Energy** Production by Fuel Type (2000 vs. 2015)

- **Natural Gas**
  - 2000: 31%
  - 2015: 30%
- **Oil**
  - 2000: 22%
  - 2015: 2%
- **Coal**
  - 2000: 18%
  - 2015: 4%
- **Hydro and Other Renewables**
  - 2000: 13%
  - 2015: 15%
- **Pumped Storage**
  - 2000: 2%
  - 2015: 1%

Source: ISO New England [Net Energy and Peak Load by Source](#)

Other renewables include landfill gas, biomass, other biomass gas, wind, solar, municipal solid waste, and miscellaneous fuels
Natural Gas and Wholesale Electricity Prices Are Linked

With natural gas the primary fuel used to produce electricity, natural-gas-fired power plants typically set the price for wholesale electricity.

![Chart showing monthly average natural gas and wholesale electricity prices in New England. Key events: Hurricanes in Gulf of Mexico, Strong Global Demand, Marcellus Shale Boom, Winter Pipeline Constraints, Summer: pipelines unconstrained, Recession.](chart.png)
Winter vs. Summer Prices: With Pipeline Constraints, the Price Spread is Growing

When pipelines are unconstrained, generators can access low-priced natural gas.
When Pipelines are Unconstrained: New England’s Wholesale Prices are Competitive with Other Regions
When Pipelines are Unconstrained: New England’s Wholesale Power Prices are Competitive with Other Regions

Monthly Average Wholesale Electricity Prices for New England, New York, and PJM
January 2015 – June 2015
(Real-Time System Prices per $/MWh)

Underlying natural gas data furnished by:
Wholesale Electricity Costs Reflect Market Conditions

Total annual wholesale market costs have ranged from $6 billion to $14 billion

Annual Value of Wholesale Electricity Markets
(in billions)

- Energy Market
- Ancillary Markets
- Capacity Market

2008: 12.1 (1.5)
2009: 5.9 (1.8)
2010: 7.3 (1.6)
2011: 6.7 (1.3)
2012: 5.2 (1.2)
2013: 8.0 (1.1)
2014: 9.1 (1.1)
2015: 5.9 (1.1)

*Preliminary data subject to reconciliation.
Putting Competitive Wholesale Markets to Work for New England

• Markets reveal a resource’s true operating cost
  – Fuel is the primary driver of operating costs
  – The dollar value of New England’s energy markets fell from 2008 to 2012 as low-cost natural gas displaced older, fossil fuel-fired units

• Gas-fired generators are becoming more efficient
  – Improvements in technology have made newer generators more economic than older generators

• Region has invested in cleaner technologies ahead of much of the rest of the country and has seen regional air emissions decline significantly over the past decade
Power Plant Emissions Have Declined with Changes in the Fuel Mix

*Reduction in Aggregate Emissions (ktons/yr)*

<table>
<thead>
<tr>
<th>Year</th>
<th>NOx</th>
<th>SO2</th>
<th>CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>59.73</td>
<td>200.01</td>
<td>52,991</td>
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<tr>
<td>2014</td>
<td>20.49</td>
<td>11.68</td>
<td>39,317</td>
</tr>
</tbody>
</table>

% Reduction, 2001–2014

|                    | ↓ 66% | ↓ 94% | ↓ 26% |

*Reduction in Average Emission Rates (lb/MWh)*

<table>
<thead>
<tr>
<th>Year</th>
<th>NOx</th>
<th>SO2</th>
<th>CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>1.36</td>
<td>4.52</td>
<td>1,009</td>
</tr>
<tr>
<td>2014</td>
<td>0.38</td>
<td>0.22</td>
<td>726</td>
</tr>
</tbody>
</table>

% Reduction, 1999–2014

|                    | ↓ 72% | ↓ 95% | ↓ 28% |

New England Shifts to Coal and Oil in the Winter

Winter 2014–2015 Fossil Fuel Mix

- **Oil**
- **Coal**
- **Natural Gas / LNG**

Daily Energy MWh

- December 2014
- January 2015
- February 2015
Winter Operations Highlight Natural Gas Pipeline Constraints as a Continuing Reliability Challenge

• Close to half—13,650 MW, or 44%—of the total generating capacity in New England uses natural gas as its primary fuel.

• 2015/16 winter outlook identifies up to 4,220 MW of natural gas-fired generation at risk of not being able to get fuel when needed.

• To address continuing concerns about natural gas pipeline constraints, the ISO will administer Winter Reliability Programs until 2018 to help improve fuel security and protect power system reliability.
Winter 2015/2016 So Far
December 1, 2015 through January 18, 2016

• Mildest December since at least 1960
  – Even milder than December 2014
  – Lowest December energy usage since 2003 (10,160 GWh)
  – Second-lowest wholesale power price at $21.35 per megawatt-hour
    • June 2015 was lowest, at $19.61/MWh

• Beginning of January was also mild

• When weather is mild:
  – Natural gas demand is lower
  – Pipelines are less constrained
  – Prices of natural gas and electricity fall

<table>
<thead>
<tr>
<th>12/1 thru 1/18</th>
<th>Winter 13/14</th>
<th>Winter 14/15</th>
<th>Winter 15/16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave monthly temp (°F)</td>
<td>29.1</td>
<td>30.7</td>
<td>37.9</td>
</tr>
<tr>
<td>Total energy consumption (GWh)</td>
<td>18,339</td>
<td>17,818</td>
<td>16,470</td>
</tr>
<tr>
<td>Peak demand (MW)</td>
<td>21,448</td>
<td>20,556</td>
<td>19,227</td>
</tr>
<tr>
<td>Date of peak and temp</td>
<td>12/17/13 15°F</td>
<td>1/8/15 20°F</td>
<td>1/5/16 22°F</td>
</tr>
<tr>
<td>Ave. real-time energy price ($/MWh)</td>
<td>$105.66</td>
<td>$53.27</td>
<td>$26.01</td>
</tr>
<tr>
<td>Ave. natural gas price ($/MMBtu)</td>
<td>$13.58</td>
<td>$7.36</td>
<td>$3.22</td>
</tr>
<tr>
<td>Total value of energy market (billions)</td>
<td>$2.024</td>
<td>$1.038</td>
<td>$0.464</td>
</tr>
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</table>

Underlying natural gas data furnished by:
More Than 4,200 MW of Generation Have Retired or Will Retire in Less Than Five Years

Major Generator Retirements:

• Salem Harbor Station (749 MW)  
  – 4 units (coal & oil)

• Vermont Yankee Station (604 MW)  
  – 1 unit (nuclear)

• Norwalk Harbor Station (342 MW)  
  – 3 units (oil)

• Brayton Point Station (1,535 MW)  
  – 4 units (coal & oil)

• Mount Tom Station (143 MW)  
  – 1 unit (coal)

• Pilgrim Nuclear Power Station (677 MW)  
  – 1 unit (nuclear)

• Additional retirements are looming
Generator Retirements and Higher Capacity Prices Signal the Need for New Supply Resources

Proposed Capacity in ISO’s Generator Interconnection Queue

- **January 2014**
  - Natural Gas: 2,500 MW
  - Wind: 1,000 MW
  - Other: 500 MW

- **January 2015**
  - Natural Gas: 6,000 MW
  - Wind: 2,000 MW
  - Other: 1,000 MW

- **January 2016**
  - Natural Gas (including dual-fuel units): 12,000 MW
  - Wind: 4,000 MW
  - Other: 2,000 MW
Forward Capacity Market Is Attracting Efficient and Fast-Starting Resources

- More than **1,600 MW** of new gas-fired generation have come forward in the last few auctions; **147 new resources** representing 6,700 MW have qualified for the next auction

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**Wallingford (90 MW)**
Combustion Turbines  
*Commercial: June 1, 2018*

**Towantic (725 MW)**
Combined-Cycle Gas Turbine  
*Commercial: June 1, 2018*

**Footprint (674 MW)**
Combined-Cycle Gas Turbine  
*Commercial: June 1, 2017*

**Medway (195 MW)**
Combustion Turbine  
*Commercial: June 1, 2018*
STATE OF THE GRID: PREPARING FOR THE HYBRID GRID
Market Enhancements Are Providing Benefits

• Provide proper signals to market participants to improve their resource’s performance, retire, or build new resources

• Price signals promoting investment, reflecting fundamentals
  – Guiding New England’s transition through a gas and renewables system
  – Attracting new entry, at competitive, transparent prices

• Benefits of well-designed capacity and energy markets
  – Greater return on investments for resources that perform reliably
  – Simpler, more predictable capacity market design
  – Promotes flexibility, innovation, and cost-effective development
Market Changes Allow Variable Resources to More Effectively Participate in the Wholesale Markets

- **Negative offer price**: allows generators like wind resources the opportunity to operate during low-load conditions when their output otherwise might be curtailed.

- **Do-not-exceed dispatch order**: allows the ISO to better manage transmission congestion to maximize the use of low-cost renewable resources and alleviate the need for curtailments.

- **Elective transmission upgrade rules**: contain options for strengthening electrically weak portions of the grid to help integrate distant resources like wind.
State Policy Requirements Drive Proposals for Renewable Energy

State Renewable Portfolio Standard (RPS)*
for Class I or New Renewable Energy by 2020

* State Renewable Portfolio Standards (RPS) promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Vermont’s new Renewable Energy Standard has a ‘total renewable energy’ requirement (reflected above), which recognizes large-scale hydro and all other classes of renewable energy.
Renewable and EE Resources Are Trending Up

Wind (MW)

- Existing: 800
- Proposed: 4,000

Nameplate capacity of existing wind resources and proposals in the ISO-NE Generator Interconnection Queue; megawatts (MW).

Solar (MW)

- PV thru 2014: 900
- PV in 2024: 2,400

2015 ISO-NE Solar PV Forecast, nameplate capacity, based on state policies.

Energy Efficiency (MW)

- EE thru 2014: 1,500
- EE in 2024: 3,600

2015 CELT Report, EE through 2014 includes EE resources participating in the Forward Capacity Market (FCM). EE in 2024 includes an ISO-NE forecast of incremental EE beyond the FCM.
Energy Efficiency Is Slowing Peak Demand Growth and Flattening Energy Use

The gross forecast of peak demand and energy use

The forecast minus the impact of EE participating in the Forward Capacity Market (FCM) to date

The forecast minus anticipated EE growth beyond FCM years

The ISO is Leading Efforts to Account for Solar Resources Connected to the Distribution System

- **Long-term solar forecast**
  - Tracking historical growth; predicting solar development 10 years ahead
  - Used in transmission planning and market needs assessments
  - In 2015, PV forecast used for first time in Installed Capacity Requirement time, reducing 2019/2020 need by 390 MW

- **Short-term solar forecast**
  - ISO creates daily forecasts of solar PV production to improve daily load forecasts

- **Interconnection rules improvements**
  - ISO is helping develop new interconnection standards to reduce reliability concerns

![Cumulative Growth in Solar PV through 2024 (MW*)](chart.png)

Source: [Final PV Forecast](https://example.com) (April 2015); Note: MW values are AC nameplate
Solar Power’s Effect on Hourly Electricity Demand
May 23, 2015

Solar Power’s Effect on Regional Electricity Demand
May 23, 2015

Megawatts

Estimated Electricity Needs Served by Solar Power
Demand Without Solar Power
Electricity Demand Seen in Real Time
Transmission Developers Are Proposing to Move Renewable Energy to New England Load Centers

- As of January 1, 2016, eleven elective transmission projects had been proposed in the ISO Interconnection Queue, totaling more than 7,000 MW of potential transfer capability
  - Primarily large-scale hydro resources from eastern Canada and wind resources from northern New England
- These merchant projects seek to address public policy goals, not reliability needs

Representative of the types of projects announced for the region in recent years

Source: ISO Interconnection Queue (January 2016)
http://www.iso-ne.com/system-planning/transmission-planning/interconnection-request-queue
Infrastructure Will Be Needed to Deliver Energy from Proposed Resources

All Proposed Generation

Developers are proposing to build 13,000 MW of generation, including nearly 8,200 MW of gas-fired generation and more than 4,200 MW of wind.

Wind Proposals

Source: ISO Generator Interconnection Queue (January 2016)
FERC Jurisdictional Proposals Only

Natural gas 63%
Wind 33%
Other 4%
STATE OF THE GRID: CONCLUSIONS
Conclusions

• **Competitive wholesale electricity markets** have resulted in significant efficiencies & have driven billions of dollars of investment in New England’s power system

• **New England’s generation fleet is changing rapidly** – the use of natural gas for power generation is increasing dramatically; older, fossil-fired units are retiring; and renewables and demand-side resources are growing

• **New England needs additional energy infrastructure** – rising demand for natural gas drives the need for additional natural gas infrastructure; increasing wind development in remote areas will require additional transmission; and growing levels of variable generation will require a fleet of flexible resources to successfully integrate

• **Wholesale power prices are directly related to natural gas prices** – when natural gas pipelines are unconstrained, natural gas and wholesale power prices drop

• **ISO New England has taken major steps** to address these challenges to reliability through financial incentives provided in the wholesale market and in changes to transmission planning processes, and will continue to work with regional stakeholders to help manage the continuing transition in the regional resource mix
Questions
For More Information...

- **Subscribe to the ISO Newswire**
  - ISO Newswire is your source for regular news about ISO New England and the wholesale electricity industry within the six-state region

- **Log on to ISO Express**
  - ISO Express provides real-time data on New England’s wholesale electricity markets and power system operations

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  - @isonewengland

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  - ISO to Go is a free mobile application that puts real-time wholesale electricity pricing and power grid information in the palm of your hand