

WORKING LIST OF REPORTS/STUDIES/PRESENTATIONS

“TRANSITION TO THE FUTURE GRID” SUBJECT

We have been asked to begin assembling a digital library of documents that may be relevant to New England’s “Transition to the Future Grid” effort. In this first pass, we decided to cast a wide net to identify potentially relevant studies, reports, papers, and presentations. *Please note, the summaries included below were mostly cut and pasted from the studies’ executive summaries, abstracts, or the like.* As indicated in the Table of Contents, the studies are organized into four high-level categories.

As we more fully digest the various studies and reports referenced below and receive input from stakeholders, we will supplement the list and/or remove those documents that are not relevant to the “Transition to the Future Grid” subject. Further, while we attempted to locate relevant materials from various sources, we most assuredly missed some studies, reports and presentations that folks think are relevant to the effort underway. Because our research remains on-going, please let us know of any such studies or reports not listed in the attached document. The goal is to upload an appropriate list of materials (with hyperlinks to the documents) within a “reference library” on the NEPOOL website and to augment that list and digital library as additional relevant studies, reports, and presentations are identified.

We would appreciate your input on the attached work-in-progress. Any input can be sent directly to NEPOOL Counsel (Sebastian Lombardi (slombardi@daypitney.com) or Rosendo Garza, Jr. (rgarza@daypitney.com)).

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Preliminary Draft

I. Future Grid/Decarbonization Studies

[Brattle Group - Achieving 80% GHG Reduction in New England by 2050 \(2019\)](#)

[Brattle Group - Achieving 80% GHG Reduction in New England by 2050 \(Tech App'x\)](#)

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

“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.”

“Electricity demand will likely double by 2050 across plausible scenarios. . . . Supplying the increasing demand will require a massive buildout of clean energy resources.”

[Brattle Group - NYISO Grid in Transition Study \(2020\)](#)

“NYISO has retained Brattle to develop simulations of NYISO markets through 2040 to inform the Grid in Transition effort.

- New York has established aggressive clean energy and decarbonization mandates, codified in the Climate Leadership and Community Protection Act (CLCPA).
- NYISO’s Grid in Transition effort seeks to understand the reliability and market implications of the State’s plans to transition to clean energy sources.
- NYISO has retained Brattle to simulate NYISO market operations and investment through 2040 to inform NYISO staff and stakeholders on market evolution.”

“Study design makes several simplifying assumptions, such as:

- Zonal, ‘pipe and bubble’ transmission topology
- Stylized representation of generators
 - Aggregated generators by zones and types
 - Economic additions and retirements in continuous increments, not ‘lumpy’
- Implementing current market rules and policies.”

[Deep Decarbonization Pathways Project - Deep Decarbonization in the Northeastern United States and Expanded Coordination with Hydro-Québec \(2018\)](#)

“This study analyzes what achieving an 80 x 50 goal [80% below 1990 levels by the year 2050] throughout the region implies for the way that energy is supplied and used The research was sponsored by the Sustainable Development Solutions Network (SDSN) in collaboration with Hydro-Québec (HQ), and conducted by Evolved Energy Research (Evolved) using the EnergyPATHWAYS energy system model, with contributions from SDSN and HQ’s research institute, IREQ.

The analysis has three main objectives:

1. To understand what changes in energy system infrastructure and technology are required to achieve the 80 x 50 goal in the Northeast
2. To understand the potential effect of expanded Northeast-HQ coordination on the cost of achieving the 80 x 50 goal in the Northeast

3. To determine if potential benefits warrant examination in greater depth, and if so what are the right questions, tools, and stakeholders for a Phase 2 study[.]”

[Energy and Environmental Economics \(E3\) - Long-Run Resource Adequacy Under Deep Decarbonization in CA \(2019\)](#)

“This study examines electricity system resource adequacy under future scenarios in which California’s economy is deeply decarbonized and heavily dependent on renewable energy. Resource adequacy standards ensure that sufficient resources are available to meet electric load under the broadest possible range of weather and resource outage conditions, subject to a standard for acceptable reliability. The study builds on prior work that E3 completed for the California Energy Commission which evaluated alternative pathways for California to achieve 80% reductions in greenhouse gas emissions from electricity, buildings, transportation, and industry by 2050. The previous work identified measures California could take to achieve greenhouse gas reductions and renewable energy targets within the electricity sector. The current study takes an in-depth look at electricity system resource adequacy requirements and which resources are needed to maintain acceptable long-run resource adequacy in a cost-effective manner under a range of plausible assumptions. This study was funded by the Calpine Corporation.”

[Energy Futures Initiative \(EFI\) \(Ernie Moniz group\) - Pathways for Deep Decarbonization in CA \(2019\)](#)

- “Meeting California’s carbon reduction goals by 2030 will require a range of clean energy pathways across all economic sectors—Electricity, Transportation, Industry, Buildings, and Agriculture This is due to the uncertainty of each pathway and the fact that there are no ‘silver bullet’ solutions.”
- “California’s ambitious policy to double economywide energy efficiency is an important step for meeting 2030 decarbonization targets.”
- “Transportation is the single largest emitting sector in California and requires transformational change to achieve aggressive decarbonization by 2030. Existing policies will have a major impact on the sector’s emissions reduction by 2030.”
- “Clean fuels (e.g., renewable natural gas [RNG], hydrogen, biofuels) are critical clean energy pathways due to the enormous value of fuels in providing flexibility and reliability for energy systems.”
- “California can meet its 60 percent RPS target by 2030 with continued expansion of wind (both onshore and offshore) and solar resources; some geothermal and increased imports of clean electricity will play a role as well.”
- “Natural gas generation will continue to play a key role in providing California’s electric grid with operational flexibility and system reliability, while enabling the growth and integration of intermittent renewables.”
- “Policies that affect natural gas in some sectors (e.g., building electrification) may have unintended impacts on other sectors that consume and rely on natural gas.”
- “Meeting California’s deep decarbonization goals by midcentury will be extremely difficult (if not impossible) without energy innovation.”
- “There are several cross-cutting technologies or classes of technologies that can help meet the large-scale decarbonization needs for several economic sectors. These include

technologies for large-scale carbon management (LSCM), hydrogen applications, leveraging carbon infrastructure and expertise, and smart systems and platforms.”

[NYISO - Reliability & Market Consideration for a Grid in Transition \(2019\)](#)

[NYISO - Reliability & Market Consideration for a Grid in Transition \(PPT\)](#)

“This white paper is intended to facilitate a thorough review of a recommended set of market enhancements to ensure that the market signals provided through the energy, ancillary services and capacity markets are aligned with system reliability needs in order to attract investment and retain competitive suppliers through the transition to 70% renewable energy by 2030. We need to take the necessary steps to prepare and further shape the competitive markets, and identify strategic transmission investment opportunities for the change that is underway and then continue to evolve our markets as a better understanding of the long term challenges is developed.”

“In order to further that objective this whitepaper: 1) describes the emerging reliability and economic challenges; 2) presents our initial identification of gaps to address; and 3) proposes next steps. We focus on market design improvements, but also identify the required operations and planning studies that will inform the trajectory of how to meet reliability as we transition to a carbon free future.”

II. Recent New England Reports/Papers/Presentations

[ISO-NE - The Clean Energy Transition and Future Pathways \(2020\)](#)

“This presentation examines how ISO New England is currently enabling the Clean Energy Transition through a competitive market for power system reliability services and considers the implications of future evolutionary pathways for the region’s wholesale electricity markets.”

[ISO-NE - Transmission System Needs for a Decarbonized Electric System \(2020\)](#)

PPT exploring regional transmission investment, the integration of renewables and storage, and the need to change planning assumption in the transmission system.

[ITC Mass Renewable Investigation \(Invest. No. 332-574\) \(2020\)](#)

“Following receipt on January 23, 2020, of a request from the Committee on Ways and Means (Committee) of the U.S. House of Representatives, under section 332(g) of the Tariff Act of 1930, the U.S. International Trade Commission (Commission) instituted Investigation No. 332-574, Renewable Electricity: Potential Economic Effects of Increased Commitments in Massachusetts, for the purpose of providing a report regarding the potential economic effects of increased renewable energy commitments in Massachusetts, and the role of renewable electricity imports in meeting these commitments.”

[Massachusetts Attorney General’s Office - Wholesale Electric Market Design for a Low-No-Carbon Future \(2020\)](#)

“[O]n October 24, 2019, the Massachusetts Attorney General’s Office . . . convened a small group of energy market design experts, thought leaders, and stakeholders to participate in a day-long, professionally facilitated symposium to discuss long-term wholesale power market design options that will best support New England’s clean energy transition, regional climate goals, and

emissions reduction mandates while maintaining reliability and reasonable costs (the ‘Symposium’). The purpose of the Symposium was to inform and advance a regional, solutions-based discussion about the future of New England’s competitive electricity markets.”

“The Symposium examined two guiding questions (‘Guiding Questions’):

1. What market design construct(s) for New England will most effectively support an electricity system comprised exclusively of renewables and other zero/very low carbon resources (many/most of which have variable output, and near zero marginal cost to operate) (the ‘decarbonized end-state’)?
2. How do we effectively transition the wholesale electric markets (during which gas will likely still be needed for reliability purposes, at least) to ensure that we achieve this long-term vision (what needs to happen and when)?”

“This paper captures the thinking and visions that emerged during the discussions at the Symposium, which included surprising areas of consensus—the need for meaningful carbon pricing and more effective scarcity pricing—and raised many questions, including, importantly, the role of the New England states in shaping resource considerations in the wholesale power market.”

[Northeast Region Emissions Reduction Summit - Accelerating to 80 \(Driving the Northeast’s Deep Decarbonization Targets\)](#)

“In order to brainstorm ideas for what would be an unprecedented undertaking and to set the stage for regional coordination efforts throughout the Northeast, Mintz, the Northeast Clean Energy Council (NECEC), and The Brattle Group convened an invitation-only summit of senior-level clean economy leaders from the public, private, and nonprofit sectors. The event brought together over 30 thought leaders and stakeholders from a broad range of invested constituents: local and state governments, utility companies, industry associations and trade groups, advocacy groups focused on the environment and transportation, and venture capital and project finance funds that invest in sustainable businesses, and private companies ranging from green energy start-ups to Fortune 500 companies.”

III. Miscellaneous

[Davis Noll and Unel - Markets, Externalities, and the Federal Power Act: The Federal Energy Regulatory Commission’s Authority to Price Carbon Dioxide Emissions \(2019\)](#)

“This Article examines how FERC has embraced market efficiency as the key tool for ensuring just and reasonable rates and has addressed all of the standard market failures that would otherwise distort the efficiency of prices: market power, asymmetric information, public goods, and externalities. The Article then shows that any economically rational effort to achieve an efficient market must attempt to address the external cost of CO₂ emissions as well. This Article argues that, from an economic perspective, FERC’s authority to pursue market efficiency should extend to either approving utility plans to internalize those external costs or to set a carbon price, just as it extends to other market failures.”

[Glick and Christiansen - FERC and Climate Change](#)

“This article discusses one of those federal agencies—the Federal Energy Regulatory Commission (FERC or the Commission)—and how its actions can have substantial consequences for climate change. . . . This article examines several areas of the Commission’s jurisdiction that have particularly important consequences for GHG emissions.”

[MITEI - “The Future of” Studies](#)

A “[c]omprehensive multidisciplinary MIT analyses that shape and influence policy, technology development, and future research.”

[PJM Study - Response to PA PUC OH Consumers’ Counsel Requests to Analyze Certain Impacts of Nuclear Power Plant Retirements \(2019\)](#)

“In response to separate requests from the Pennsylvania Public Utility Commission (PA PUC) and the Ohio Consumers’ Counsel (OCC), PJM Interconnection studied cost and emission impacts of potential nuclear power plant retirements in Pennsylvania and Ohio.

- To evaluate these impacts, PJM simulated market results for the year 2023 under various resource mixes, including what exists today, projected conditions for the future and several combinations of potential nuclear unit retirements.
- The PJM base case includes the announced retirements of nuclear units in Pennsylvania and Ohio: Three Mile Island (TMI), Beaver Valley 1 & 2, Davis-Besse and Perry, and also includes new generation with a planned in-service date of 2023 and an executed Interconnection Service Agreement.
- Modeling the base case, considering retirements and new entry, shows that wholesale energy market net-load payments would decrease by \$1.6 billion across the PJM region compared to today’s system due to the significant entry of new, efficient resources.
- PJM executed three simulations of the requested nuclear unit retirement scenarios. These scenarios assume the requested combinations of nuclear unit retirements occur and also assume that those generators in the queue that have executed an Interconnection Service Agreement and are planned to come online between 2020 and 2023 would enter the market as scheduled.”

[Power Systems Engineering Research Center - Public Report on the Future Grid](#)

“Funded by the U.S. Department of Energy (DOE) ‘The Future Grid to Enable Sustainable Energy Systems’ project focuses on how to integrate higher penetrations of renewable generation and other future technologies into the grid while enhancing grid stability, reliability, and efficiency. It also aims to stimulate discussion among the academic, industry, and government communities on what it will take to shape the future grid for the mid-twenty-first century.”

IV. Potential Future Market Frameworks/Options

A. Carbon Pricing

i. NYISO’s Carbon Pricing Efforts

- [Analysis Group - NYISO Carbon Pricing Report \(2019\)](#)
- [Analysis Group - NYISO Carbon Pricing Report \(PPT\) \(2019\)](#)

- [Analysis Group - NYISO Carbon Pricing Report \(Technical App'x\) \(2019\)](#)
 “New York has a home-grown tool—a proposed carbon pricing mechanism in the state’s wholesale market administered by NYISO—that can provide a number of benefits, including support for New York policy makers’ goals to reduce carbon emissions as quickly and as economically as possible. Introducing a carbon price in the state’s wholesale electric market administered by NYISO can lead to a number important outcomes Without the carbon price, New York policy makers may be inadvertently tying one hand behind the market’s back, at a time when New York’s aspirations for a clean energy economy call for all hands to be clapping together in unison.”
- [Brattle Group - Analysis of a New York Carbon Charge \(PPT\) \(2018\)](#)
 - “Internalizing a carbon charge would invite a broad range of solutions to compete to meet decarbonization goals cost-effectively, which should improve economic efficiency over existing policies alone”
 - “The proposed design helps prevent distortions at NYISO’s seams that could reduce economic efficiency gains”
 - “We estimate economic savings of \$7m/yr in 2022, rising to \$50m/yr by 2030”
 - “A separate question is how much of the economic gains are enjoyed by consumers vs. producers, and if higher energy prices transfer wealth from consumers to producers”
 - “We estimate a carbon charge could reduce emissions of CO₂ and NO_x”
 - “Benefits could increase with more innovative emissions reductions the market might produce in response to prices (but not captured in the analysis)”
 - “Benefits could be much greater if carbon charges prevent conflicts between state programs and wholesale electricity markets”
- [Brattle Group - Pricing Carbon into NYISO’s Wholesale Energy Market \(2017\)](#)
 “At the request of its stakeholders, the New York Independent System Operator (NYISO) commissioned The Brattle Group in August 2016 to explore whether and how New York State environmental policies may be pursued within the existing wholesale market structure. In developing its analysis, Brattle received valuable input from the NYISO, the New York Department of Public Service (DPS), and stakeholders. The resulting report, presented here, considers that input but solely reflects the opinions of its authors. This report is intended to provide a first step in a discussion on how to harmonize state policy and wholesale markets in New York.”
- [NYISO - Carbon Pricing in NY \(2019\)](#)
 “Overview on carbon pricing in NYISO; discusses Climate Leadership and Community Protection Act and integrating markets and public policy through carbon pricing.”
- [NYISO - IPPTF Carbon Pricing Proposal \(2018\)](#)
 “The Integrating Public Policy Task Force (IPPTF) was created as a forum for the NYISO, New York State Department of Public Service, New York State Research and Development Authority, electricity market participants, members of the public, and interested stakeholders to explore concepts and proposals for incorporating the social cost of carbon emissions in wholesale energy markets to better harmonize the state’s energy

policies and the operation of those wholesale markets. On April 30, 2018, a straw proposal was released outlining a potential design to incorporate the social cost of carbon dioxide emissions in the wholesale electricity markets (Carbon Pricing Straw Proposal).”

ii. PJM’s Carbon Pricing Senior Task Force

Last year, a Carbon Pricing Senior Task Force (CPSTF) was established in PJM to “engage in education and then investigate any process and rule changes necessary to integrate regional or sub-regional carbon pricing mechanisms.” To access PJM’s dedicated CPSTF website, please click [here](#). What follows are some of the presentations/reports provided at CPSTF meetings to date.

- [Institute for Policy Integrity - Carbon Pricing in RTO Markets Jurisdictional Considerations \(2019\)](#)
A PPT reviewing jurisdictional consideration in carbon pricing.
- [Monitoring Analytics - Carbon Pricing Education \(2019\)](#)
- [PJM - Advancing Zero Emission Objectives Through PJM’s Energy Markets \(2017\)](#)
“PJM Interconnection believes market design can advance state policy initiatives and adapt to changing conditions to ensure the PJM region continues to reap the benefits of competitive markets. To address the desire of some states to subsidize supply resources to meet carbon-reduction initiatives, this paper explores how all or a subregion of PJM could affix a price on carbon that could be reflected in wholesale energy market prices. Specifically, we examine how regional and subregional carbon pricing could be implemented in the region PJM serves.”
- [PJM - Carbon Pricing Impacts on LMP \(2019\)](#)
Review of the potential impacts of carbon pricing on LMPs.
- [PJM - Carbon Study Objective & Assumptions \(2019\)](#)
Discussing PJM’s carbon study objective and methodology.
- [PJM - Study of Carbon Pricing & Leakage Mitigation Mechanisms \(2020\)](#)
- [PJM - Expanded Results of Study of Carbon Pricing & Potential Leakage Mitigation Mechanisms \(2020\)](#)
- [PJM - Study of Carbon Pricing & Potential Leakage Mitigation Mechanisms Example Problem Formulations \(2020\)](#)
A review of a production-cost model and modeling of carbon prices from RGGI.
- [Resources for the Future - Concepts for Carbon Pricing \(PJM\) \(2019\)](#)
- [Solar Wind Energy Assoc. & Solar Energy Industries Assoc. - Jurisdictional Considerations Related to Carbon Pricing in PJM](#)

B. Forward Clean Energy Market

[Brattle Group - How States, Cities, & Customers Can Harness Competitive Markets \(2019\)](#)

“In this whitepaper, we propose a new forward clean energy market (FCEM) in order to harness technology-neutral, broad-source competition and innovation. The FCEM would provide a competitive, regional market for clean electricity attributes. It would enable states, cities, and customers to achieve their ambitious carbon targets at lower costs. Furthermore, it would complement existing competitive wholesale electricity markets.”

C. Other Proposed Alternative Approaches/Ideas

[Grid Strategies - The Need for Capacity Market Replacement or Reform \(2019\)](#)

“This paper summarizes capacity market performance, outlines key design flaws that regulators have approved, and provides some ideas for future directions that state and federal policy makers could take to improve the reliability and efficiency of markets for customers.”

[Grid Strategies & Regulatory Assistance Project - Wholesale Electricity Market Design for Rapid Decarbonization a Decentralized Markets Approach \(2019\)](#)

“Paper argues that a market structure with a central spot market and active de-centralized forward procurement between wholesale buyers and sellers (including exchange-based trading) will lead to sufficient investment to achieve resource adequacy, will facilitate a sufficiently rapid decarbonization, and will do so at the lowest reasonable cost to consumers.”

[Wilkinson Baker Knauer \(prepared for American Public Power Association\) - Mandatory Capacity Markets & the Need for Reform \(2020\)](#)

“The reforms proposed in this paper recognize that state and utility resource planning for electricity supply should be fully accommodated within a workable paradigm for the RTOs/ISOs. Comprehensive resource planning benefits customers, as does the ability to access a voluntary market to sell or procure marginal supply, and to achieve the efficiencies of the centralized dispatch of resources through the current RTO/ISO energy markets. As discussed further in this white paper, this reform proposal rests on two pillars: (1) the transition of mandatory capacity constructs to voluntary residual markets to supplement primary methods of procuring capacity (bilateral contracting or self-builds); and (2) a framework for a greater role in resource planning and procurement for the LSEs and the states to enhance the first pillar.”

[Grid Strategies - Retail Electric Market Structure Reforms \(2020\)](#)

“The study identifies two key flaws in retail market structures that hinder resource procurement: rules around default service provision that undermine retail suppliers’ incentive to sign long-term contracts, and insufficient creditworthiness of retail suppliers. States can improve retail structures by: 1. Leveling the playing field between default and competitive services; 2. Ensuring retail suppliers are sufficiently creditworthy to execute long-term contracts. Together these recommendations to improve retail structures both improve their performance and enable beneficial wholesale market reforms.”