NESCOE
New England States Committee on Electricity

Transition to the Future Grid:
Preliminary Discussion of Study-related Process

On March 5, 2020, the NEPOOL Participants Committee expressed strong and uniform interest in advancing in the nearest term discussion about analysis of the future state of the regional power system in light of current New England state energy and environmental laws, referred to as *Transition to the Future Grid*.[1]

NESCOE appreciates NEPOOL's broad expressions of support for New England to move forward to analyze our power system and market structures in contemplation of the foreseeable and binding requirements of law and to do so on a firm calendar that is established in-region.

Since the March 5th meeting, world health challenges have arrived in force in New England. Health and human safety take priority.

ISO-NE is rightly focused on maintaining our power grid and being vigilant in protecting its employees who are indispensable to that end.

Similarly, various personnel of market participants that together keep the lights on in New England are also focused on maintaining essential services and doing so in a way that puts employees' health first.

State governments and officials are likewise focused on supporting core public services, including the reliability of the electric power system and consumer protections.

With gratitude for this priority focus, and in furtherance of NEPOOL members' expression of interest in beginning the *Transition to the Future Grid* discussion in technical committees, NESCOE has prepared some material to enable a continuation of our regional conversation in April. Further, in recognition of ISO-NE's and various market participants' attention on current

[1] Last summer, NESCOE and, separately, various market participants requested that ISO-NE plan to allocate market development and planning resources in 2020 to support states and stakeholders in analyzing and discussing potential future market frameworks that contemplate and are compatible with the implementation of state energy and environmental laws. See http://nescoe.com/wp-content/uploads/2019/07/WorkPlan2020Request_16July2019.pdf.

operational matters, NESCOE offers to present preliminary material to facilitate others' reaction and discussion at subsequent meetings.

NESCOE provides the following materials and offers to present them to the NEPOOL Joint Markets and Reliability Committees in April:

1. Some preliminary process-oriented ideas about the *Future Grid Study* in response to NEPOOL members' broad expressions of interest in an inclusive and transparent study process.
2. A draft conceptual study schedule that highlights steps and milestones.
3. A very high-level summary of carbon reduction-related studies conducted in 2018-2019 by diverse interests.

In addition to giving a high-level overview of recent relevant studies and outputs as they relate to the Future Grid Study (item no. 3, above), NESCOE offers to give a staff sense of ISO-NE study tools and outputs as they relate to the Future Grid Study and would welcome hearing market participants' views of the same in April and at subsequent committee meetings.

To be clear, all the materials are preliminary and offered for the purpose of facilitating reactions, questions and discussion at subsequent meetings. We hope this is helpful in bringing forward constructive feedback that will help move the process ahead. Please note that none of the materials reflect the views of NESCOE or any NESCOE Manager. Indeed, NEPOOL's feedback may help inform those views.

Finally, nothing in this material is intended to imply a view about NEPOOL processes and none should be inferred.

SOME IDEAS TO FACILITATE AN INCLUSIVE AND TRANSPARENT FUTURE GRID STUDY

Preliminary and for discussion only
Does not represent the views of ISO-NE, NEPOOL, NESCOE or any NESCOE Manager

A. Contract Management and Transparency

- Consultant will be retained by ISO-NE to conduct analysis for ISO-NE, States and NEPOOL Participants (together, "New England Study Group")
    - Consultant will sign a non-disclosure agreement (NDA) with ISO-NE in connection with confidential information, data, etc.
    - Throughout the study and modeling process, Consultant will bring input/modeling options directly to the New England Study Group, which will jointly determine direction according to the provisions below.
    - States, ISO-NE, and NEPOOL Participants will not have input opportunities to the consultant outside of the process described below to allow for contract management, cost containment and transparency.

B. Process for Consultant Direction

- The process for New England Study Group to provide direction to the consultant is as follows:
    - New England Study Group will discuss the study and its elements at joint NEPOOL Markets and Reliability Committee meetings ("MC/RC meetings"). New England Study Group will not have input opportunities to the study outside of the MC/RC meetings to allow for contract management, cost containment and transparency (without limiting consultant's practical need to obtain information or data).
    - The consultant will present modeling options with pros and cons and information about implications of such options, along with the consultant's independent recommendation and the basis for it, at MC/RC meetings for New England stakeholder discussion.
    - New England Study Group may suggest alternatives to the consultant's recommendation at MC/RC meetings. Consultant will retain authority to decline to adopt alternatives if such alternative is impossible or in the consultant's independent professional judgment would materially and adversely affect the study objectives. If the Consultant declines to adopt alternatives, consultant will provide an explanation in writing and discuss with the RC/MC upon request.

C. Voting Structure

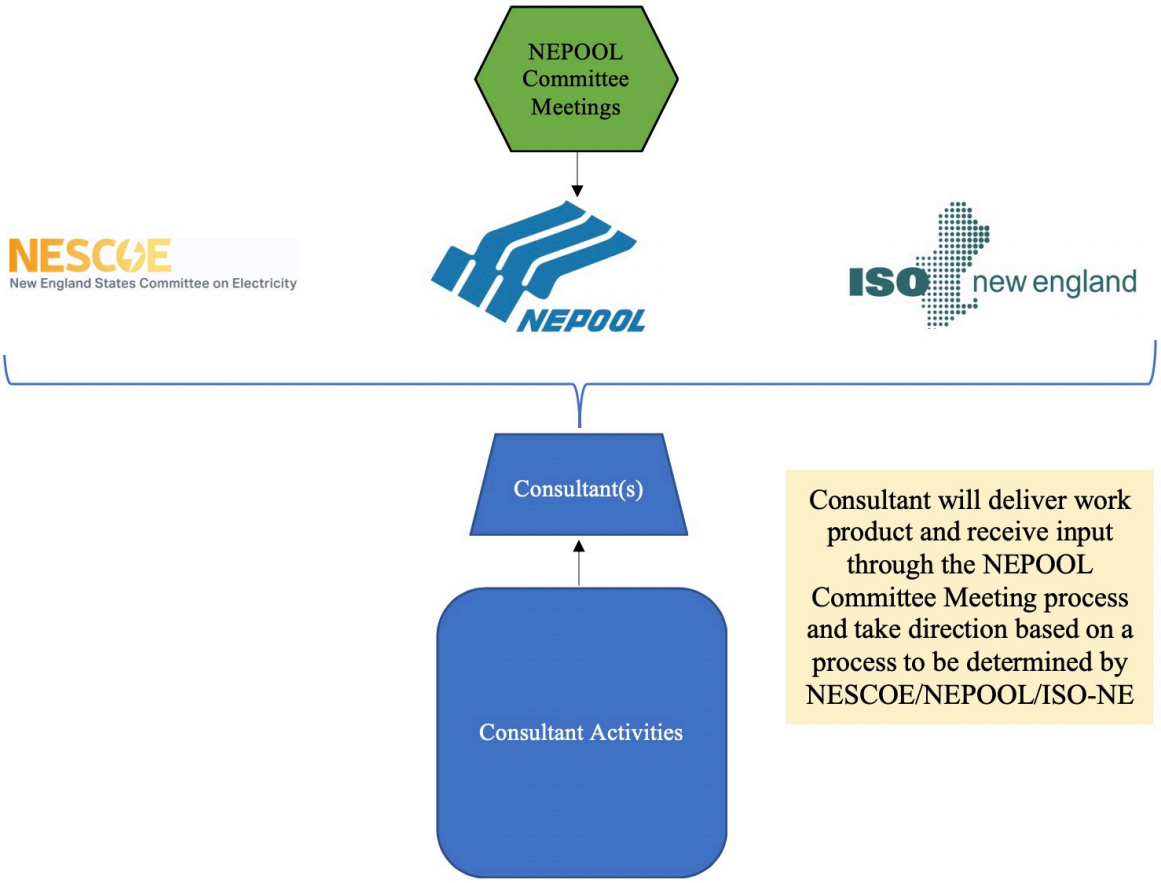
- As in all matters, ISO-NE, NEPOOL and NESCOE will try to reach agreement in the first instance.
- NEPOOL will have one vote on the consultant's recommendation and any alternatives to it, which vote will be pursuant to its governance arrangements.
- NESCOE will have one vote on the consultant's recommendation and any alternatives to it.
- ISO-NE will have one vote on the consultant's recommendation and any alternative to it.
- A majority vote of the NEPOOL/ISO-NE/NESCOE votes will constitute direction to the consultant.
- In light of the study's purpose to examine a future system operating in the context of the requirement of state laws, NEPOOL and NESCOE will each have unilateral authority (i.e., not subject to a New England Study Group vote) to identify one future scenario. This does not preclude a range of futures as defined by New England Study Group.

Voting Structure Example:

- *Example 1*: NEPOOL votes 80% (illustrative) to support the consultant recommendation, NESCOE votes to support the consultant recommendation, and ISO opposes the consultant recommendation. Consultant proceeds according to the 2/3 support.
- *Example 2*: If none support the consultant's recommendation, the consultant proposes an alternative. This may be an alternative offered in New England Stakeholders' MC/RC meetings or consultant's substitute recommendation.

In addition to discussing the issues above, New England Study Group need to discuss other issues before commencing a study, such as, for example, if there are any additional conditions around Consultant's ability to exercise professional judgment around alternatives the Consultant deems problematic (i.e., to retain the benefits of the Consultant's expertise), and other issues that arise in initial conversations.

EXHIBIT A


NEPOOL Committee Meetings
NESCOE
New England States Committee on Electricity
NEPOOL
ISO new england
Consultant(s)
Consultant Activities
Consultant will deliver work product and receive input through the NEPOOL Committee Meeting process and take direction based on a process to be determined by NESCOE/NEPOOL/ISO-NE

(NEPOOL meeting and voting schedule for items that require a vote need to overlayed; this is not intended to offer a view on NEPOOL's business processes and none should be inferred)	**Number of Days per Task**	**Number of Days from the Start**	
Task	**Days**	**Begin**	**End**
Continuing State Consideration of Mechanisms and Options • States consider alternative mechanisms to achieve the requirements of state laws		Ongoing	
Identify Analysis Objectives • Establish a statement of purpose for the study and identify questions the study is intended to inform • Determine relevant metrics and related deliverables	17	1	18
Develop Study Scope and Methods • An approach for conducting the study with enough detail to determine feasibility, milestones, and processes • Describe the analytical tools and / or methods of analysis that will provide useful information related to the study's objective or statement of purpose • A hypothetical schedule and coordination framework • Expectations around inputs, outputs, and process	14	19	33
Establish Analytical Team and Delegate Deliverables • Group of advisors that will provide suggestions, comments, and recommendations around study issues, input assumptions • Group of technical experts and/or consultants with the expertise, capabilities, and availability to perform analyses described in scope • Assign responsibility / delegate analytical tasks with milestones and dates	30	34	64
Assumption and Scenario Development • Development comprehensive sets of assumptions related to future electric sector scenarios (e.g., loads, resource mixes, fuel and allowance prices, etc.). • Design a range of scenarios that provide a distribution of outcomes that provide useful information related to the study objective or statement of purpose	25	65	90
Issue Milestone Report 1: Objective, Scope, Methods, Assumptions • Initial report describing the effort, the plan for analyzing the issue(s), and the agreed up on set of assumptions that will go into the rest of the assumptions	15	91	106

(NEPOOL meeting and voting schedule for items that require a vote need to overlayed; this is not intended to offer a view on NEPOOL's business processes and none should be inferred)	**Number of Days per Task**	**Number of Days from the Start**	
Task	**Days**	**Begin**	**End**
Modeling Scenarios of the Future System • An initial four-month modeling exercise to conduct several simulations of the future power sector (and other sectors of the economy?) • The type of modeling is TBD – but could be production cost and/or capacity expansion. Time frame enables many detailed simulations.	120	107	227
Issue Milestone Report 2: NEPOOL Summer Mtg, Studies Update, Analysis Gaps, Legal Issues • A second report providing an update on regional coordination efforts, an update on the modeling, a description of the gaps (or shortcomings) in the proposed plan for conducting the modeling (or identification of complementary analysis), and an overview of legal issues related to markets and policies.	15	200	215
Issue Preliminary Modeling Results • The modeling results from the initial simulations are provided to stakeholders. • The Analytical Team and/or Consultant interprets the results for stakeholders and answers questions about the initial results. • The Analytical Team and/or Consultant suggests / recommends additional simulations to perform based on the initial results (i.e., sensitivity analysis, exploration of result "surprises") and/or additional analyses to answer stakeholder questions in response to preliminary results.	15	228	243

(NEPOOL meeting and voting schedule for items that require a vote need to overlayed; this is not intended to offer a view on NEPOOL's business processes and none should be inferred)	**Number of Days per Task**	**Number of Days from the Start**	
Task	**Days**	**Begin**	**End**
Model Sensitivity Cases • Another two months to conduct additional simulations.	60	244	304
Perform Related Economic Analysis • Examine impacts on other electricity and/or related markets • Further examine the bases for input assumptions / analyze reasonableness of certain modeling outcomes and results • Examine impacts on environment and / or economy • Analyze resource-level economics implied by certain modeling outcomes • Consider alternative assumptions, analyses, and approaches • Consider cost-effectiveness of various modeling and analytical results	90	244	334
Perform Related Engineering Analysis • Transmission Feasibility and/or System Impacts of New Interconnections • Thermal, Voltage, and Stability of Future System Resource Mixes and Topologies • Probabilistic Resource Adequacy • Examine system information and other operational requirements	90	244	334
Issue Final Modeling Results • The modeling results from the secondary simulations are provided to stakeholders. • The Analytical Team and/or Consultant interprets the results for stakeholders and answers questions about the secondary results.	15	305	320
Issue Milestone Report 3: Preliminary Study Results • A third report providing an overview of the modeling results, a high-level interpretation of the modeling results, discussion of any issues uncovered during the modeling, and description of how the pending related economic and engineering analyses will supplement the modeling results.	15	321	336

Concurrent Efforts

(NEPOOL meeting and voting schedule for items that require a vote need to overlayed; this is not intended to offer a view on NEPOOL's business processes and none should be inferred)	**Number of Days per Task**	**Number of Days from the Start**	
Task	**Days**	**Begin**	**End**
Integrate Modeling, Economic, and Engineering Analyses • The Analytical Team and/or Consultant interprets and synthesizes the results of the modeling, economic, and engineering analyses • The study results are organized and integrated into a cohesive whole • The Analytical Team and/or Consultant develops a list of observations	90	335	425
Issue Milestone Report 4: Final Study Results • A fourth and final report recapping all the work performed and directly addressing the study objective and statement of purpose • A list of conclusions from the study • Detailed results for the entire study	15	426	441
NEPOOL, NESCOE, ISO-NE Determine Next Steps	15	442	457

Clean Energy Accelerator by Brattle

Weiss, J.; Hagerty, J.; Achieving 80% GHG Reduction in New England by 2050: Why the region needs to keep its foot on the clean energy accelerator (September 2019)
Funder: Coalition for Community Solar Access

Purpose: Estimate whether and how much clean energy resource additions in New England need to achieve the 2050 decarbonization goals.

> **Limitation:** Resource cost estimates were used in selecting resource mixes, otherwise the study provides no economic results – just clean capacity MW/year estimates.

Premise: To achieve the 2050 goals, New England must electrify the largest remaining sources of GHG emissions – transportation, residential heating, and commercial heating – and so a sustained focus on adding clean energy resources and decarbonizing the electric sector is essential to meeting these goals.

Scenarios: Efficiency Focused, Electrification Focused, and Electrification and Renewable Fuels with various combinations of clean energy portfolios: Large-Scale Resources, Balanced Portfolio, and Local Solar and Storage.

Notable Observations:
- Offshore wind and solar provide the vast majority of potential clean energy resources and the total technical potential for clean energy resources is 10x higher than projected 2050 demand in a decarbonized economy.
- Existing imported hydroelectric power with new transmission is projected to be the least cost clean energy resource until 2030, when offshore wind and solar become least cost on a levelized $/MWh basis.

Findings: **Annual clean energy resource additions need to increase by a factor of four to eight times the current level (4x to 8x) to achieve 2050 carbon emissions reduction goals**, requiring approximately 5,100 MW of new clean capacity per year. Each clean energy resource faces additional constraints that may limit its role.

Deep Decarbonization with HQ

Williams, J.H., et al.; Deep Decarbonization in the Northeastern United States and Expanded Coordination with Hydro-Québec (April 2018)
Funders: Sustainable Development Solutions Network and Hydro-Quebec

Purpose: Economic scenario analysis of the Northeast (New York and New England) and Hydro Quebec energy supply mix in 2050.

> **Limitation:** The results are sensitive to dated cost assumptions that are rapidly changing. The analysis relies on three-year-old cost estimates for offshore wind, which have decreased approximately by half.

Premise: Economy-wide 80% reduction in GHG emissions by 2050 implies there must be a major increase of electric load, roughly doubling today's load by mid-century, accompanied by a must be a vast increase in low carbon generation.

Scenarios: Low Decarbonization and Deep Decarbonization with various combinations of Wind, Hydro, and Transmission expansion.

Notable Observations:
- In 2050, two-thirds of all generation comes from solar PV and wind power.
- Systems with high penetrations of wind and solar have greater ramping and load-following requirements than those with a more balanced portfolio – such requirements may exceed natural gas carbon constraints.
- HQ reservoir capacity can provide balancing on a seasonal scale. More interconnections would enable south-north flows of excess solar generation. Storing excess solar generation in the HQ reservoir may reduce renewable curtailments and emissions associated with balancing the ISO-NE system.

Findings: **More interconnections between the Northeast and HQ may be a less expensive approach to decarbonization than an alternative with an even greater reliance on offshore wind and solar.** Imported Canadian onshore wind firmed with hydro may be less expensive than some offshore wind resources.

Deep Decarbonization in California by E3

Ming, Z., et al.; Long-Run Resource Adequacy under Deep Decarbonization Pathways for California (June 2019)
Funder: Calpine Corporation

Purpose: Examine resource adequacy under future scenarios in which California's economy is deeply decarbonized and heavily dependent on renewable energy. Builds on several prior studies examining decarbonization pathways.

> **Limitations:** Other low-carbon alternatives to natural gas generation, including nuclear and renewables with ultra-long duration energy storage, were not considered in the study. The resource adequacy model did not include any transmission limitations.

Premise: Some form of firm generation capacity is needed to ensure reliable electric service. Natural gas capacity is likely to play a role in balancing renewable generation and maintaining resource adequacy.

Scenarios: High Biogas (for space heating and industrial processes) and High Electrification with various combinations of renewable resources and storage.

Notable Observations:

- Total installed capacity on the system more than doubles from 2020 to 2050
- It would be extremely costly and impractical to replace all natural gas generation capacity with solar, wind and storage, due to the large quantities of these resources that would be required
- The biggest driver of reliability challenges in a system where most generation is intermittent is the potential for multi-day periods of low renewable production

Finding: **The least-coast electricity portfolio to meet the 2050 economy-wide greenhouse gas goals for California includes 17-35 GW of natural gas generation capacity for reliability (compared to the California's current natural gas fleet totaling approximately 29 GW).**

FCEM Detailed Design by Brattle

Spees, K., et al.; How States, Cities, and Customers Can Harness Competitive Markets to Meet Ambitious Carbon Goals: Through a Forward Market for Clean Energy Attributes (September 2019)
Funder: nrg

Purpose: Propose a detailed market design for a competitive, regional forward clean energy market (FCEM) for clean energy attributes.

> **Limitation:** Third-party administrator of such a market, such as a state agency, a multi-state organization, or even an independent system operator, may require enabling legislation and/or regulatory approval of implementing tariff changes.

Premise: Achieving ambitious renewable and clean energy goals is unlikely to be achieved cost-effectively using traditional policy instruments.

Scenarios: A variety of different resources and technologies procured to achieve clean energy goals under (i) technology-specific subsidies and bundled contract procurements and (ii) a competitive FCEM.

Notable Observations:

- It is possible to establish technology-specific "carve outs" to ensure a minimum share of the procurements could include nascent technologies that may be higher cost.
- A multi-year forward procurement with moderate commitment and forward periods short enough to respond to changes in market conditions leaves the burden of technology and market fundamental risks with developers and investors who are best equipped to assess and mitigate risks and invest accordingly.
- A single state or group of states could collaborate to develop and implement the clean energy market through an appropriate agency, possibly with a governance model similar to that used in the Regional Greenhouse Gas Initiative (RGGI).

Finding: **Broad competition will minimize the costs of achieving carbon goals.**

NESCAUM White Paper

In September 2018, the Northeast States for Coordinated Air Use Management (NESCAUM) issued a white paper: **Greenhouse Gas Mitigation Analysis for New England**. The white paper is designed to provide high-level insights about the magnitude of actions needed to achieve New England's ambitious climate goals. There are several key lessons that can be drawn from excerpts of this analysis:

- ***Immediate action is required***. The scale of change that needs to occur is massive. Given the long time-horizon for stock-turnover, New England policy-makers need to start implementing policies now to **avoid costly early retirements of fossil fuel technologies**. This is particularly pertinent to the electric grid, which operates on a decadal time-scale and is critical to decarbonize early to provide a low-carbon source of energy for the electric technologies needed to reduce carbon emissions in the other major sectors.
- ***Electrify end-use energy consumption***. To reduce GHG emissions, end-use energy consumption should be shifted to electric technologies, such as electric vehicles in transportation and air source heat pumps for residential and commercial buildings, which emit no direct emissions. These electric technologies are also typically more energy efficient than fossil fuel technologies, which reduces overall energy demand in the economy.
- ***Decarbonize the electric grid***. The increase in electrification will shift emissions from the end-use sources to the power plants that produce electricity. **New England will need to deeply decarbonize the electric grid in order to ensure that GHG emissions significantly decline from the electric generation sector as the grid experiences a significant increase in load.** A continuing shift to natural gas, even though less carbon-intensive than coal and oil, is not capable of meeting the region's 2030 and 2050 goals, and diverts investments from longer-term zero-carbon technologies.
- ***Focus on building thermal.*** The New England region is unique in the amount of energy needed to heat homes and businesses and the amount of heating oil consumed to do so.
- *Energy efficiency is effective at reducing GHGs in the short-term, but is not, in and of itself, a long-term solution to deep decarbonization.* Energy efficiency is a cost-effective method for reducing emissions and flattening load growth under current conditions. However, **if future GHG reduction targets are to be met through electrification of other end-use sectors, like transportation and buildings, electric demand will increase significantly, potentially 2 to 3 times above current generation by 2050**. To meet this growth, new zero-carbon generation will need to be added to the grid, while continuing to displace all forms of current fossil generation. As the grid decarbonizes, energy efficiency as a GHG reduction strategy will have diminishing impacts. Other benefits, however, will continue to exist, such as reducing the extent of needed electric capacity additions. Therefore, it should be recognized that at some future point decreasing demand from a low-carbon electricity grid will not be a significant GHG reduction strategy. Instead, it will be driven by other goals, such as cost reductions.
- ***A price on carbon could simplify carbon reductions.*** In addition to implementing individual discrete policies to push multiple markets toward low-carbon technologies in each sector, an **economy-wide price on carbon** could provide a relatively simple and effective method to achieve the required GHG reductions.