The Integrated Clean Capacity Market
A Design Option for New England’s Grid Transition

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PRESENTED TO
New England Power Pool

PRESENTED BY
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What is an “Integrated Clean Capacity Market”?  

**Design Concept:** Three-year forward market that attracts the optimal resource mix for reliability and state policy goals. Market would maintain key elements from today’s market, but would be a fit-for-purpose market for achieving the 80-100% clean electricity future.
How does the Integrated Clean Capacity Market compare to other options in consideration?

Any useful path forward for New England will have to include a package of at least one solution meeting both of the central design objectives:

**Solutions for Achieving Resource Adequacy Objectives**
- Energy-only market
- Integrated planning & contracting
- Forward capacity market

**Solutions for Achieving State Policy Objectives**
- Carbon pricing
- Integrated planning & contracting
- Forward clean energy market

**Integrated Clean Capacity Market** is a natural “package” for achieving a clean, reliable resource mix.
What is an “Integrated Clean Capacity Market”?

The Integrated Clean Capacity Market would be a centralized, three-year forward market for procuring capacity and clean energy needs.

**Demand**
- **Capacity**: ISO-NE establishes the quantity of capacity need (mandatory)
- **Clean Energy**: States & customers establish demand for unbundled clean energy attribute credits (CEACs)

**Co-Optimized Auction Clearing**
- Broad regional market
- Three-year forward auction
- Co-optimized procurement of unbundled capacity and CEACs
- 7-12 year price lock-in for new

**Supply**
- All resources can compete
- Fossil resources can sell only capacity
- Clean resources can sell both capacity and CEACs
# Key design elements

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Resource Adequacy Objectives</th>
<th>Clean Electricity Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Responsible Entity for Defining the Need</strong></td>
<td>• ISO New England</td>
<td>• State policymakers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Voluntary buyers (retailers, companies)</td>
</tr>
<tr>
<td><strong>Product Definition</strong></td>
<td>• Unforced capacity (UCAP MW)</td>
<td>• Clean energy attribute credit (CEAC)</td>
</tr>
<tr>
<td></td>
<td>• Keep locational specificity (as today)</td>
<td>• States would make an effort to align definitions into a uniform product to the extent possible (though multiple products would be accommodated as needed)</td>
</tr>
<tr>
<td></td>
<td>• Consider also specifying: separate summer and winter products &amp; “flexible” capacity needs</td>
<td>• Consider: “dynamic” CEAC product</td>
</tr>
<tr>
<td><strong>Supply Eligibility</strong></td>
<td>• All clean and fossil resources are eligible</td>
<td>• All clean resources are eligible for a “base” product</td>
</tr>
<tr>
<td></td>
<td>• ELCC-based accounting for resource-neutral capacity values (by location, season, and flexibility)</td>
<td>• All revenues are considered “in market”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• States can specify technology (but aim to limit the number and size to maximize competition)</td>
</tr>
<tr>
<td><strong>Quantity to Procure</strong></td>
<td>• Quantity needed to support 1-in-10</td>
<td>• States and customers decide the quantity needed</td>
</tr>
<tr>
<td></td>
<td>• Based on advanced reliability modeling that considers resource characteristics &amp; flexibility needs in the clean grid</td>
<td>• Pre-existing contracts are fully accounted for in this market as self-supply</td>
</tr>
<tr>
<td><strong>Willingness to Pay</strong></td>
<td>• Sloping demand curves for each capacity product</td>
<td>• States submit sloping demand curves for state-mandated CEAC demand</td>
</tr>
<tr>
<td></td>
<td>• Hierarchy of needs reflected in price formation (e.g. import-constrained and “flexible” capacity prices are equal or greater than system/traditional capacity prices)</td>
<td>• Voluntary buyers can submit price-quantity pairs to exceed state mandates</td>
</tr>
</tbody>
</table>
How might the capacity market need to evolve to align with the 80-100% clean electricity future?

<table>
<thead>
<tr>
<th>Continue to work well?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Broad regional market</td>
</tr>
<tr>
<td>• Unbundled products</td>
</tr>
<tr>
<td>• Technology-neutral competition</td>
</tr>
<tr>
<td>• Co-optimized, value-maximizing auction clearing</td>
</tr>
<tr>
<td>• Transmission constraints reflected</td>
</tr>
<tr>
<td>• Marginal-cost-based pricing</td>
</tr>
<tr>
<td>• Private sector takes most investment risk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Likely need evolution?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Incorporate a new design objective: policy goals</td>
</tr>
<tr>
<td>• Define separate summer and winter capacity products (separate demand and supply accounting)?</td>
</tr>
<tr>
<td>• Define “flexible” capacity requirements?</td>
</tr>
<tr>
<td>• Adopt more accurate supply accounting for all resources based on effective load carrying capability (ELCC) and accounting for plant outage rates</td>
</tr>
<tr>
<td>• Advanced reliability modeling for the clean grid</td>
</tr>
<tr>
<td>• Eliminate out-of-market interventions</td>
</tr>
<tr>
<td>• Fully enable all emerging technologies</td>
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</tbody>
</table>
Example: Integrated Clean Capacity Market Auction Clearing
Co-optimized procurement of capacity and clean energy

BIDS

Demand

- Capacity (MW)
- Clean Energy (CEACs)

Supply

- Total annual resource cost ($)
- Capacity quantity (UCAP MW)
- Clean attribute quantity (CEAC)

CO-OPTIMIZED AUCTION CLEARING

Similar to the FCM Clearing

- **Objective function**: Maximize social surplus (area under demand curves minus cleared resource cost)
- **Cleared resources**: Least cost resources for meeting capacity & CEAC demand
- **Price setting**: Marginal cost of meeting incremental demand

CLEARING RESULTS

- **Clearing Prices**
- **Cleared Resources**

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How is demand for capacity and clean energy expressed?

Separate demand curves would be used for each product:

**Capacity Demand Curve**
- Separate capacity demand curves for:
  - System & zones
  - Summer & winter
  - Traditional & flexible capacity

**Clean Energy Demand Curve**
- Separate clean energy demand curves for:
  - Each state
  - Technology carve-outs
  - Voluntary bids

Note: Simplified example. Not intended to reflect New England.
How would resources offer?

Offer structure is **one price for two products**

- Offer price is total annual going-forward revenue requirement
- Unbundled CEAC and UCAP products clear at different prices
- Seller is presumed indifferent whether revenues are earned from selling capacity or CEAC

**Example: Resource Offers**

<table>
<thead>
<tr>
<th>Type</th>
<th>Size (ICAP MW)</th>
<th>Qualified Capacity Rating (UCAP MW)</th>
<th>Qualified Clean Energy (CEAC GWh)</th>
<th>All-in Cost (less E&amp;AS Revenues) ($/ICAP kW-y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Gas</td>
<td>400</td>
<td>368</td>
<td>0</td>
<td>$48</td>
</tr>
<tr>
<td>New Gas</td>
<td>800</td>
<td>733</td>
<td>0</td>
<td>$66</td>
</tr>
<tr>
<td>Nuclear</td>
<td>200</td>
<td>180</td>
<td>1,577</td>
<td>$90</td>
</tr>
<tr>
<td>Solar</td>
<td>200</td>
<td>70</td>
<td>350</td>
<td>$60</td>
</tr>
<tr>
<td>Hydro</td>
<td>200</td>
<td>150</td>
<td>876</td>
<td>$96</td>
</tr>
<tr>
<td>Onshore Wind</td>
<td>300</td>
<td>96</td>
<td>788</td>
<td>$84</td>
</tr>
<tr>
<td>Offshore Wind</td>
<td>300</td>
<td>135</td>
<td>1,051</td>
<td>$156</td>
</tr>
<tr>
<td>Storage</td>
<td>250</td>
<td>230</td>
<td>438</td>
<td>$96</td>
</tr>
<tr>
<td>DR</td>
<td>60</td>
<td>60</td>
<td>0</td>
<td>$36</td>
</tr>
<tr>
<td>EE</td>
<td>40</td>
<td>40</td>
<td>0</td>
<td>$24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,750</strong></td>
<td><strong>2,062</strong></td>
<td><strong>5,081</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note: Simplified example. Not intended to reflect New England.
How are prices set?

Co-optimized price formation reflects marginal cost of each product.

- **Capacity Clearing**
  - Capacity Supply Curve (If resources earned no CEAC revenues)
  - Supply Curve (Accounting for CEAC revenues)
  - $4/kW-m

- **CEAC Clearing**
  - CEAC Supply Curve (If resources earned no capacity revenues)
  - Supply Curve (Accounting for capacity revenues)
  - $27/MWh

Note: Simplified example. Not intended to reflect New England.
What resources clear?

<table>
<thead>
<tr>
<th>Traditional Capacity Market</th>
<th>Integrated Clean Capacity Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleared Capacity UCAP MW</td>
<td>Cleared Capacity UCAP MW</td>
</tr>
<tr>
<td>Cleared CEACs GWh</td>
<td>Cleared CEACs GWh</td>
</tr>
</tbody>
</table>

- Wind
- Gas
- Hydro
- DR
- Storage
- Solar
- Nuclear
- Gas

Note: Simplified example. Not intended to reflect New England.
How could an Integrated Clean Capacity Market guide the energy transition?

Extended simplified example illustrates the different resource mix cleared as the quantity of required CEACs increases*

*Extended simplified example is identical to prior slides other than the quantity of CEACs required. A full time series analysis would consider how offer prices and UCAP values change over time.
Pros and Cons
Advantages and challenges to consider if pursuing an Integrated Clean Capacity Market

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Efficiency benefits of co-optimization</td>
<td>• Complexity</td>
</tr>
<tr>
<td>• Builds on demonstrated successes from the current capacity market (broad competition, ability to attract investment)</td>
<td>• Requires states and ISO to work together</td>
</tr>
<tr>
<td>• Flexible framework can accommodate variety of state preferences &amp; evolving reliability needs</td>
<td>• Governance</td>
</tr>
<tr>
<td>• Offer states an in-market solution to meet policy</td>
<td>• Transitional challenges to identify and mitigate near-term impacts on customers and existing resources</td>
</tr>
<tr>
<td>• Economically balance signals to attract new clean resources, retain flexible gas plants in transition, and prevent uneconomic oversupply of capacity</td>
<td></td>
</tr>
</tbody>
</table>
Appendix: Example Detail
# Example Detail: Integrated Clean Capacity Market Clearing

## Resource Offers and Clearing

<table>
<thead>
<tr>
<th>Offered Quantity</th>
<th>Existing Gas</th>
<th>New Gas</th>
<th>Nuclear</th>
<th>Hydro</th>
<th>Solar</th>
<th>Onshore Wind</th>
<th>Offshore Wind</th>
<th>Storage</th>
<th>DR</th>
<th>EE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAP (MW&lt;sub&gt;N&lt;/sub&gt;)</td>
<td>400</td>
<td>800</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>300</td>
<td>300</td>
<td>250</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>UCAP (MW&lt;sub&gt;C&lt;/sub&gt;)</td>
<td>368</td>
<td>733</td>
<td>180</td>
<td>150</td>
<td>70</td>
<td>96</td>
<td>135</td>
<td>230</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>CEACs (GWh/year)</td>
<td>0</td>
<td>0</td>
<td>1,577</td>
<td>876</td>
<td>350</td>
<td>788</td>
<td>1,051</td>
<td>438</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Offer Price ($/kW-m&lt;sub&gt;N&lt;/sub&gt;)</td>
<td>$4.0</td>
<td>$5.5</td>
<td>$7.5</td>
<td>$8.0</td>
<td>$5.0</td>
<td>$7.0</td>
<td>$13.0</td>
<td>$8.0</td>
<td>$3.0</td>
<td>$2.0</td>
</tr>
</tbody>
</table>

## Cleared Quantity

<table>
<thead>
<tr>
<th>Cleared Quantity</th>
<th>Existing Gas</th>
<th>New Gas</th>
<th>Nuclear</th>
<th>Hydro</th>
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<td>0</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>300</td>
<td>0</td>
<td>129</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>UCAP (MW&lt;sub&gt;C&lt;/sub&gt;)</td>
<td>341</td>
<td>0</td>
<td>180</td>
<td>150</td>
<td>70</td>
<td>96</td>
<td>0</td>
<td>119</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>CEACs (GWh/year)</td>
<td>0</td>
<td>0</td>
<td>1,577</td>
<td>876</td>
<td>350</td>
<td>788</td>
<td>0</td>
<td>226</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Percent Cleared (%)</td>
<td>93%</td>
<td>0%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>0%</td>
<td>52%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

## Revenues

<table>
<thead>
<tr>
<th>Revenues</th>
<th>CEACs (SM/year)</th>
<th>Capacity (SM/year)</th>
<th>Total (SM/year)</th>
<th>CEACs ($/kW-m&lt;sub&gt;N&lt;/sub&gt;)</th>
<th>Capacity ($/kW-m&lt;sub&gt;N&lt;/sub&gt;)</th>
<th>Total ($/kW-m&lt;sub&gt;N&lt;/sub&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEACs</td>
<td>$0</td>
<td>$18</td>
<td>$18</td>
<td>$0</td>
<td>$3</td>
<td>$4</td>
</tr>
<tr>
<td>Capacity</td>
<td>$0</td>
<td>$9</td>
<td>$8</td>
<td>$0</td>
<td>$3</td>
<td>$3</td>
</tr>
<tr>
<td>Total</td>
<td>($/kW-m&lt;sub&gt;N&lt;/sub&gt;)</td>
<td>($/kW-m&lt;sub&gt;N&lt;/sub&gt;)</td>
<td>($/kW-m&lt;sub&gt;N&lt;/sub&gt;)</td>
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<td>($/kW-m&lt;sub&gt;N&lt;/sub&gt;)</td>
</tr>
</tbody>
</table>

ICAP = Installed capacity  
UCAP = Unforced capacity  
CEAC = Clean Energy Attribute Credit  
N = Nameplate  
C = Capacity rating  

## System-Wide Results

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Cleared Quantity</th>
<th>Offered Quantity</th>
<th>Clearing Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,750 (MW&lt;sub&gt;N&lt;/sub&gt;)</td>
<td>1,500 (MW&lt;sub&gt;N&lt;/sub&gt;)</td>
<td>$4.3 ($/kW-m&lt;sub&gt;N&lt;/sub&gt;)</td>
<td></td>
</tr>
<tr>
<td>5,081 (GWh/year)</td>
<td>3,817 (GWh/year)</td>
<td>$27.4 ($/MWh)</td>
<td></td>
</tr>
</tbody>
</table>
Dr. Kathleen Spees is a principal at The Brattle Group with expertise in wholesale electricity markets design and environmental policy analysis.

Dr. Kathleen Spees is a Principal at The Brattle Group with expertise in designing and analyzing wholesale electric markets and carbon policies. Dr. Spees has worked with market operators, transmission system operators, and regulators in more than a dozen jurisdictions globally to improve their market designs for capacity investments, scarcity and surplus event pricing, ancillary services, wind integration, and market seams. She has worked with U.S. and international regulators to design and evaluate policy alternatives for achieving resource adequacy, storage integration, carbon reduction, and other policy goals. For private clients, Dr. Spees provides strategic guidance, expert testimony, and analytical support in the context of regulatory proceedings, business decisions, investment due diligence, and litigation. Her work spans matters of carbon policy, environmental regulations, demand response, virtual trading, transmission rights, ancillary services, plant retirements, merchant transmission, renewables integration, hedging, and storage.

Dr. Spees earned her PhD in Engineering and Public Policy within the Carnegie Mellon Electricity Industry Center and her MS in Electrical and Computer Engineering from Carnegie Mellon University. She earned her BS in Physics and Mechanical Engineering from Iowa State University.