Future Grid: Review of Past/Ongoing and Proposed Studies

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NEPOOL Markets and Reliability Committee Meeting

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Introduction

- MC/RC requested review of certain past/ongoing studies for potential to inform future grid study to be developed ("Future Grid Study"). Request was to identify objectives/questions asked in each study and potential for analysis and model to be used in Future Grid Study. To advance discussions, we also looked at the Future Grid Study request proposals.

- Observations on studies and proposals are from NEPOOL counsel; final word on them is for those who conducted, commissioned, or proposed the studies.

- Six past/ongoing studies were identified for examination: (1) 2016 NEPOOL Economic Study; (2) 2019 NESCOE Economic Study; (3) Massachusetts 2050 Roadmap Effort; (4) Eversource "Grid of the Future" Study; (5) E3/EFI "Electric Reliability under Deep Decarbonization" Study; and (6) 2019 Brattle Group "Achieving 80% GHG Reduction in New England by 2050" Study.

Overview of Analysis

- The slides below look at:
  - Scope of Future Grid Study effort, based on the “Bubble” Chart* that was presented at the March 5, 2020 NPC meeting
  - The objectives, overall purpose, subordinate questions asked, scenarios and modeling used for each past/ongoing study; specific observations
  - General observations regarding the past and ongoing studies
  - Observations regarding the proposals for the Future Grid Study
  - Final comments

* The “Bubble” Chart is Agenda Item 5 from the March NPC Meeting. To access, please click here.

Scope of Study Effort (from "Bubble" Chart)

- Objective: Assess and discuss future state of the regional power system in light of current state energy and environmental policies.

- Study Process to Define and Assess Future State of Regional Power System: 1. Identify Resource Mix in [Year]; 2. Identify Resource & Operational/Reliability Needs

  *Assumptions, future scenarios, etc. to be developed within stakeholder process.

- Gap Analysis: As part of study process, conduct a gap analysis to determine whether, in the future state envisioned, the markets (current design plus ESI) provide resources/ISO-NE what they need to continue to reliably operate the system? If not, what market deficits need to be addressed to assure reliability?

- Discuss Potential Market Approach(es) to Address Gap(s): Based on study results/gap analysis, explore potential market approaches to address any future gaps identified in the prior step, including evaluation of the pros/cons of different approaches and discussion of how any such market approach contemplates state energy and environmental laws.

  {Note: Identification and discussion of potential future pathways/market frameworks is currently on a separate track at the NPC.}

2016 NEPOOL Economic Study, Phase I

Objective and Overall Purpose	
Subordinate Questions	revenues to the fixed costs for generic new generation total regional emissions under alternative scenarios

2016 NEPOOL Economic Study, Phase I

Scenarios	four scenarios did not seem especially relevant to the Future Grid Study.
Modeling	calculates least-cost transmission-security-constrained unit commitment and economic dispatch under differing sets of assumptions and minimizes production costs for a given set of unit characteristics
Note	In 2017, the Conservation Law Foundation requested an Economic Study of NEPOOL Scenario 3 to make it an emissions-compliant scenario. Also requested three other scenarios:“ EE + Offshore ,“ Onshore Less EE/PV , and“ Wind Less found by searching“ 2017 Economic Study in the ISO-NE website.

2016 NEPOOL Economic Study, Phase II

Overall Purpose	**Evaluate physical quantities of ramping, reserves, and regulation that could be needed to meet environmental policy goals**
Modeling	ElectricPower Enterprise Control System (EPECS) simulator was developed to address the multi-time scale nature of renewable energy integration. It consists of four simulation layers: EPECS assessed:
Note	these items were not the focus of Phase II

Observations on NEPOOL Study

- Study completed
- Looked at both economic and operational consequences of future grid scenarios
- Looked at two year snapshots in relatively near horizon: 2025 and 2030; would need to be extended
- Not intended to backcast from future grid to how we get there
- Economic modeling done by ISO-NE using Gridview tool available to the ISO; operational modeling (regulation, ramping and reserves) done by outside consultant using Electric Power Enterprise Control System (EPECS) simulation tool; FCM and gas constraint modeling done by outside consultants
- Of the six scenarios, Scenarios 3 and 6 seem more consistent with and in the scope of the intended Future Grid Study; would need to be updated/supplemented in significant ways (e.g., did not look at electrification of building and transportation sectors; did not consider all current emissions compliance requirements). Could supplement with 2017 CLF Economic Study.

2019 NESCOE Economic Study

<table>
<tr><td>Objective and Overall Purpose</td><td>Study the interconnection of as much as 8,000 MW (nameplate) of new offshore wind resources off the coast of southern New England by 2030</td></tr>
<tr><td>Subordinate Questions</td><td>additional offshore wind resources, at different points of interconnection into southeastern New England, and to estimate transmission upgrade costs associated with these conceptual configurations</td></tr>
<tr><td>Scenarios (Offshore Wind Additions (Nameplate) with 1,000 MW of RFP-committed)</td><td>
<table>
<tr><th>NESCOE Year 2030</th><th>Gross Demand</th><th>Energy Efficiency</th><th>Behind-the-Meter PV (Nameplate)</th><th>Utility Scale PV (Nameplate)</th><th>Supply (incl. Demand Resources)</th><th>Retirements</th><th>RFP Committed Generation</th><th>Off-Shore Wind Additions (Nameplate)</th><th>Demand from Heat Pumps</th><th>Demand from Electric Vehicles</th><th>Battery Storage Additions</th></tr>
<tr><td>NESCOE_2000</td><td colspan="4" rowspan="5">Based on 2019 CELT Forecast</td><td rowspan="5">2019 CELT generators and cleared FCA 13 resources</td><td rowspan="5">FCA 13 and Mystic 8&9</td><td rowspan="5">NECEC (1,090 MW of firm import)
1,000 MW of off-shore wind (nameplate)[1]</td><td>1,000 MW</td><td rowspan="2">None</td><td rowspan="5">550,000 vehicles</td><td rowspan="5">2,000 MW</td></tr>
<tr><td>NESCOE_3000</td><td>2,000 MW</td></tr>
<tr><td>NESCOE_5000</td><td>4,000 MW</td></tr>
<tr><td>NESCOE_6000</td><td>5,000 MW</td><td rowspan="2">2,050 MW</td></tr>
<tr><td>NESCOE_8000</td><td>7,000 MW</td></tr>
</table>
[1] Includes Vineyard Wind (800 MW) and Revolution Wind (200 MW)
</td></tr>
<tr><td>Modeling</td><td>system was modeled at the zonal level, and New England was modeled as a constrained single area for unit commitment. The 2030 transfer capabilities for internal and external transmission interfaces were based on the values established for 2025 for FCM and regional planning studies.

interconnection analysis was performed at the feasibility level with a handful of solution concepts

system operating requirements associated with the 2016 Economic Study.</td></tr>
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Observations on NESCOE Study

- Study completed, but no transmission cost estimates were provided; the ancillary services analysis used the NEPOOL study scenarios
- Focused on interconnection of offshore wind additions only
- Geographically limited to southern New England offshore wind
- Included both an economic analysis and a conceptual level transmission analysis, both done by ISO using available tools
  - Provides analysis of system emissions estimates associated with increasing levels of off-shore wind
- Also included some operational effects analysis (regulation, ramping and reserves capability) using same outside consultant and modeling tool and scenarios as for the NEPOOL operational study
  - Directionally indicative due to scenario assumptions
- Time frame limited to 2030
- Not fully consistent with scope of Future Grid Study because of limited focus, but possibly could be used as a component of a larger Future Grid Study to examine the offshore wind piece

Massachusetts 2050 Roadmap Effort

Overall Purpose	**Identify the strategies, policies, and implementation pathways for MA to achieve“ net sequestration), and the priorities to achieve an interim goal by 2030**
Subordinate Questions	achieve deep, permanent GHG emissions.
Scenarios	an 85% reduction below 1990 levels. Northeast (NY, New England, Maritimes) is moving together towards IPPC-compliant emissions targets. product, various levels regional coordination and OSW deployment, availability of thermal electricity generation, fully-renewable primary energy supply.
Modeling (Evolved Energy Research)	demand scenarios (additional information here). electricity generation and balancing, alternative fuel production, and direct air capture (additional information here).

Observations on MA Study

- Draft study report release expected mid- to late-Sept. (published in final in Dec.)
- Includes granular data for all commercialized energy supply technologies, and 363 demand-side technologies in 5-year time-steps based on 8,760 integrated dispatch modeling for entire Northeast.
- **Approach is to start with the goal (net zero by 2050) and develop a range of cost-effective technical supply and demand portfolios capable of achieving it**
- Method – Bottom up backcasting to explore wide range of compliant scenarios:
  - 1. Underlying drivers of energy demand advanced to 2050 levels;
  - **2. Design system to reliably meet 2050 energy demand at required emissions level across the economy—all sectors, all fuels;**
  - 3. Work back to 2020 with attention to stock rollover timing to minimize stranded asset costs;
  - 4. Pathway scenarios are designed to test the system and gain insight into low-carbon system dynamics and cross-sector inter-dependencies across more than a half-dozen Global Warming Solutions Act-compliant futures; and
  - 5. Produce very granular data (hourly dispatch; 5-year capacity time-step) data to enable decision-making re: implementation
- Modeling tools: EnergyPATHWAYS is open-source but RIO is not
- Some of the data/analysis/assumptions could be useful to the Future Grid Study, including to help establish assumptions and identify gaps; seems to focus on how to achieve an end state goal; not completed; uses a proprietary modeling tool ISO would need to obtain or hire third party

Eversource's "Grid of the Future" Study

Overall Purpose	**Analyze the impact of decarbonization policy on the electric grid out to 2050; quantify electric system changes needed to meet regional carbon emission reduction targets**
Subordinate Questions	
Scenarios	scenarios assume achievement of 80% economy-wide GHG reduction below 1990 levels by 2050 reduction below 1990 levels by 2050
Modeling	Comprehensive industry research and hourly economic simulations for the next three decades; hourly simulations run by London Economics using POOLMOD, a proprietary modeling tool
Preliminary Results	the timing of peak load, resource adequacy needs for dispatchable resources, etc. in a need for focus on Grid operations and planning to ensure reliability and cost effectiveness

Observations on Eversource Study

- Study is ongoing
- Looks at how decarbonization efforts across the economy will impact energy system dynamics in New England
- Focus is on supply mix, demand changes, hourly supply and demand dynamics, total cost of supply, clearing prices, and total cost to load.
- Looks out to 2050 but scenarios focus on 2030 and 2040
- Deliverables include multiple scenarios with detailed information on supply, demand, storage, and transmission that successfully achieve regional decarbonization targets
- Uses POOLMOD as a modeling tool, a proprietary model that simulates security constrained dispatch in ISO-NE
- Seems consistent with scope of intended Future Grid Study; scenarios might need to be extended to 2050; modeling tool might not be available to ISO- ISO would need to obtain or hire third party

E3/EFI "Electric Reliability under Deep Decarbonization"

Overall Purpose	**Analyze whether New England can provide affordable, reliable power under future scenarios that achieve net zero economy-wide GHG emissions by 2050**
Subordinate (Corollary) Questions	successful in New England, given weather, policy, economics, etc.? other sectors by 2050? adequacy needs through 2050 while achieving economy-wide GHG goals? How much firm capacity is needed in the medium to long-term, and how substitutable renewable generation is for firm dispatchable capacity
Scenarios and Modeling	designed to meet 2050 economy-wide decarbonization goals cost resource portfolios to meet GHG targets

Observations on E3/EFI Study

- This study is not yet finalized
- Study looks out to 2050
- Includes a first step that seems to focus on how to achieve 2050 goals
- Uses a RESOLVE model to develop least-cost resource portfolios to meet GHG targets
- Uses a New England RECAP model to tests the resource adequacy of the supply resource portfolios
- Includes some conceptual transmission constraints/cost analysis
- Some of the data/analysis/assumptions could be useful to the Future Grid Study, including to help establish assumptions and identify gaps; seems to focus partly on how to achieve an end state goal; not completed; uses a proprietary modeling tool ISO would need to obtain or hire third party

2019 Brattle Group "Achieving 80% GHG Reduction in New England by 2050" Study

Overall Purpose	**Estimate whether and how much clean energy resource additions in New England need to accelerate to achieve the 2050 decarbonization goals**
Subordinate Questions	emissions (transportation, residential heating, and commercial heating)?
Scenarios	
Modeling	Decarbonized Energy Economy (DEEP) Model is an economy-wide energy and emissions model designed to investigate the implications of decarbonization policies. DEEP includes a bottom-up analysis of electrification and other approaches, such as energy efficiency, to achieve decarbonization mandates and simulates how these changes impact hourly electric load. DEEP then identifies investments in clean resources (e.g., renewables) and dispatchable resources (e.g., combustion turbines or battery storage) to reliably balance and operate the system. It is designed for rapid investigation of many scenarios and sensitivities.

Observations on Brattle Study

- Study is completed
- Looks out to 2050
- Asks what supply resource changes need to occur to achieve a specific goal: 80% GHG reduction by 2050 relative to a 1990 baseline
- Includes some analysis of reliability resource needs but not an in depth analysis of reliability gaps or transmission
- Uses a model proprietary to the Brattle Group; ISO-NE would need to obtain or hire third party
  - DEEP ("An economy-wide energy and emissions model designed to investigate the implications of decarbonization policies. DEEP includes a bottom-up analysis of electrification and other approaches, such as energy efficiency, to achieve decarbonization mandates and simulates how these changes impact hourly electric load.")
- Although this study seems to focus on how to achieve an end state, some of its data/analysis could be useful

General Observations on Past Studies

- The past/ongoing studies that seem most consistent with the scope of the intended Future Grid Study are the:
  - NEPOOL Economic Study (would need updating and supplementing, perhaps with 2017 CLF Economic Study)
  - Eversource's "Grid of the Future" Study
  - E3/EFI "Electric Reliability under Deep Decarbonization" Study

- Some of the data/analysis/assumptions from the Massachusetts 2050 Roadmap Effort study and the Brattle Group study could be useful to the Future Grid Study, including to help establish assumptions and identify gaps; seem to focus on how to achieve an end state goal; MA study not completed; each uses modeling tools that ISO does not have

- The NESCOE study is more limited in scope and would provide only a part of the analysis/information being sought in the Future Grid Study.

Observations on Proposed Studies

- The following slides provide initial, high-level observations on the nine proposed studies* that were considered at the August 4, 2020 MC/RC meeting.

- The observations are from NEPOOL counsel only and are intended to facilitate further discussion of the proposals and how they might fit into the intended Future Grid Study.

* To view the proposed study requests, please click here.

Observations on Proposed Studies

- The National Grid proposal seems generally consistent with the scope but has a transmission/storage focus (using bi-directional, controllable transmission for purposes of leveraging energy storage between New England and Quebec). Mentions 2035 values; not sure it extends to 2050. Unclear whether it would identify reliability gaps. Would use modeling tools that include Gridview, steady-state power flow and a tool for forecasting FCA clearing prices. Proposal to consider impact of bi-directional, controllable transmission to external regions could probably be included as a scenario in various other studies.

- The Eversource proposal seems like a complete economic and reliability study and consistent with the intended scope of the Future Grid Study. The modeling tools associated with it (Gridview and GE MARS) are used by the ISO.

Observations on Proposed Studies

- Some of the proposals seem to have a more limited focus that could be worked into a larger study, or potentially could be used as change cases/scenarios/sensitivities, but are not necessarily proposals for a full Future Grid Study on their own, including:
  - EMA: Focuses on two interconnection cases (capacity interconnection and minimum interconnection) and how these impact markets/operations
  - FirstLight: Focuses on certain considerations for storage in the assumptions and modeling
  - Multi-Sector Group A: Focuses on the impact on needs for ramping, regulation and load-following resources of a 2050 decarbonized future grid; does not include an economic analysis. Would build upon NEPOOL Phase 2.
  - Multi-Sector Group B: Focuses on a transmission system assessment of a 2050 decarbonized future grid
  - NextEra/Dominion: Focuses on loss of Seabrook and Millstone nuclear

Observations on Proposed Studies

- NESCOE submitted a “pathway” scenario that would look at the years 2035 and 2040 under certain electrification assumptions. Seems like it could work into a larger study as a scenario to be considered.

- The Anbaric proposal seems outside the scope of the intended Future Grid Study because it identifies a goal and then studies how to achieve it. Possibly could be used for assumptions that go into the study, identification of reliability gaps, or sensitivities to the study, rather than the focus of the study.

Final Comments

- Project administrator, working with NEPOOL, NESCOE and the ISO, can facilitate further stakeholder consideration of:
  - What can and should be used from past/ongoing studies
  - What needs to be updated/supplemented from those studies
  - Consolidation of proposed studies into an integrated proposal consistent with the intended scope of the Future Grid Study
  - What modeling tools/services should be used and their availability
  - Perhaps next step should be to develop a straw proposal for a study using the input from study proponents and from past/ongoing studies, consistent with the intended scope of the Future Grid Study