
New Hampshire Residential Ratepayer Advisory Board

Eric Johnson
Director, External Affairs
ISO New England (ISO) Has Two Decades of Experience Overseeing the Region’s Restructured Electric Power System

- **Regulated** by the Federal Energy Regulatory Commission
- **Reliability Coordinator** for New England under the North American Electric Reliability Corporation
- **Independent** of companies in the marketplace and **neutral** on technology
ISO New England Performs Three Critical Roles to Ensure Reliable Electricity at Competitive Prices

**Grid Operation**
Coordinate and direct the flow of electricity over the region’s high-voltage transmission system

**Market Administration**
Design, run, and oversee the markets where wholesale electricity is bought and sold

**Power System Planning**
Study, analyze, and plan to make sure New England's electricity needs will be met over the next 10 years
Dramatic Changes in the Energy Mix

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. 2017)

- **Nuclear**: 31% (2000) vs. 31% (2017)
- **Oil**: 22% (2000) vs. 1% (2017)
- **Coal**: 18% (2000) vs. 2% (2017)
- **Natural Gas**: 15% (2000) vs. 48% (2017)
- **Hydro**: 7% (2000) vs. 8% (2017)
- **Renewables**: 8% (2000) vs. 11% (2017)

Source: ISO New England Net Energy and Peak Load by Source

Renewables include landfill gas, biomass, other biomass gas, wind, solar, municipal solid waste, and miscellaneous fuels.
Power Plant Emissions Have Declined with Changes in the Fuel Mix

**Reduction in Aggregate Emissions (ktons/yr)**

<table>
<thead>
<tr>
<th>Year</th>
<th>NO\textsubscript{x}</th>
<th>SO\textsubscript{2}</th>
<th>CO\textsubscript{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>59.73</td>
<td>200.01</td>
<td>52,991</td>
</tr>
<tr>
<td>2016</td>
<td>16.27</td>
<td>4.47</td>
<td>37,467</td>
</tr>
</tbody>
</table>

% Reduction, 2001–2016

|                  | ↓ 73% | ↓ 98% | ↓ 29% |

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

<table>
<thead>
<tr>
<th>Year</th>
<th>NO\textsubscript{x}</th>
<th>SO\textsubscript{2}</th>
<th>CO\textsubscript{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>1.36</td>
<td>4.52</td>
<td>1,009</td>
</tr>
<tr>
<td>2016</td>
<td>0.31</td>
<td>0.08</td>
<td>710</td>
</tr>
</tbody>
</table>

% Reduction, 1999–2016

|                  | ↓ 77% | ↓ 98% | ↓ 30% |

Source: 2016 ISO New England Electric Generator Air Emissions Report, December 2017 (draft)
The Region Has Lost—and Is at Risk of Losing—Substantial Non-Gas Resources

Major Generator Retirements:

- **Salem Harbor Station (749 MW)**
  - 4 units (coal & oil)

- **Norwalk Harbor Station (342 MW)**
  - 3 units (oil)

- **Mount Tom Station (143 MW)**
  - 1 unit (coal)

- **Vermont Yankee Station (604 MW)**
  - 1 unit (nuclear)

- **Brayton Point Station (1,535 MW)**
  - 4 units (coal & oil)

- **Pilgrim Nuclear Power Station (677 MW)**
  - 1 unit (nuclear)

- **Bridgeport Harbor Station (564 MW)**
  - 2 units (coal & oil)

- Additional retirements are looming
The New England states are promoting GHG reductions on a state-by-state basis, and at the regional level, through a combination of legislative mandates (e.g., CT, MA, RI) and aspirational, non-binding goals (e.g., ME, NH, VT and the New England Governors and Eastern Canadian Premiers).

* MA, RI, NH, and VT use a 1990 baseline year for emissions reductions. CT and the NEG-ECP use a 2001 baseline. ME specifies reductions below 2003 levels that may be required “in the long term.” For more information, see the following ISO Newswire article: [http://isonewswire.com/updates/2017/3/1/the-new-england-states-have-an-ongoing-framework-for-reducin.html](http://isonewswire.com/updates/2017/3/1/the-new-england-states-have-an-ongoing-framework-for-reducin.html).
State Policy Requirements Drive Proposals for Renewable Energy

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

<table>
<thead>
<tr>
<th>Year</th>
<th>VT</th>
<th>MA</th>
<th>RI</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>55%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>59%</td>
<td>15%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>63%</td>
<td>16%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>71%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2035</td>
<td>75%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2040</td>
<td>75%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Connecticut’s Class I RPS requirement plateaus at 20% in 2020. Maine’s Class I RPS requirement plateaus at 10% in 2017 and expires in 2022 (but has been held constant in this chart for illustrative purposes). Massachusetts’ Class I RPS requirement increases by 1% each year after 2020 with no stated expiration date. New Hampshire’s percentages include the requirements for both Class I and Class II resources (Class II resources are new solar technologies beginning operation after January 1, 2006). New Hampshire’s Class I and Class II RPS requirements plateau at 15.7% in 2025. Rhode Island’s requirement for ‘new’ renewable energy plateaus at 36.5% in 2035. Vermont’s ‘total renewable energy’ requirement plateaus at 75% in 2032; it recognizes all forms of new and existing renewable energy and is unique in classifying large-scale hydropower as renewable.
Wind Power and Natural Gas Dominate New Resource Proposals in the ISO Interconnection Queue

Approximately 14,800 MW

By Type

- Wind, 8,552, 58%
- Natural Gas, 4,563, 31%
- Solar, 1,116, 8%
- Battery Storage, 400, 3%
- Pump Storage, 66, <1%
- Hydro, 33, <1%
- Biomass, 37, <1%

By State

- MA, 6,054, 41%
- CT, 2,179, 15%
- VT, 80, 1%
- NH, 163, 1%
- RI, 1,125, 8%
- ME, 5,166, 35%

Note: Some natural gas proposals include dual-fuel units (oil); some wind and solar proposals include battery storage; megawatts represent nameplate capacity ratings; megawatts have been rounded for each proposal.

Source: ISO Generator Interconnection Queue (January 2018)
FERC and Non-FERC Jurisdictional Proposals
Developers Are Proposing Large-Scale Transmission Projects to Help Deliver Clean Energy to Load Centers

- Developers are proposing 20+ elective transmission upgrades (ETUs) to help deliver 16,500+ MW of clean energy
  - Mostly Canadian hydro and onshore wind from northern New England
- Wind projects make up 58% of proposed new power resources, but most are remote
- Massachusetts has plans to contract for 1,600 MW of offshore wind

Map is representative of the types of projects announced for the region in recent years

Source: ISO Interconnection Queue (January 2018)
Key Grid Challenge: Fuel Security

Ensuring the region’s generators have adequate fuel to produce electricity, particularly in the winter.

ISO New England Publishes *Operational Fuel-Security Analysis*

- The goal of the [study](#) is to understand future effects of trends already affecting power system operations.

- The analysis examines more than 20 cases of generating resource and fuel-mix combinations during the 2024-2025 winter, and quantifies each case’s **fuel security risk**
  - *i.e.*, the number and duration of energy shortfalls that could occur and that would require implementation of emergency procedures to maintain reliability.

- The study assumed **no additional natural gas pipeline capacity** would be added to serve generators during the timeframe of the study.
Operational Fuel-Security Analysis Differs from Previous Studies

• Unlike the ISO’s previous studies on fuel challenges, this study:
  – Quantifies *operational* risk by measuring energy shortfalls and system stress
  – Focuses on the availability of energy over an *entire winter* period rather than capacity availability on just peak days
  – Does not directly consider fuel costs or prices
  – Does not examine impacts of expanded natural gas pipeline capacity on a winter peak day

• As with all projections, the hypothetical resource combinations described may never materialize
  – Further, power systems conditions vary on a daily and hourly basis and may not behave exactly as predicted in study models
Six Major Conclusions

The study results suggest the following major conclusions:

1. **Outages**: The region is vulnerable to the season-long outage of any of several major energy facilities

2. **Key dependencies**: Reliability is heavily dependent on LNG and electricity imports; more dual-fuel capability is also a key reliability factor

3. **Logistics**: Timely availability of fuel is critical, highlighting the importance of fuel-delivery logistics

4. **Risk**: All but four of 23 scenarios result in load shedding, indicating a trend towards increased fuel-security risk

5. **Renewables**: More renewables can help lessen fuel-security risk, but are likely to drive oil-and coal-fired generator retirements which, in turn, require more LNG

6. **Positive Outcomes**: Higher levels of LNG, imports, and renewables can minimize system stress and maintain reliability; delivery assurances and transmission expansion would be needed
Generation Mix Changes on Cold Days

2015 Annual Fuel Mix Compared with Day of Highest Coal and Oil Generation in 2015

Key Fuel Variables

The study modeled a wide range of resource combinations that might be possible by winter 2024/2025 considering five key fuel variables:

1. Retirements of coal- and oil-fired generators
   - The study assumes that New England will have no coal-fired plants in winter 2024/2025

2. Imports of electricity over transmission lines from New York and Canada

3. Oil tank inventories (i.e., how often on-site oil tanks at dual-fuel power plants are filled throughout the winter)

4. Level of liquefied natural gas (LNG) injections into the region’s natural gas delivery and storage infrastructure

5. Level of renewable resources on the system
**Key Fuel Security Assumptions – Renewables**

<table>
<thead>
<tr>
<th>Case Scenario</th>
<th>Renewables Total MW (rounded)</th>
<th>Breakdown MW</th>
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<tbody>
<tr>
<td></td>
<td>Onshore Wind</td>
<td>Offshore Wind</td>
</tr>
<tr>
<td>2017</td>
<td>4,600</td>
<td>1,200</td>
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<tr>
<td>Reference Case</td>
<td>6,600</td>
<td>1,200</td>
</tr>
<tr>
<td>More Renewables</td>
<td>8,000</td>
<td>1,200</td>
</tr>
<tr>
<td>Max Renewables</td>
<td>9,500</td>
<td>1,200</td>
</tr>
</tbody>
</table>
Demand and System Stress Measurements

- System stress was measured by several operational metrics including:
  - Actions during a capacity deficiency (OP-4)
  - Depletion of ten-minute reserves
  - Load shedding
Hours of Emergency Actions under Modeled Scenarios, Ordered Least to Most
Appendix A - Detailed Results

<table>
<thead>
<tr>
<th>Reference Case (I.e., Current Trends) and Single-Variable Cases</th>
<th>Total Winter Impact</th>
<th>Inputs</th>
<th>OP 4 Actions</th>
<th>OP 7 Action, Load Shedding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reff Case (Ref)</td>
<td>1,200</td>
<td>100</td>
<td>2</td>
<td>2,500</td>
</tr>
<tr>
<td>Less Imports</td>
<td>-400</td>
<td>100</td>
<td>2</td>
<td>2,500</td>
</tr>
<tr>
<td>More Dual-Fuel Replacement</td>
<td>100</td>
<td>2</td>
<td>2,500</td>
<td>6,000</td>
</tr>
<tr>
<td>More Refs</td>
<td>100</td>
<td>2</td>
<td>2,500</td>
<td>6,000</td>
</tr>
<tr>
<td>Low Boundary</td>
<td>-400</td>
<td>100</td>
<td>2</td>
<td>2,500</td>
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<td>1,200</td>
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<td>Reference Case (I.e., Current Trends) and Single-Variable Cases</td>
<td>Total Winter Impact</td>
<td>Inputs</td>
<td>OP 4 Actions</td>
<td>OP 7 Action, Load Shedding</td>
</tr>
<tr>
<td>Outage Cases (Modeled on Reff Case and Max Cases, Assumed More Dual-Fuel Tank Fills)</td>
<td>1,200</td>
<td>100</td>
<td>3</td>
<td>2,500</td>
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<td>Default LNG Outage Ref</td>
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<td>Compressor Outage</td>
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<td>100</td>
<td>3</td>
<td>2,500</td>
</tr>
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Note: Details of each case, including assumptions and calculations, are provided in the report.
Next Steps

• The ISO released this fuel-security report January 17, 2018 and will continue to discuss its results with stakeholders

• A key question to be addressed will be the level of fuel-security risk that the ISO, the region, and its policymakers and regulators are willing to tolerate

• As the system operator responsible for system reliability, the ISO must independently assess the level of risk to reliable operation

• Discussions with stakeholders on potential solutions to address fuel-security risks are targeted to begin later in 2018
ISO New England Releases Several New Publications

**2018 Regional Electricity Outlook**
Provides an in-depth look at New England’s biggest challenges to power system reliability, the solutions the region is pursuing, and other ISO New England efforts to improve services and performance.

**New England Power Grid Profile**
Provides key grid and market stats on how New England’s wholesale electricity markets are securing reliable electricity at competitive prices and helping usher in a cleaner, greener grid.

**New England State Profiles**
Provides state-specific facts and figures relating to supply and demand resources tied into the New England electric grid and state policies transforming the resource mix in the region.
Questions