Transmission System Planning
Meeting the Challenges

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Chair PSPI TPWG
PES General Meeting
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Transmission Planning Must Meet Criteria

• National
  – FERC/NERC Requirements

• Reliability Council
  – Northeast Power Coordinating Council

• Regional
  – ISO-New England

• Local
  – Transmission Owner and Customer Specific
Overview: Meeting Transmission Planning Challenges

• Evolving regulatory requirements and planning for policy
• Integrating of variable resources and smart grid technologies
• Changing system characteristics and technologies
• Transmission Planning Working Group activities
  – Identify issues
  – Discuss potential solutions
Evolving Regulatory Requirements and Planning for Policy

• FERC Order 1000 requirements
  – Nonincumbent transmission development
  – Interregional Planning
  – Planning for policy

• Environmental constraints
  – Water intake and discharge
  – Ozone standards and regulations on fine particulate matter
  – Mercury and Air Toxics Standards
  – Clean Power Plan
  – Licensing review of existing hydro and nuclear plants
  – Siting requirements

• Renewable resource development
Environmental Issues and Renewable Integration

- Existing and upcoming environmental regulations will continue to affect the region’s generators
  - Over the past decade, average and marginal emissions rates have declined, in part due to increased use of natural gas
  - Higher operating costs, reduced capacity, or energy production
  - Additional capital improvements and resource retirements
  - Increased use of natural-gas-fired generation is likely
  - Relicensing of nuclear and hydro facilities could reduce output and flexibility

- Public policy and regulation are driving the development of renewable resources, energy efficiency, and distributed generation

- Wind projects that interconnect to weak portions of the system are at risk of curtailment unless the transmission system is expanded

- Expanded interconnections with Canada could provide access to hydro resources and diversify the supply
All Proposed Generation

Developers are proposing to build more than 11,000 MW of generation, including 7 GW of gas-fired generation and 4 GW of wind.

- Natural gas: 63%
- Wind: 36%
- Other: 1%

Wind Proposals

- ME: 3,304 MW
- VT: 152 MW
- NH: 62 MW
- MA: 472 MW

Source: ISO Generator Interconnection Queue (March 2015)
FERC Jurisdictional Proposals Only
Example: New England has Significant Wind Potential

- Population and electric demand are concentrated along the coast in central and southern New England.
- 12,000 MW of onshore and offshore wind potential
  - Preliminary screening eliminated wind sites near urban areas and sensitive geographic locations (e.g., Appalachian Trail).
- Transmission will be required to connect potential wind resources to load centers in New England.
ISO-NE Example: The Fuel Mix of Resources is Changing
ISO-NE Capacity Resources

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
<th>MW</th>
</tr>
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<tbody>
<tr>
<td>2015</td>
<td>13,653 44.4%</td>
<td>30,749 MW</td>
</tr>
<tr>
<td>2018</td>
<td>15,325 49.2%</td>
<td>31,130 MW</td>
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<tr>
<td>2024</td>
<td>21,303 56.7%</td>
<td>37,604 MW</td>
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</table>
Shale Gas is a Game Changer

Source: DOE Quadrennial Review
Possible Pipeline Opportunities

Source: DOE Quadrennial Review
Possible Electric Transmission Opportunities

N. Dakota: 1,800 miles

Québec: 250 mi.

New Brunswick: 500 mi.
Example: Slow Growth of Net Peak and Energy Demand

New England: Summer 90/10 Peak (MW)

New England: Annual Energy Use (GWh)

<table>
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<tr>
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<th>Gross</th>
<th>Net(a)</th>
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<tbody>
<tr>
<td>NEL</td>
<td>1.0</td>
<td>0.0</td>
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<tr>
<td>50/50 and 90/10</td>
<td>1.3</td>
<td>0.6</td>
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<tr>
<td>Summer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50/50 and 90/10</td>
<td>0.7</td>
<td>-0.1</td>
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<tr>
<td>Winter</td>
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Benefits of DG Grid-Support Functionalities

Can allow for cost-effective achievement of public policies

Improved Performance: Distribution

• Mitigate voltage swings caused by PV variability
• Increase hosting capacity of distribution feeders
• Visibility/control

Improved Performance: Transmission

• Disturbance tolerance
• Known, reliable behavior, especially during system events
• Visibility/control
DG Capabilities Affect Transmission System Performance

- High/low frequency and high/low voltage ride through
- Voltage support
- Default and emergency ramp rate limits
- Reconnect by “soft-start” methods after disconnect
- Communications capability needed to activate/deactivate DG functionalities and parameters, as well as support other DG functionalities that may be needed in the future
HVDC and FACTS will Grow
Example: ISO-NE

<table>
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<th>Device&lt;sup&gt;(a)&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>HVDC</td>
<td>A. Highgate</td>
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<tr>
<td></td>
<td>B. Sandy Pond</td>
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<tr>
<td>VSC HVDC</td>
<td>C. Cross-Sound Cable</td>
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<tr>
<td>SVC</td>
<td>D. Chester</td>
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<tr>
<td></td>
<td>E. Barnstable</td>
</tr>
<tr>
<td></td>
<td>F. Ascutney</td>
</tr>
<tr>
<td>DVAR</td>
<td>G. Stony Hill (2)&lt;sup&gt;(b)&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>H. Bates Rock&lt;sup&gt;(b)&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>I. Kibby (2)</td>
</tr>
<tr>
<td></td>
<td>J. Granite Wind</td>
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<tr>
<td>Statcom</td>
<td>K. Essex</td>
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<tr>
<td></td>
<td>L. Glenbrook</td>
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<tr>
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<td>M. Granite</td>
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<tr>
<td>condensers</td>
<td>N. Jay</td>
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<tr>
<td></td>
<td>O. Saco Valley</td>
</tr>
<tr>
<td>Planned dynamic</td>
<td>Associated with various generators in Maine</td>
</tr>
<tr>
<td>devices</td>
<td></td>
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</table>

Associated with various generators in Maine
Onshore and Offshore Transmission Proposals are Vying to Move Renewable Energy to New England Load Centers

ISO-NE Representative Projects and Concept Proposals

- a. Northern Pass – Hydro Quebec/Northeast Utilities
- d. Bay State Offshore Wind Transmission System – Anbaric Transmission
- e. Northeast Energy Corridor – Maine/New Brunswick/Irving
- f. Muskrat Falls/Lower Churchill – Nalcor Energy
- g. Maine Yankee—Greater Boston
- h. Maine—Greater Boston
- i. Northern Maine—New England
- j. Plattsburgh, NY—New Haven, VT
- k. New England Clean Power Link – TDI New England

Note: These projects are NOT reliability projects, but ISO New England’ s role is to ensure the reliable interconnection of these types of projects.
Technological Issues

- Energy Storage
- Advanced Control
- Advanced Protection
- Synchronized Phasor Measurements
- Dealing with Complete and Incomplete Observability
- Intelligent Visualization Techniques
- Advanced Metering Infrastructure
- Dynamic Ratings and Condition Monitoring
- Interactions between the bulk system and distribution system
- Analysis tools
Requirements

- Steady State Simulation Studies
- Dynamic Simulation Studies
- Transient Voltage Simulation Studies
- Switching Surge Studies
- Training of personnel
- Study a wide number of system conditions
- Use of probabilistic tools
PSPI TPWG Activities

- Panel: Planning Transmission for Co-optimization with Resource Expansion – Part II
  - Continuation of driving needs for transmission expansion determined by policy makers and market participants
  - Part III planned for GM16

- Tutorial on transmission planning proposed for GM16
Your Ideas
Questions