2030 Power System Study
Report to the New England Governors
2009 Economic Study: Scenario Analysis of Renewable Resource Development

States’ Blueprint as guiding policy and regulatory framework

ISO economic study as technical support
Economic Study: Approach

• ISO conducted “scenario analysis” for development of renewable resources, focused primarily on wind

• Up to 12,000 MW of wind in New England
  – 7,500 MW onshore and 4,500 MW offshore
    • Offshore distributed evenly between Maine, Massachusetts, Rhode Island
  – Incremental cases: 2,000 MW / 4,000 MW / 8,000 MW
  – Nameplate capacity ratings

• Other resources
  – Demand resources, plug-in electric vehicles (PEVs), energy storage, and expanded imports
  – Range of resource penetrations (low / medium / high)
Economic Study: Approach, cont.

- **Timing and sensitivities**
  - Evaluated long-term horizon: approximately 20 years into the future (around 2030)
  - Evaluated generator retirement and repowering scenarios for units in service for 50 / 60 / 70 years by the year 2030
  - Evaluated sensitivity of each scenario to higher fuel prices, transmission constraints

- **States developed study assumptions with technical support from ISO**
Study Results

• Environmental metrics
  – Retirement and repowering scenarios produce the lowest SO\textsubscript{2}, NO\textsubscript{x}, and CO\textsubscript{2} emissions; wind scenarios also produce significant SO\textsubscript{2}, NO\textsubscript{x}, and CO\textsubscript{2} reductions

• Energy contribution from wind and hydro
  – Developing 5,500 MW of wind could supply 12% of New England’s energy in 2030
  – Developing 12,000 MW of wind and expanding ties with Eastern Canada (assumed to be wind and hydro) could supply 26% of New England’s energy from wind and an additional 9% from hydro in 2030
Study Results, cont.

• Wholesale Electric Energy Prices
  – Average annual prices are lower in scenarios that add low-cost energy to the system (such as higher wind penetration) or remove energy from the system (such as higher demand-resource penetration)
  – Retiring large amounts of fossil fuel generators and replacing them with advanced natural gas units also produces lower prices
  – Some resources would retire if energy market revenues were reduced or would need to consider other sources of revenue

• Wholesale electric energy prices do not include capital costs of the resources and associated transmission
Connecting Wind Energy to Load Centers

- 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
Summary of Scenarios for Renewable Resources

Offshore and near-shore wind and wind imports can achieve 15% of New England’s energy

<table>
<thead>
<tr>
<th>Description</th>
<th>New Capacity (Megawatts)</th>
<th>Percent of New England Wind Energy (%)</th>
<th>Preliminary Transmission Cost Estimates (Billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>From New England:</strong></td>
<td></td>
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<td></td>
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<tr>
<td>4,000 MW of offshore wind plus</td>
<td>5,500 MW (1,430 miles)</td>
<td>12%</td>
<td>$4.7 B to $7.6 B</td>
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<tr>
<td>1,500 MW of near-shore onshore wind*</td>
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<tr>
<td>12,000 MW of wind</td>
<td>12,000 MW (4,320 miles)</td>
<td>23%</td>
<td>$19 B to $25 B</td>
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<tr>
<td><strong>From New England and Eastern Canada:</strong></td>
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</tr>
<tr>
<td>5,500 MW of wind (from above) plus</td>
<td>8,500 MW (2,100 miles)</td>
<td>15%</td>
<td>~$7 B to ~$12 B</td>
</tr>
<tr>
<td>3,000 MW of additional imports from Québec and New Brunswick**</td>
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<td></td>
</tr>
<tr>
<td>12,000 MW of New England wind plus</td>
<td>15,000 MW (5,000 miles)</td>
<td>26%</td>
<td>~$17 B to ~$36 B</td>
</tr>
<tr>
<td>3,000 MW of additional imports from Québec and New Brunswick**</td>
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</tbody>
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* Offshore wind was assumed to have a capacity factor of 40.7 percent. Onshore wind outside of Maine was assumed to have a capacity factor of 35.4 percent, while onshore wind in Maine and New Brunswick was assumed to have a 29.3 percent capacity factor.

** Estimate does not include facilities in Québec and New Brunswick; only includes cost of potential transmission in New England.
Transmission Scenarios

• ISO developed 16 conceptual transmission scenarios
  – 13 scenarios to connect wind in New England, and
  – 3 scenarios to expand ties to neighboring regions

• Transmission scenarios developed as robust, workable solutions with cost estimates based on actual project experience
  – More detailed transmission studies would be required if the region pursues specific projects
  – New voltage classes may be needed for higher wind penetration scenarios (345 kV is the backbone of the existing system)
Transmission for 5,500 MW of Wind

- Potential transmission to connect 4,000 MW of offshore and 1,500 MW of near-shore onshore wind
- New transmission paths
  - New 345 kV line from Maine to Connecticut
  - New HVDC underwater cable from Maine to Boston
- Local loops to collect wind in Maine
- Preliminary cost estimate: $6 billion
Transmission for 3,000 MW of Imports

• Potential new transmission ties to Eastern Canada
  – Import 1,500 MW from Québec via new +/-450 kV HVDC line
    • Preliminary cost estimate: $1.6 billion
  – Import 1,500 MW from New Brunswick via new +/-450 kV HVDC line
    • Preliminary cost estimate: $2 billion
  – Cost estimates represent only the cost of potential transmission facilities in New England
Transmission for 12,000 MW of Wind

- New higher voltage backbone loop around New England
  - Local loops to collect wind in Maine
- Preliminary cost estimates:
  - 500 kV: $19 billion
  - 765 kV: $25 billion
Transmission for 10,000 MW via Midwest

- New 500 kV or 765 kV backbone loop from New York-New England border to load centers in southern New England

- Preliminary cost estimate: $20-$47 billion
  - Transmission reinforcements required to deliver power within New England, plus
  - ISO’s estimate of New England’s share of cost of building transmission from Midwest to NY-NE border
Economic Study: Highlights

• Region has significant renewable options nearby
  – New England has significant potential to develop onshore and offshore renewable resources and to expand trade with nearby Eastern Canada

• Transmission investment will be needed
  – Transmission will be needed to integrate renewable resources into the electric grid and deliver energy from remote areas to load centers

• Region has success building transmission
  – New England’s success developing major reliability projects is a solid platform for studies to evaluate additional transmission scenarios
  – ISO, New England transmission owners, and state officials play critical roles in transmission development