ISO-NE ELCC STUDY: FINDINGS AND RECOMMENDATIONS

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NRDC’s Perspective on RCA Reforms

NRDC supports fair and robust accounting for the reliability contributions of both clean and conventional resources

The Resource Capacity Accreditation (RCA) decisions ISO-NE makes will impact whether FCM helps achieve:

- **Accurate Resource Adequacy:** a reliable grid that avoids retaining unneeded legacy resources
- **A Level Playing Field:** equitable and robust accreditation for all resources
- **Fair Allocation of Benefits:** fair compensation of state-level value creation from clean resource development
- **State Decarbonization Targets:** integration of ISO-NE’s markets with state-level policy, planning, and procurements

As noted in our [August 9 presentation](#), NRDC engaged GE Energy Consulting to provide quantitative analysis of key RCA methodology decisions in ISO-NE, which is the focus of our presentation today.
The NRDC-GE study evaluated the impacts of different RCA methodology decisions on 2028 and 2040 ISO-NE resource portfolios, as the region decarbonizes, using an Effective Load Carrying Capability (ELCC) approach.

As discussed in further slides, we found that:

1. The growing portfolio of clean energy resources will provide substantial reliability value.
2. Capturing thermal limitations is key to ensuring reliability and equity.
3. Average and marginal RCA approaches produce markedly different incentives and equity outcomes.
4. Reliability outcomes across summer and winter seasons are highly sensitive to input assumptions.
5. Other policy choices, such as EUE/LOLE, have significant implications.
Overview: RCA Reform Recommendations

Based on these findings, we recommend:

1. **Clean Energy**: Ensure the RCA market design appropriately reflects the reliability contributions of clean energy resources, including solar, wind, and storage, and the interactive effects between resources.

2. **Thermal Resources**: Ensure the RCA market design and modelling assumptions reflect the realities of thermal limitations, including correlated outage risk due to fuel supply constraints and ambient derates.

3. **Average vs. Marginal**: Thoroughly examine the policy and efficiency benefits and trade-offs between marginal and average RCA approaches, as well as potential hybrid approaches, before moving forward with a final structure.
Based on these findings, we recommend:

4. **Annual vs. Seasonal**: Consider the trade-offs between an annual and seasonal FCM and RCA in the context of ISO-NE’s near-term transition to a dual-peaking and, later, winter-peaking system.

5. **Other Parameters**: Consider the impacts and durability of other key RCA design features and assumptions, including choice of reliability metric (LOLE vs. EUE) and the impacts of climate change.
ISO-NE ELCC STUDY
APPROACH AND DESIGN

EDUARDO IBANEZ, TECHNICAL DIRECTOR, GE ENERGY CONSULTING
GE Energy Consulting constructed a model of ISO-NE in GE MARS, using publicly available resources.

Two years were simulated:
- 2028: one of the first capacity years that would be affected by new accreditation
- 2040: to capture longer trends, especially increasing amounts of renewables and storage (model to match base case scenario in ISO-NE’s Pathways study)

Applied ELCC calculations to the model to study:
- Marginal ELCC
- Class average ELCC
- Portfolio ELCC

A list of sensitivities were considered, to study the impact of major assumption changes on the results.

Impacts on capacity value were studied for:
- Thermal units
- Utility-scale solar PV, onshore wind, offshore wind, and battery storage
GE Multi-Area Reliability Simulation (GE MARS)

GE MARS is a full sequential Monte Carlo simulation, and the chronological representation of the system includes:
- Equipment forced outages
- Uncertainty in forecasted loads
- Transmission interface forced outages and contracts
- Uncertainty in renewable and storage output

GE MARS calculates several reliability indices, but in this study we focused on:
- Daily loss of load expectation (LOLE) in days/year
- Expected Unserved Energy (EUE) in MWh/year

A wide range of unit types are supported by GE MARS:
- Thermal units
- Co-generation
- Energy-limited units
- Hourly-based generation units (such as wind or solar)
- Energy storage units

This study ignored internal transmission constraints in the ISO-NE and external assistance from neighboring regions
Effective Load-Carrying Capability (ELCC) Technique

Capacity values were calculated using the ELCC technique

Capacity value for resources can be estimated in several ways, amongst others:

- **Marginal ELCC**: Marginal reliability benefit of the next incremental unit
- **Class average ELCC**: Average reliability contribution of all the resources of a single class
- **Portfolio ELCC**: Reliability contribution of resources across multiple classes (e.g., solar, wind, and battery storage)
- **Vintaged Marginal ELCC**: Marginal reliability benefit of the resource when installed (static over time)

Portfolio ELCC captures synergistic contributions between different classes (e.g., solar and battery storage) that would not be captured by the individual class average ELCC values.

Certain resources can present saturation effects, and class average will decline with deployment; in those cases:

\[
\text{Marginal ELCC} < \text{Average ELCC}
\]

Vintaged Marginal ELCC is shown here for illustrative/comparative purposes but was not considered in this study.
GE Energy Consulting’s standard model for ISO-NE, which utilizes publicly available data from FERC, NERC, NPCC, and ABB’s Velocity Suite, was used as the starting point.

Deployment of solar, wind, batteries was adjusted to match the main scenario in ISO-NE’s Pathways study.*

Historical load data for 7 years (2007-2013) was used to represent weather variability.

Hourly renewable profiles were generated and matched the load weather years (2007-2013):
- Onshore and onshore wind profiles were based on NREL’s Wind Integration National Dataset Toolkit
- Utility-scale and distributed solar PV profiles were based on the National Solar Radiation Database

All storage units were assumed to be able to hold 4-hours of energy (e.g., a 100-MW unit can hold 400 MWh).

Three sensitivities were used to capture impacts:

- Sensitivity 1: Gas supply risk
- Sensitivity 2: Impact of ambient temperature
- Sensitivity 3: Higher levels of electrification

Additionally, throughout the study we captured the impact of using different reliability metrics to calculate capacity value:

- Daily loss of load expectation (LOLE) in days/year
- Expected unserved energy (EUE) in MWh/year
Sensitivity 1: Gas Supply Risk

• The goal was to measure the impact that restrictions on non-firm gas supply could have on system reliability and capacity values across classes.

• Three different levels of gas outages were considered as sensitivities:
  - Loss of 40% of gas unit capacity (3,700 MW*)
  - Loss of 50% of gas unit capacity (4,635 MW)
  - Loss of 60% of gas unit capacity (5,562 MW+)

• Along with the severity of the outage, we considered increasing durations of that outage around the winter peak day of:
  - 1 week
  - 2 weeks
  - 4 weeks

• All combinations were studied; the Base Case assumed a 1-week outage at 40% derate.


The study considered the impact of including derates in thermal unit capacity due to higher ambient derates.

Derate assumptions adapted from a recent EPRI study* and applied based on unit type.

In the worst-case scenario (above 35°C, or 95°F), this represented a loss of 1,300 MW.

### Sensitivity 2: Impact of Ambient Temperature

<table>
<thead>
<tr>
<th>Generator type</th>
<th>Ambient temperature (°C)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Combined cycle</td>
<td>0</td>
</tr>
<tr>
<td>Combustion turbine</td>
<td>0</td>
</tr>
<tr>
<td>Diesel</td>
<td>0</td>
</tr>
<tr>
<td>Hydro/PS</td>
<td>0</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0</td>
</tr>
<tr>
<td>Steam turbine</td>
<td>0</td>
</tr>
</tbody>
</table>

The historical weather shapes (2007-2013) do not capture how load patterns are expected to evolve in the future, especially as electrification increases.

We used data from NREL’s Electrification Future Study to develop load modifications.

Figure below shows the effect on average day per season in 2040:
  - Electrification increases peak load values
  - Changes are not uniform across seasons
MODELING TAKEAWAYS: KEY FINDINGS AND RECOMMENDATIONS

NICK PAPPAS, NP ENERGY (CONSULTANT TO NRDC)
Finding 1: Reliability Contributions of Clean Resources

Achieving the clean resource development identified in the Pathways report would result in significant reliability contributions from the clean resource fleet:

- Utility-scale solar, wind, and storage capacity can meet:
  - 21% of ISO-NE’s gross peak in 2028 (5,388 MW PCAP)
  - 44% of ISO-NE’s gross peak in 2040 (12,460 MW PCAP)

- Solar and wind energy can meet:
  - 34% of ISO-NE’s energy needs in 2028
  - 65% of ISO-NE’s energy needs in 2040

- Including hydro, nuclear, and distributed PV:
  - 61% of ISO-NE’s energy needs in 2028
  - 90% of ISO-NE’s energy needs in 2040

**Recommendation 1:** Ensure the RCA market design appropriately reflects the reliability contributions of clean energy resources, including solar, wind, and storage, and the interactive effects between resources
Finding 2: No Resource is Perfect (Capacity), Including Thermal

Thermal resources face various use limitations, including correlated outages, ambient derates, and fuel supply risk, all of which should be included to accurately assess thermal reliability contributions.

• Ambient Derates at 95°F:
  ➢ Fossil resource output can decline by 4-7%
  ➢ Nuclear output can decline by almost 10%

• Fuel Supply Risk:
  ➢ Significant but uncertain; ELCC penalty is function of magnitude and duration (input assumptions)
  ➢ Severe supply outage can have major impacts on marginal ELCC value of gas units

Further analysis and input refinement is critical: Fossil risk drives reliability modeling results, seasonal LOLE variability, and market outcomes.

Recommendation 2: Ensure the RCA market design and modelling assumptions reflect the realities of thermal limitations, including correlated outage risk due to fuel supply constraints and ambient derates.
Finding 3: Major Gaps Between Average and Marginal Accreditation

At high penetrations, average and marginal accreditation have vastly different results for clean energy resources:

2028 Capacity Awards for RE + Batteries:
- **Average**: 5,388MW
- **Marginal**: 3,173MW
  - **Missing Megawatts**: 2,215MW (41%)

2040 Capacity Awards for RE + Batteries:
- **Average**: 12,460MW
- **Marginal**: 6,005MW
  - **Missing Megawatts**: 6,455MW (52%)

Socializing over half of the total reliability contributions of clean resources could result in a reduced market signal for reliability in clean resource selection and development.

**Recommendation 3**: Thoroughly examine the policy and efficiency benefits and trade-offs between marginal and average RCA approaches, as well as potential hybrid approaches, before moving forward with a final structure.
Recent analysis from E3* identified major shifts in revenue sources for renewables and storage on a net zero system:

- Renewable revenue would need to come largely from payments outside current markets (e.g., clean attribute payments under state policies, Forward Clean Energy Market, etc.)
- Storage revenue would need to come largely from capacity awards
- While not specific to ISO-NE, directional trends are likely to be consistent across decarbonizing regions

If storage resources are accredited on a marginal basis, reducing their capacity awards by approximately half relative to the fleet’s PCAP contribution, will other out-of-market payments be necessary to incentivize storage development?

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Finding 3 (continued): The “Missing Money” for Clean Resources

Understanding the timing and nature of reliability events is critical to ensuring accurate ELCC accreditation—assumptions about the distribution of outages between seasons will have significant impacts on ELCC results, particularly marginal ELCC:

**Seasonal Distribution of Outages by Modeled Fuel Supply Risk Event:**
- The share of outages occurring in winter is moderate, but present, in all fuel risk scenarios
- The share of outages occurring in winter is substantial at longer outage durations

Accurately identifying when and why outages occur will have outsized impact on marginal ELCC results

**Recommendation 4:** Consider the trade-offs between an annual and seasonal FCM and RCA in the context of ISO-NE’s near-term transition to a dual-peaking and, later, winter-peaking system
ELCC results are also highly sensitive to other input assumptions, including the choice of reliability metric, impacts of electrification, and impacts of climate change.

Reliability Metric:
- Loss of Load Expectation (LOLE) and Expected Unserved Energy (EUE) are related but distinct reliability metrics which will calibrate differently and produce different ELCC results, particularly for marginal ELCC.

Peak Load and Load Shapes:
- Future load is unpredictable, and will shift in magnitude and shape as electrification, climate change, and behind-the-meter resource development occur.
- Differing assumptions for each of these inputs can result in significantly different ELCC Results.

Recommendation 5: Consider the impacts and durability of other key RCA design features and assumptions, including choice of reliability metric (LOLE vs. EUE) and the impacts of climate change.
Summary of Recommendations

1. **Clean Energy**: Ensure the RCA market design appropriately reflects the reliability contributions of clean energy resources, including solar, wind, and storage, and the interactive effects between resources.

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