AGENDA
JOINT MEETING
NEPOOL MARKETS & RELIABILITY COMMITTEES
WEDNESDAY, JULY 1, 2020

Location: Teleconference
Call-in Number: 1-866-803-2146 / Access Code: 7169224
WebEx: WebEx Link
WebEx Password: nepool

Item	Description	Time Allotted
1	CHAIRS' OPENING REMARKS	9:30 – 9:45
	(A) Approval of Minutes [66.67% MC vote] [66.67% RC vote] • Joint MC/RC Meeting Date: May 27, 2020	
2*	TRANSITION TO THE FUTURE GRID STUDY	
	(A) PREPARING FOR ANALYSIS/ SCENARIO ASSUMPTION PROPOSALS (MC Chair and RC Chair) Overview of draft assumption table for upcoming analysis proposal submissions.	9:45 – 10:15
	(B) OVERVIEW OF THE 2020 NATIONAL GRID ECONOMIC STUDY REQUEST (NGrid: Tim Martin) (1st MC/RC Mtg) Overview of details of the study request and thoughts on consideration for assumption development with the Transition to the Future Grid study.	10:15 – 10:45
	(C) OVERVIEW OF THE EVERSOURCE/ LONDON ECONOMICS STUDY (Eversource: Vandan Divatia and London Economics: Julia Frayer) (1st MC/RC Mtg) Overview of the pathways study, which analyzes a range of potential technology and policy pathways that achieve economy wide carbon reduction.	10:45 – 11:30
	(D) OVERVIEW OF THE MASSACHUSETTS 80 BY 50 STUDY (Undersecretary for Climate Change, Massachusetts Executive Office of Energy and Environmental Affairs: David Ismay) (1st MC/RC Mtg) Overview of the Massachusetts decarbonization study which aims to develop a roadmap to 2050 that will identify the strategies, policies, and implementation pathways for MA to achieve at least 80% GHG reductions by 2050.	11:30– 12:00
	LUNCH	12:00 – 12:30

* Material distributed for this agenda item
AGENDA ITEMS with BOLD & ITALICIZED FONT: MC ACTION Requested
WMPP: Wholesale Markets Project Plan

	(E) ANALYTICAL FRAMEWORK FOR THE TRANSITION TO THE FUTURE GRID STUDY (CMEEC: Brian Forshaw) (1st MC/RC Mtg) Presentation of an analytical framework for the analysis.	12:30 – 1:00
	(F) VIEWS ON THE SCOPE AND ASSUMPTIONS (Advanced Energy Economy: Caitlin Marquis) (1st MC/ RC Mtg) Presentation of AEE's views on the scope and assumptions for the study.	1:00 – 1:45
	(G) FURTHER THOUGHTS ON A PATH FORWARD (NRG and SunRun: Peter Fuller) (2nd MC/RC Mtg) Continued discussion of ideas and suggestions on how to structure the study.	1:45 – 2:45
3	OTHER BUSINESS	2:45 – 2:50

* Material distributed for this agenda item
AGENDA ITEMS with BOLD & ITALICIZED FONT: MC ACTION Requested
WMPP: Wholesale Markets Project Plan

memo

To: NEPOOL Markets and Reliability Committees (MC, RC)

From: Mariah Winkler, MC Chair; Emily Laine, RC Chair; Robert Stein, RC Vice Chair; and William Fowler; MC Vice Chair

Date: June 25, 2020

Subject: Future Grid Study: July Meeting Purpose and Preparing for Analysis/Scenario Assumption Proposals

The future grid study is a collaborative effort amongst regional industry stakeholders, the New England states, and ISO New England to further assess and explore potential reliability and operational issues in light of evolving state energy and environmental policies.

The initial joint MC/RC meetings on this effort have been focusing on highlighting existing analyses, and those in development, relating to the upcoming transition. Presenters have been noting available modelling capabilities and discussions are beginning to focus on proposed study objectives, including how to structure the study and develop assumptions. Several participants have noted a desire to proceed quickly and streamline the development of assumptions, scenarios, and results for this assessment. Therefore, in the coming months, we will be focusing on efficiently developing these assumptions and scenarios based on proposals from the stakeholders and states.

At the July 1 meeting, several stakeholders will share information about relevant, ongoing studies, and potential study frameworks and desired outputs for the future grid study. We recommend that the members of the committees focus on how these studies and frameworks can be best utilized to achieve Future Grid goals. In order to facilitate the development – and natural consolidation – of proposals, we have developed the attached draft form as a template for collecting requests. We will discuss the form on July 1 and seek feedback on refinements. We plan to distribute the final form a few days after the July meeting with the objective of having stakeholders propose their analysis/scenario assumptions by populating this form ahead of the August meeting (homework, if you will). Individual organizations may submit completed charts for committee consideration or entities with common interests may choose to work together offline to prepare a joint submission.

We also need to consider how detailed workflow will be managed between meetings. For example, some have suggested hiring an independent consultant to manage these efforts, designating a small representative working group of individuals willing to commit time towards managing study details, or similar. We would like to discuss this at the July 1 meeting as well.

In order to prepare the other committee members as much as possible and allow time for NEPOOL Counsel to consolidate the submissions into a format that can be used for discussion at the August 4 meeting, submissions should be sent to the MC Secretary by no later than **July 17, 2020**. At the August 4 meeting, stakeholders will review the compiled analysis proposal submissions and we will begin developing a consensus study scope. We will also turn to discussion of who can perform the work as well as target completion dates.

In alignment with the study chart discussed at the March 2020 Participants Committee, once the operational/reliability needs of the future are identified, we anticipate a gap analysis will need to be performed. This will help identify any market deficits that may need to be addressed to assure the continued reliable operation of the system.

As indicated by the NEPOOL Chair (Nancy Chafetz) at yesterday's Participants Committee meeting, in parallel with this current effort at the MC/RC, separate meetings will be held to explore and learn about potential (market) frameworks for New England's future grid. We encourage members who are interested to participate in upcoming meetings and discussions on that broader topic, the first of which will be held via teleconference at the August 6 Participants Committee meeting.

Requestor Details	**Requestor(s)**	List the company or organization name(s) associated with the proposal.
Request Details	**Objective**	Clearly articulate what the requestor(s) are specifically seeking to learn from the request.
	Base Case Description	Describe the base case which will be the starting point for additional scenarios to be run from. If the base case will be based on a prior analysis, please note this and clarify what updates are being proposed to the assumptions.
	Additional Scenarios	Describe any scenarios which would be performed from the base case. These scenarios should specify which variables will be changed in a given scenario and by how much. If the scenarios will be based on a prior analysis, please note this and clarify what updates are being proposed to the scenarios.
	Associated Prior/Ongoing Study	If applicable, list associated prior or ongoing study which may be the basis for the proposal or where assumptions are derived from.
Outputs and Deliverables	**Metrics to Develop and Examine**	Describe the metrics which would be utilized and the types of data the requestor(s) are seeking to examine (loads, prices, etc.)
	Deliverable(s)	Describe the deliverables of the proposed analysis. Note the type of information, analyses, and/or observation areas which the requestor(s) are seeking further information on with the request. Please note whether the deliverable is to be utilized as an assumption in another proposal.

Requestor Details	Request Details				Outputs and Deliverables		Proposal Technical Summary			Base Case Input Assumptions						
Requestor	Objective	Base Case Description	Additional Scenarios	Associated Prior/Ongoing Study	Metrics to Develop and Examine	Deliverable(s)	Analysis Type	Proposed Modeling Tool(s)	Proposed Modeling Approach	Transmission Network	Study Years(s) / Timeframes	Supply Resource Mix (New and Retired)	Wholesale Net Load (Gross, EE, Btm PV, Utility PV)	Electrification Forecasts (Heating and Transportation)	Battery and Other Storage Additions	Other
(example) Widget, LLC	(example) • Determine how high percentages of variable resources on system would impact or change operational contingency planning • Determine extent of transmission system upgrades required for a future resource mix under a fully decarbonized economy; • Determine if (current) market outcomes under high renewable/storage penetration cases would provide revenues to cover expected capital and/or operational/maintenance costs for resources (by	(example) The base case is similar to the Widget 20XX Economic Study Request with the updates noted in the "Base Case Input Assumptions" columns.	(example) The Scenarios to be included are similar to the Widget 20XX Economic Study Request with the following updates: 1. Generation Fleet Meeting Existing State Renewable Portfolio Standards (“RPS”) and Steam Units Retired and Replaced with NGCC units: Use the Base Assumptions, including the retirement assumption. Assume that targeted energy requirement for the New England states’ RPS goals as of April 1, 2020 will be met by physical renewable/clean energy resources. Any retirement replacement and any supply growth above RPS will be met by new NGCC units. 2. Generation Fleet Meeting Existing RPS and All Future Needs Met with New Renewable/Clean Energy Resources: Same as Scenario 1, except assume all needed capacity will be met by renewable/clean energy resources. The mix of renewable/clean energy resources will be determined in the stakeholder scoping process. 3. Generation Fleet Meeting Existing RPS Plus Additional Renewable/Clean Energy Resources: Same as Scenario 2 except include additional MW by 2025 and 2030 of new renewable/clean energy resources above the existing RPS requirements. Specifics of this “RPS-Plus” Scenario 3 are included Appendix 1 to the Proposal and will be further	(example) These assumptions are based on updating the Widget 20XX Economic Study Request.	(example) Provide all the same metrics from the Widget 20XX Economic Study Request.	(example) Provide all the same deliverables from the Widget 20XX Economic Study Request.	Market Analysis	GridView	(example) Simulate economic operation of power system chronologically	(example) The transmission topology will be the one used in FCA #14, plus upgrades associated with resources that cleared in FCA #14 and any Proposed or Planned reliability projects on ISO’s March 2020 RSP Project List.	(example) Model 2025 and 2030.	(example) Existing resources will be the generation fleet and demand response and energy efficiency (“EE”) resources as of FCA #15, plus: (i) any additional generation that is operating or under construction but has not cleared in an FCA as of April 1, 2020, and (ii) any generation with an approved I.3.9 and that is still in the interconnection queue as of April 1, 2020. Individual cases will model amounts of capacity and energy-only resources consistent with their respective designs, unless otherwise noted. Retirement cases will retire oldest half in MW of the conventional oil and coal-fired steam units by 2025 and next oldest half in MW by 2030 (including dual fuel units)	(example) EE, solar photovoltaic (“PV”) and load projections will be based on 2020 CELT Forecast, but remove EE discount factors and use the FCA 14 methodology for Behind-the-Meter Solar PV adjustment and extrapolation of the CELT forecast out to 2030. There will be further discussion with the stakeholders on development of any material load sensitivities.	(example) Utilize the CELT 2020 electrification forecasts for the given analysis years.	(example) There will be further discussion with the stakeholders on development of any material battery or storage additions.	(example) When adding natural gas combined cycle (“NGCC”) generation, the location will first be assumed to be at the location of retired units and then at the Hub. When adding renewable/clean energy resources, their locations will be at locations consistent with resources in the current interconnection queue as of April 1, 2020 with the same relative proportion of MW at those locations (i.e., first include generation in the current queue and then add generation, if needed, proportionally based on current locations of generation in the queue); except that Offshore wind resources will be added at the ISO interconnection points closest to federally-designated Wind Energy Areas. Fuel price forecasts will come from the EIA data for New England. The impact of alternative fuel prices can be determined exogenously unless they affect the dispatch order of resources. Use high and low fuel price sensitivities to determine effect on dispatch order. After initial runs are done, determine whether any fine tuning of the EIA prices should be done to recognize seasonal price or basis differentials. There will be further discussion with stakeholders on how to model imports. Assume prices for RGGI allowances and prices for other environmental emission allowances. Specific assumptions of prices will be developed through further discussion with stakeholders
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2020 Economic Study Request

MC/RC Joint Meeting
July 1, 2020

nationalgrid

Motivation

- **Drivers**
  - States are increasingly procuring and assigning value to clean resource production
  - NESCOE 2019 Offshore Wind study showed high levels of renewable spillage
  - MIT's "Deep Decarbonization of the Northeastern U.S. and the Role of Canadian Hydropower" 2020 study demonstrated bi-directional transmission with Quebec complements high intermittent resource mixes in New England
- **Purpose**
  - Identify a potential pathway, leveraging transmission and battery storage, to meet state clean energy goals
  - Evaluate use of large scale, dispatchable reservoir hydro in fully integrating large penetrations of intermittent renewables cost-effectively
    - Scale of storage needs at high intermittent penetration likely to be met by a diversity of resources
    - Seasonal and resource diversity between New England and Quebec may be leveraged to the more effective achievement of state policy goals and benefit of customers

Study Overview

- **High-level Assumptions**
  - 2035 Study Year
    - Demand extrapolated from 2020 CELT
    - Heating load of ~9,500 GWh
    - EV load of ~7,000 GWh
    - 2015 weather year for wind and PV profiles
- **Scenarios**
  - Incremental resources: beginning with “base case”, varies offshore wind, solar and thermal retirements
  - Bi-directional: varies use of existing ties and additional ties to explore potentially up to 3,600MW of export capability to Quebec
  - Battery Storage: varies the amount of in-region battery storage with the lowest at 2,000MW as used in the NESCOE study
- **Deliverables**
  - Economic: Production cost, marginal prices, load-serving entity energy expenses, congestion, spillage, emissions, exchange with Quebec
  - Ancillary Services: load following/ramping, operating reserves, regulation

Status and Next Steps

- **Previous PAC presentations by National Grid and ISO-NE**
  - April 23, 2020 – National Grid request
  - May 21, 2020 – ISO-NE Assumptions Part I
  - June 17, 2020 – ISO-NE Assumptions Part II
- **Study will continue to progress at the PAC**
  - July 22, 2020 – ISO-NE Assumptions Part III
  - Q3 2020 – draft results expected and sensitivities identified
  - Q4 2020 – sensitivity results and draft ancillary services results expected
  - Q1 2021 – draft and final reports expected

Supporting the Future Grid Initiative

- **Carbon compliant resource mix**
  - "Base Case" meets 2035 legislated targets for the New England states, interpolating midpoints for target dates beyond 2035
- **Pathway with a focus on storage**
  - Provides a pathway emphasizing role of exchange with Quebec
    - Previous studies indicate Quebec may be utilized as a balancing resource, complementing intermittent renewables
    - Important to include this pathway option when analyzing operational issues as part of the Future Grid Initiative
  - Includes various levels of in-region battery storage for short-term storage
    - In combination with the long-term storage option provided by bi-directional exchange with Quebec, spillage may reduce, more effectively using renewables at all hours

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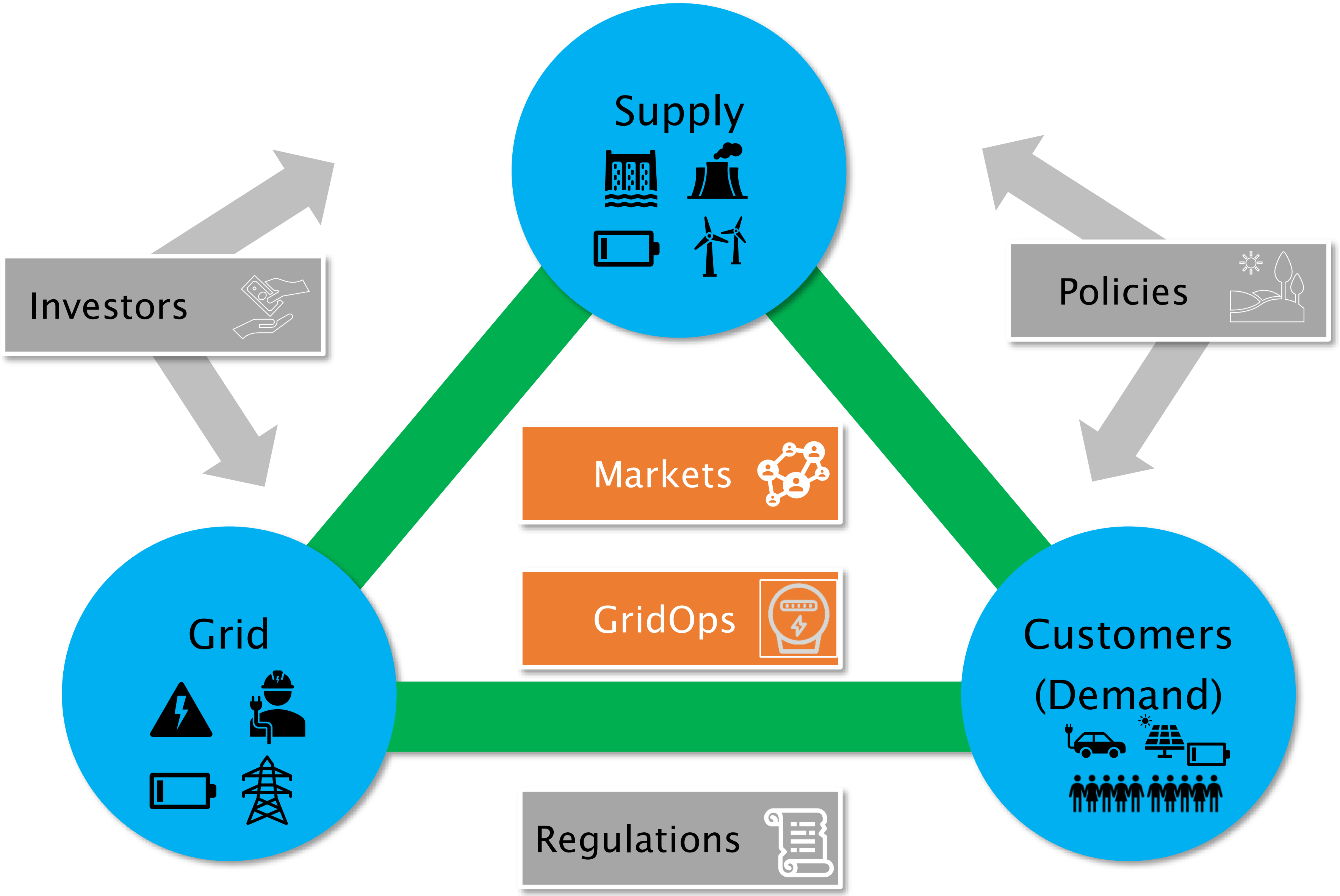
Eversource's Grid of the Future Study Methodology & Preliminary Results

Joint MC/RC Meeting

July 1st, 2020

Economic modeling and analysis performed by London Economics International on behalf of Eversource

Eversource's Grid of the Future Study analyzes the impact of decarbonization policy on the electric grid



Goal of the Study

- Quantify electric system changes needed to meet regional carbon emission reduction targets

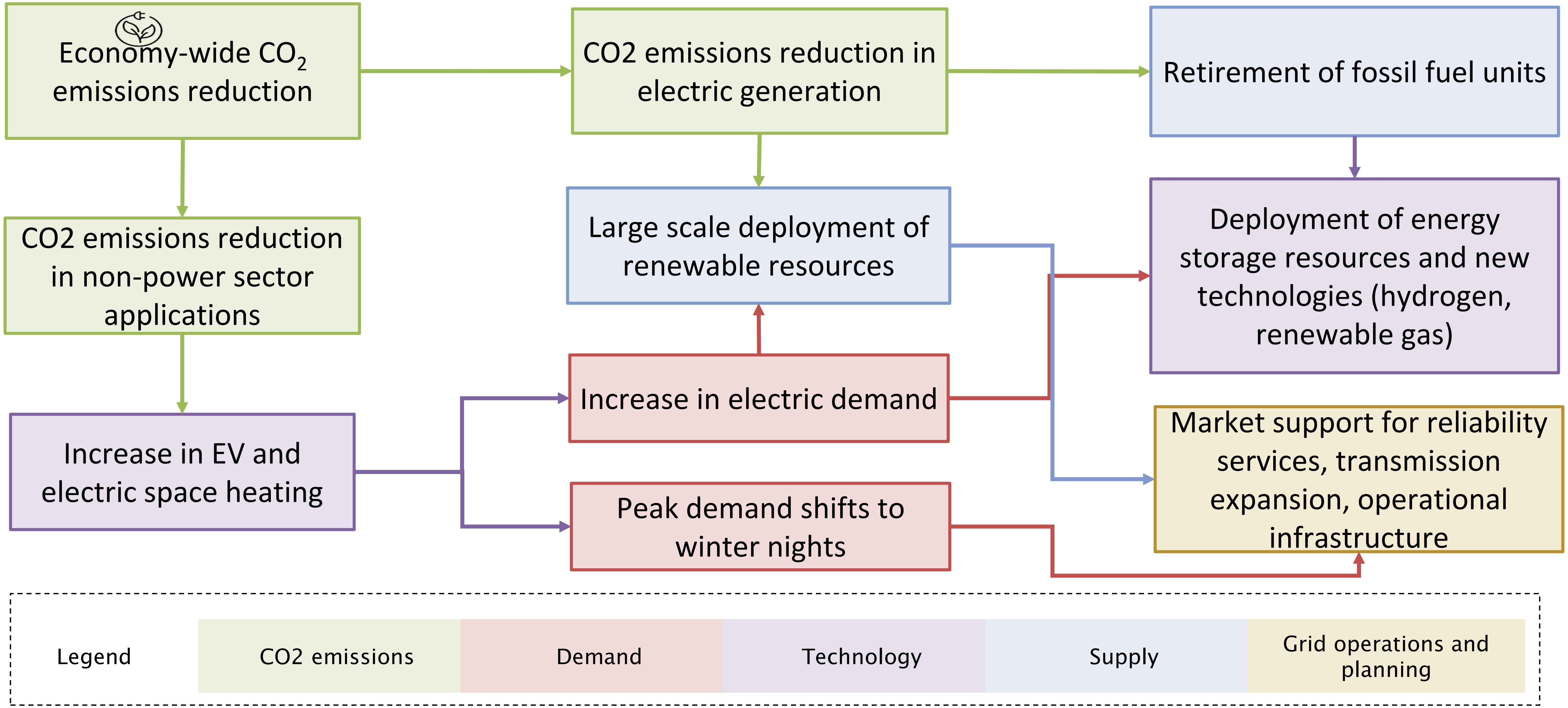
Eversource's Role

- Strategies and actions to enable a clean energy future reliably and cost effectively
- System planning and operational needs
- Resource adequacy and system attributes needed in the future
- Enable Transmission and Market policies.

Study Approach

- London Economics performed comprehensive industry research and hourly economic simulations for the next three decades to identify specific changes to the electric grid necessary to support decarbonization policies

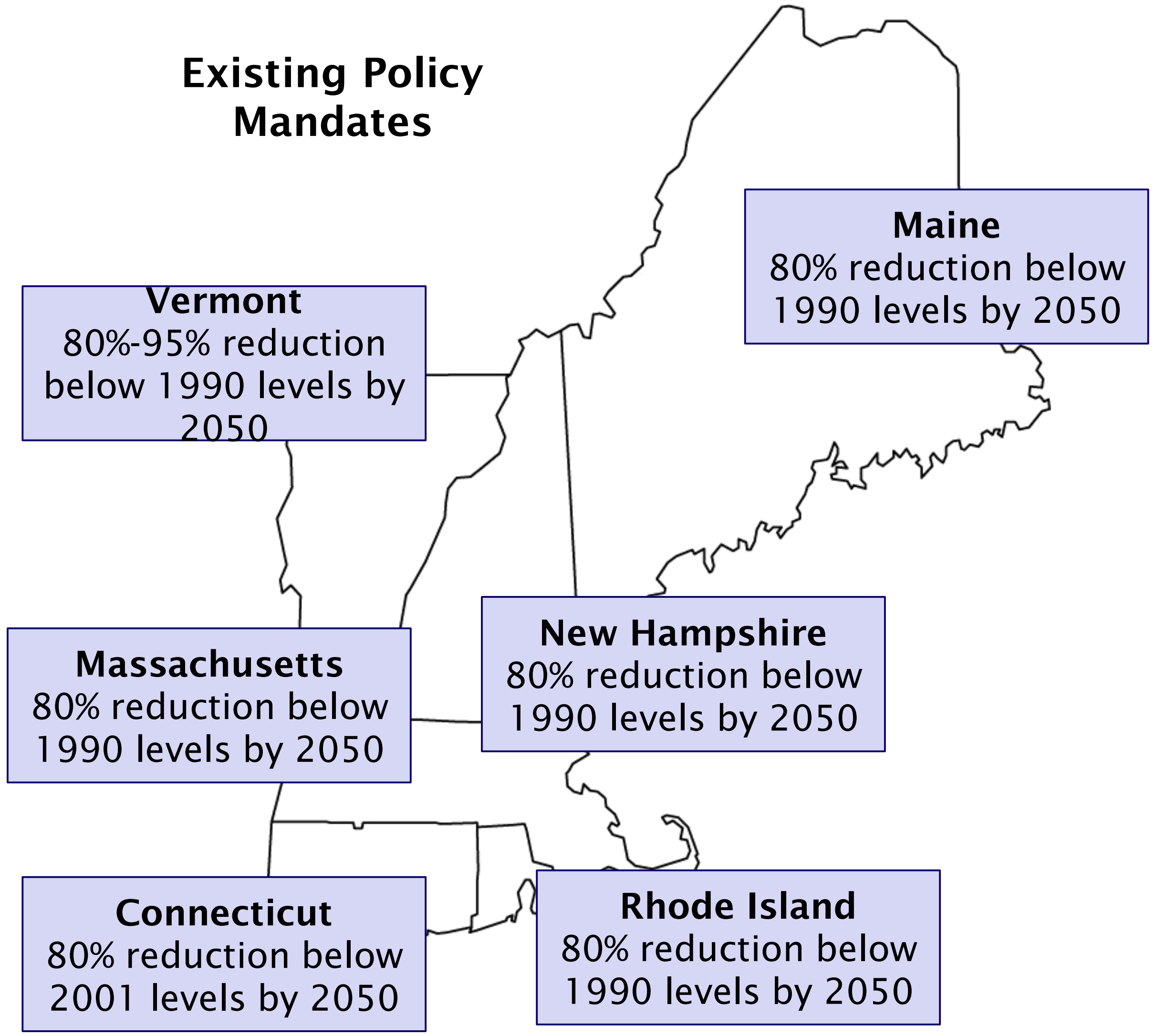
An economy-wide CO_2 emissions reduction would result in major changes to the electricity eco-system



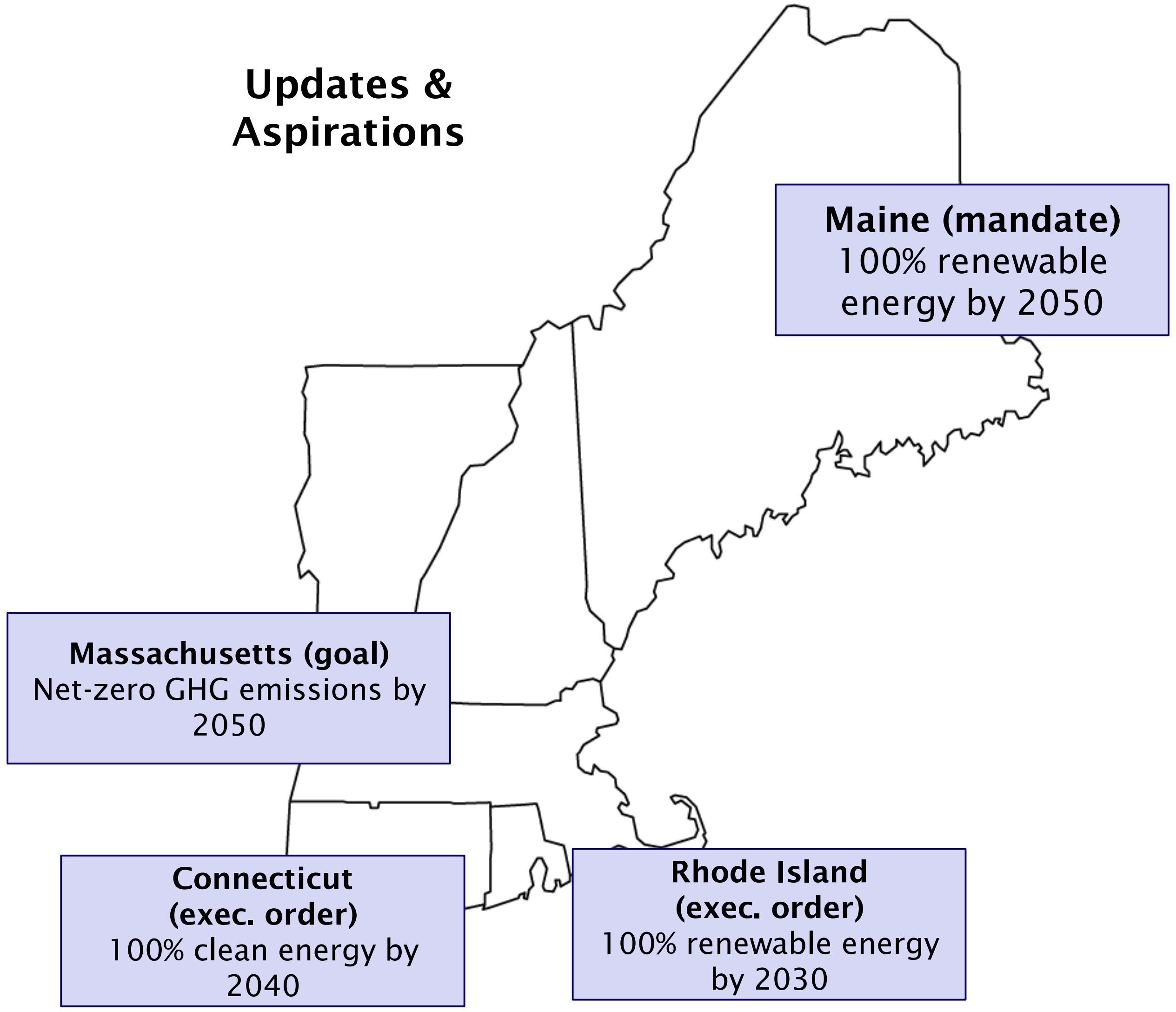
Study scenarios align with current decarbonization policies

Eversource Grid of the Future Scenarios

Existing Decarbonization Mandates
(80% reduction below target levels by 2050)



Aggressive Decarbonization to capture potential future policy
(95% reduction below target levels by 2040)



The Grid of the Future Study was intentionally designed to understand changes in all sectors of the economy and their impact on the Electric Grid

Traditional studies to date have focused mostly on individual sectors

Electric sector only accounts for ~14% of the carbon footprint of New England

Main carbon emissions source in New England is transportation, and we assume transportation sector would decarbonize by converting the passenger fleet to EV

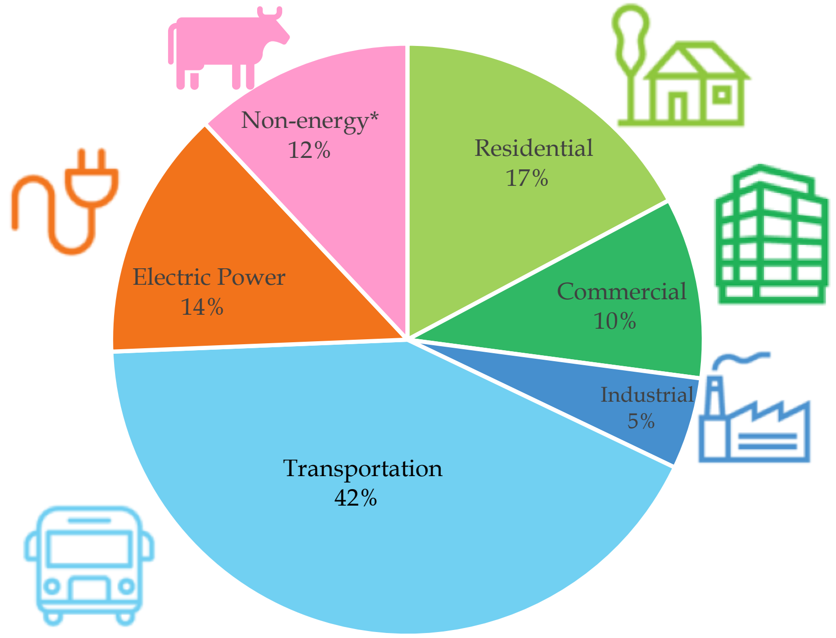
EVs account for 48% of emission reduction from 2020 to 2030 and 2030 to 2040

Decarbonizing other sectors of the economy will result in both higher demand for electricity and changes in demand dynamics

Current energy consumption is still heavily fossil fuel-reliant

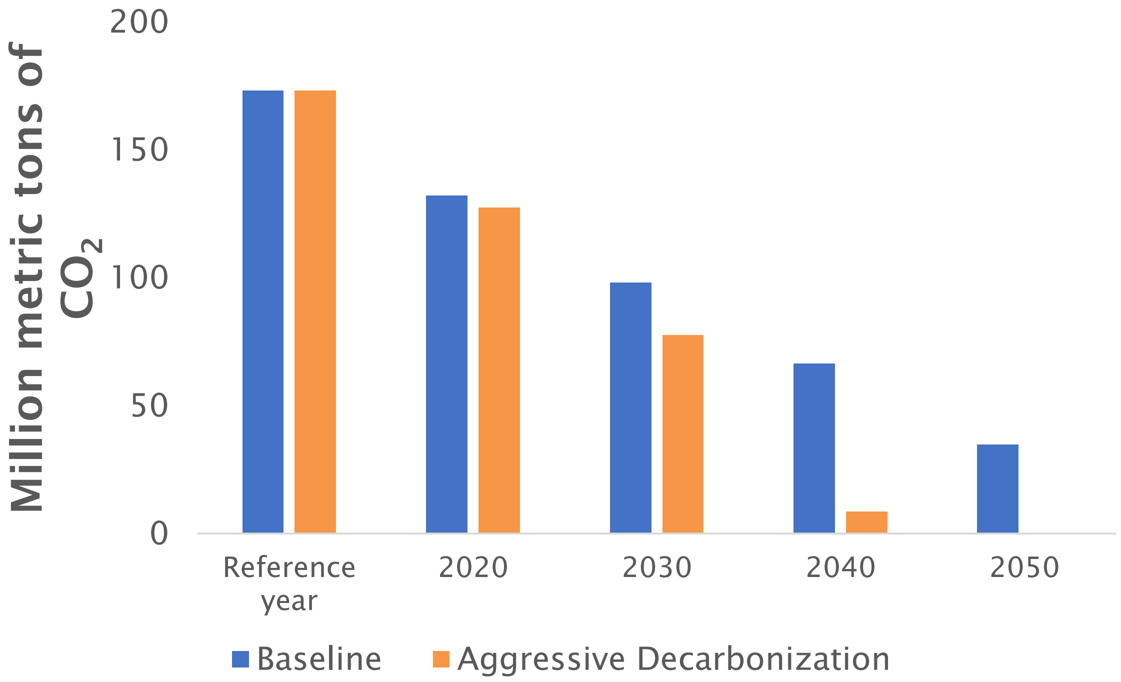
Major changes in supply mix and the grid are required to meet future objectives

Share of CO2 emission in New England (2017)

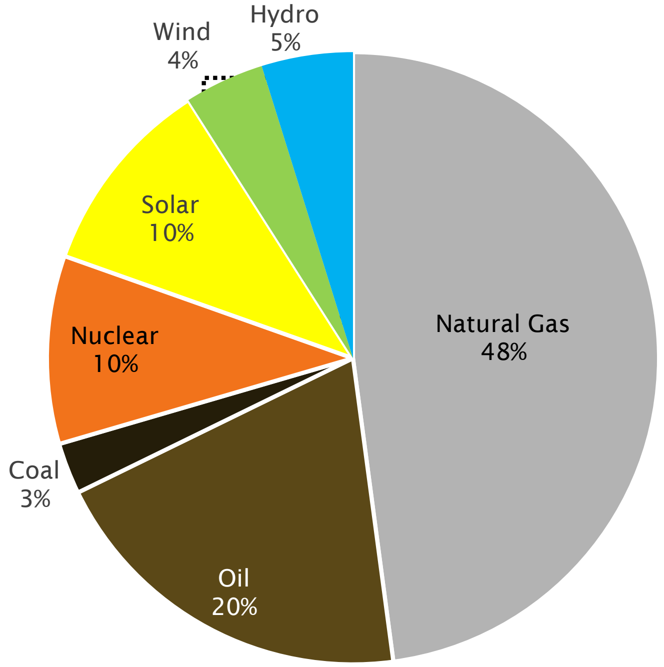


Source: EIA State Carbon Dioxide Emission Data and each state's GHG Inventory for non-energy emission

CO_2 Emissions reduction targets

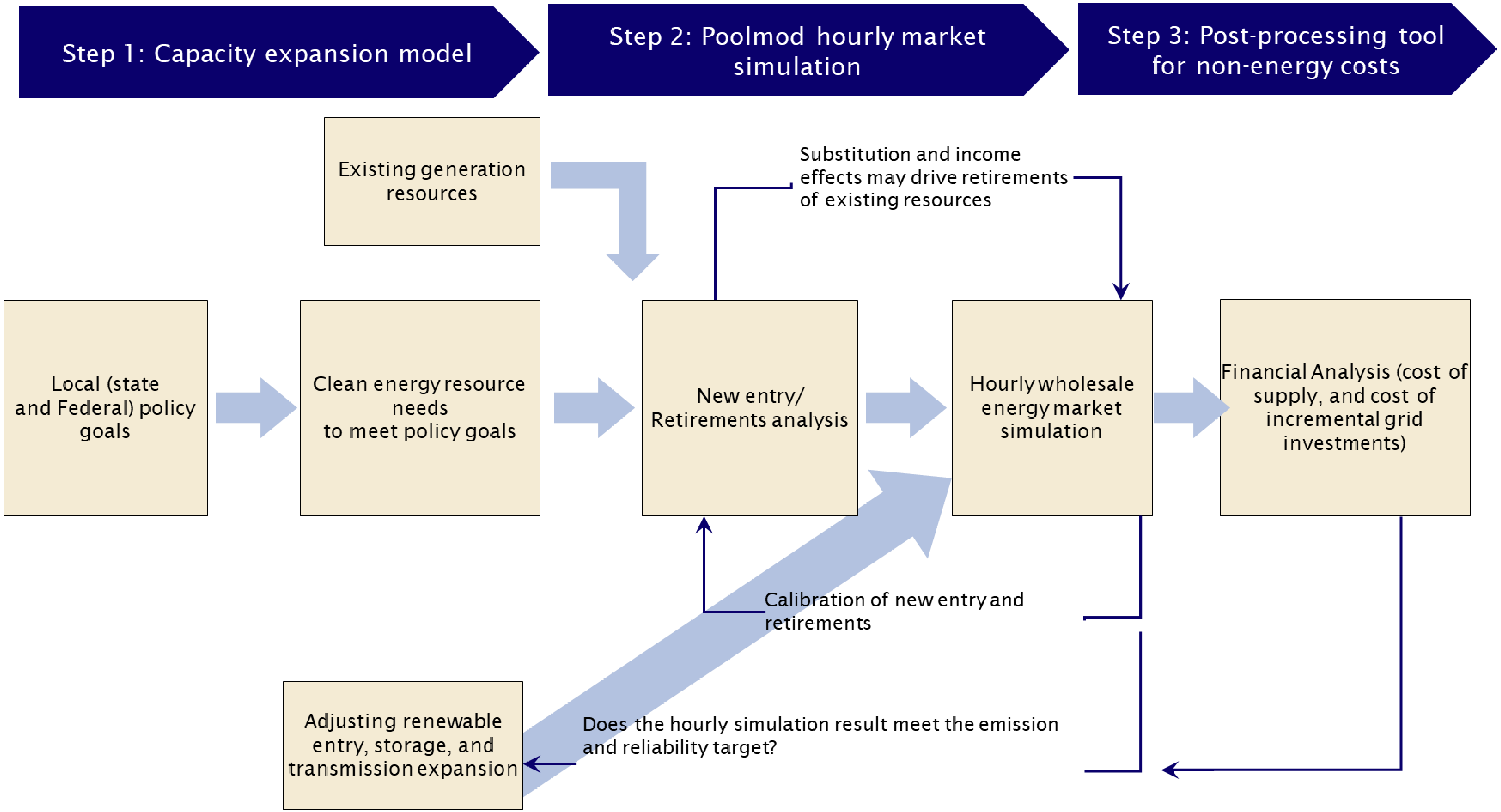


Installed capacity mix in New England (2019)



Source: ISO-NE Regional Energy Outlook 2020, LEI analysis

Three-step process deployed to simulate how carbon policy will impact energy system dynamics in New England



Study results identify significant demand changes in New England

- Net demand (TWh) will increase over the next three decades despite significant reductions from EE and BTM PV
  - By 2040, electricity demand from EVs would amount to 18 TWh (13% of net load) under the 80% by 2050 scenario
  - By 2040, electricity demand from ASHPs would amounts to 7 TWh (5% of net load) under the 80% by 2050 scenario

- Daily and seasonal demand dynamics will shift significantly due to electrification and more distributed technologies
  - System peak shifts from mid-day summer to mid-night winter
  - Intra-day ramping increases dramatically
  - System dynamics increasingly sensitive to flexible/responsive demand

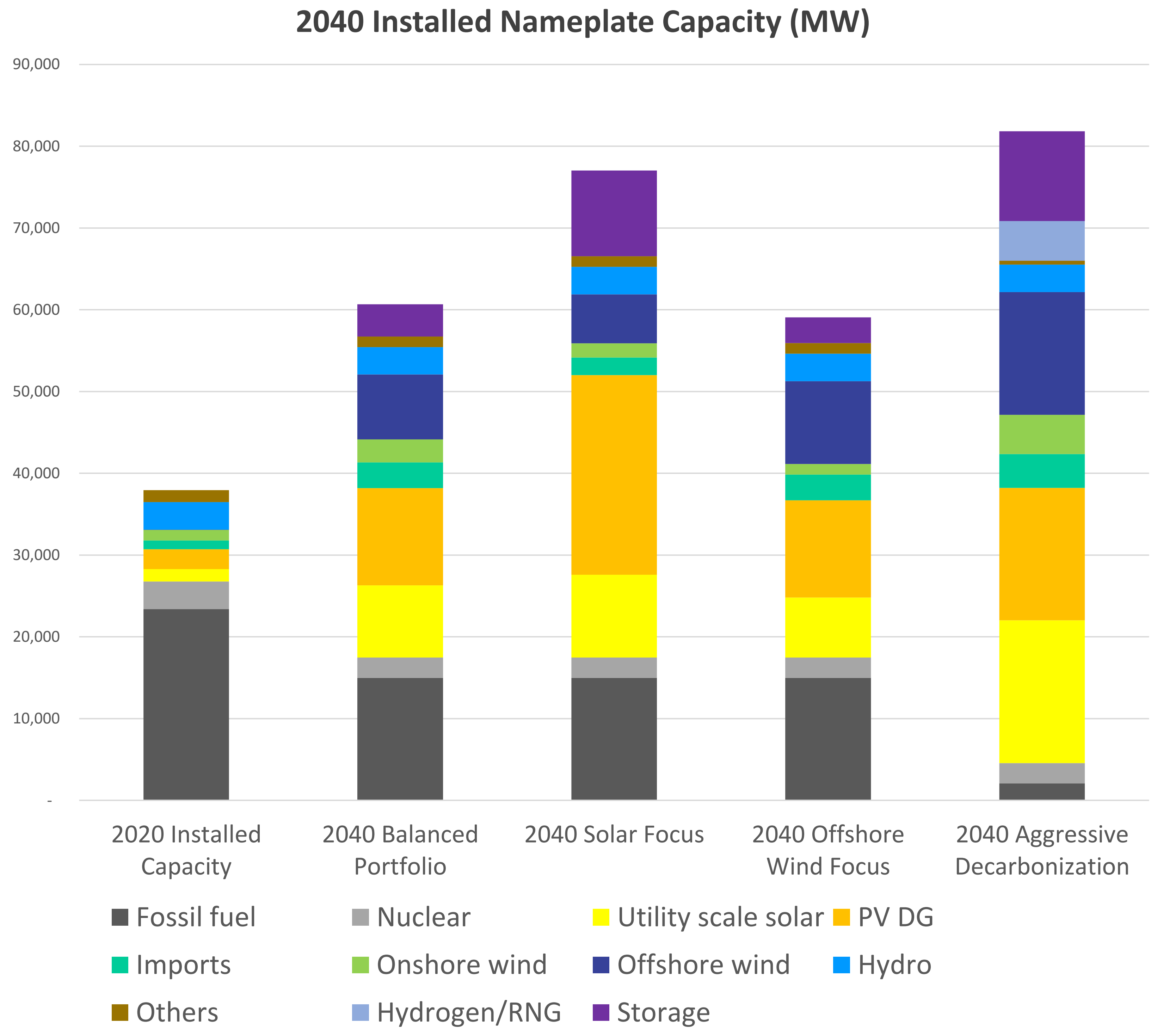
All scenarios require significant changes in supply by 2040 to reliably meet carbon targets

- New England would require 58 – 71 GW of installed generation capacity and 3 – 10 GW of storage capacity by 2040, depending on supply mix and carbon targets

- Continued operation of some Gas generation is necessary for reliability in all scenarios, but gas-fired generation has to be limited in order to meet emissions targets

- Aggressive decarbonization goals will likely require some new form of dispatchable low-emission generation (e.g. long-duration storage, RNG, etc.)

- Given the scale of new investment needed, energy market revenues alone are not sufficient – by 2040, the “missing money” is more than double the current size of the capacity market

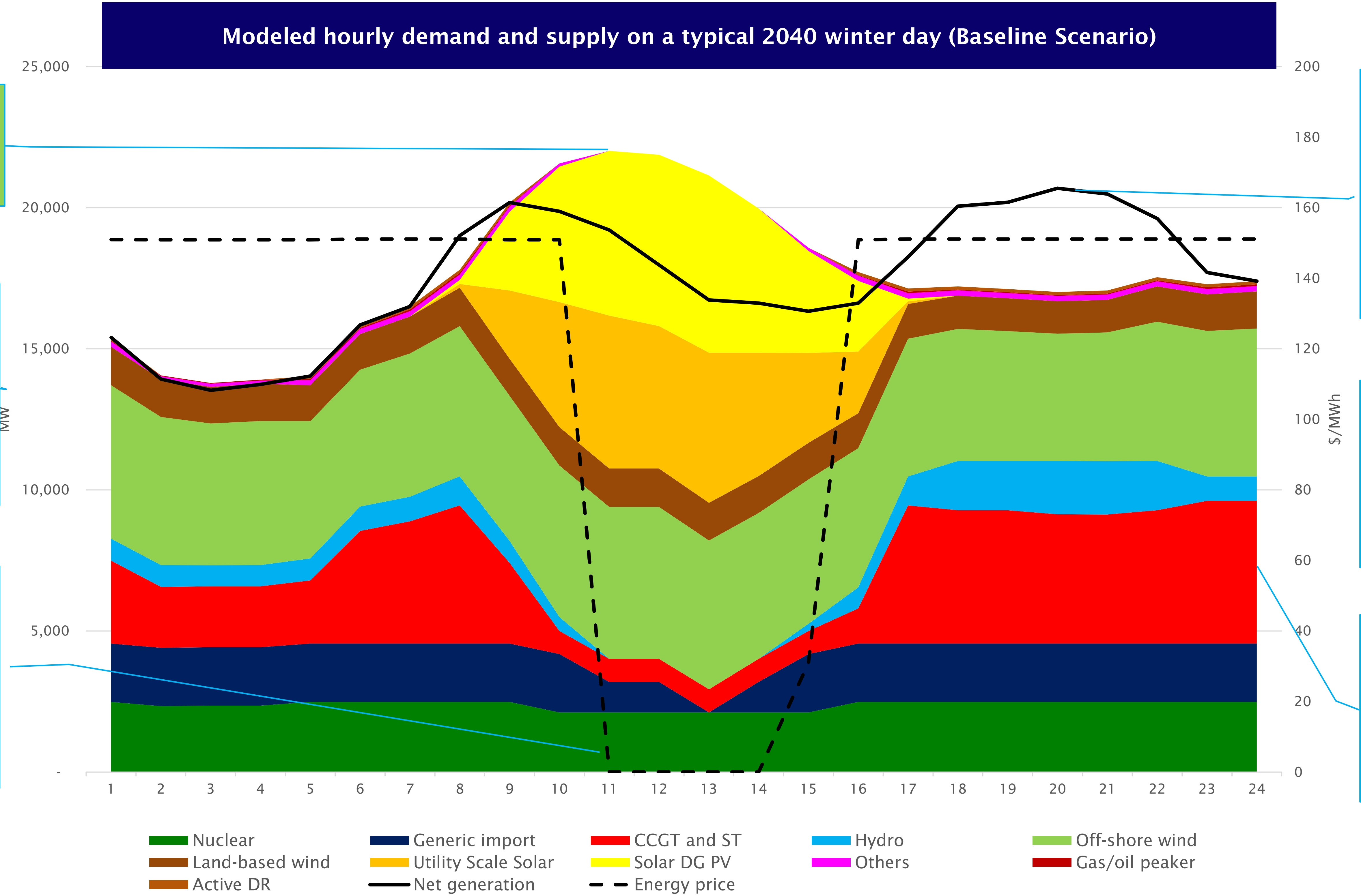


Hourly simulations shows daily excess solar generation by 2040 and value of battery storage in balancing demand and supply

Solar is no longer coincident with peak demand

Storage charges during mid-day when net demand is low (therefore total supply is higher than net demand in these hours)

Energy prices go to zero (or negative if negative bidding is allowed) during mid-day when there is excess solar generation



Net peak demand moves to night-time, mainly driven by EV charging after typical commute hours, and PV generation during mid-day

Storage discharges during late afternoon / evening when net demand is high

Dispatchable resources such as CCGT, ST, Hydro are needed to balance load

NEPOOL Markets & Reliability Committees

Overview of the Massachusetts 2050 Roadmap Effort

David Ismay
Undersecretary for Climate Change
Executive Office of Energy and Environmental Affairs

July 1, 2020

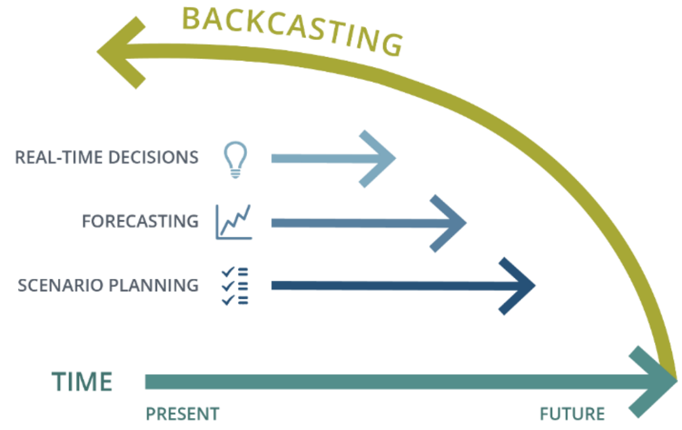
- Overview of Effort
- Methodology
- Timing & Impact

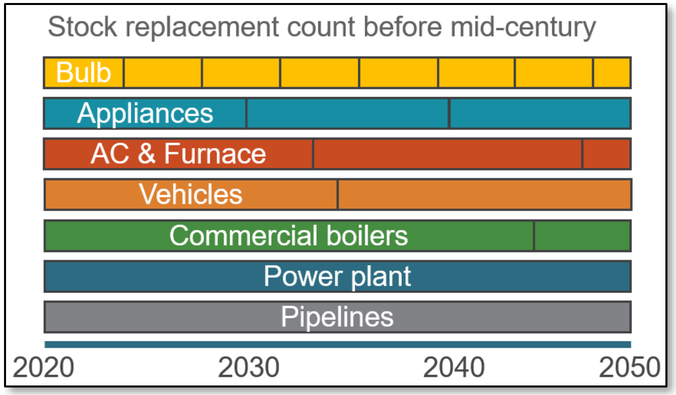
2050 Decarbonization Roadmap Effort

- *2050 Roadmap*: Identify and develop the strategies, policies, and implementation pathways by which MA can achieve new legal mandate for 2050:
  - Net Zero: at least 85% of 1990 level GHG reductions + sequestration

- *2030 Clean Energy & Climate Plan*: Priorities and requirements for the next decade:
  - *Tactical* - Programs & policies to achieve required 10-year emissions reductions in 2030
  - *Strategic* - Structural changes (markets and business models) to support sustained reductions post-2030

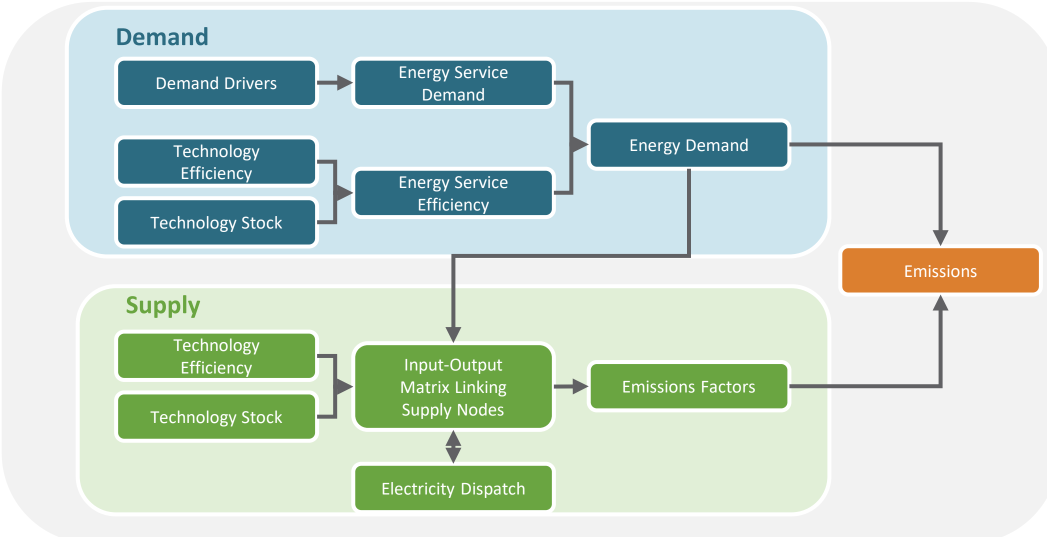
- Approach – Start with the "what" (Net Zero by 2050) and work backwards to understand the "how"
  - Policy is then set based on understanding the energy transitions required and physical options available in the context of other factors such as cost, feasibility, equity, etc.
- Method – Bottom up backcasting 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 GWSA-compliant futures;
  5. Produce very granular data (hourly dispatch; 5-year capacity time-step) data to enable decision-making re: <u>implementation</u>

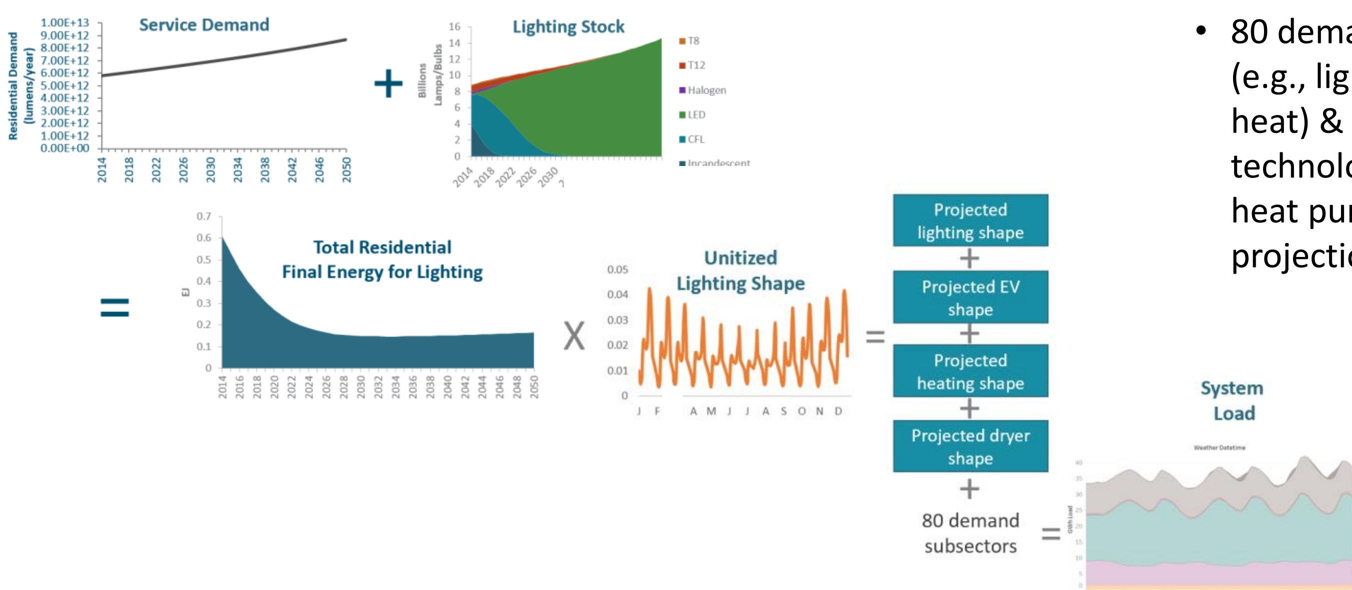




EVOLVED ENERGY RESEARCH

	ENERGY PATHWAYS	RIO
Description	Scenario analysis tool that is used to develop economy-wide energy demand scenarios	Optimization tool to develop portfolios of low-carbon technology deployment for electricity generation and balancing, alternative fuel production, and direct air capture
Application	EnergyPATHWAYS (EP) scenario design produces parameters for RIO's supply-side optimization: • Demand for fuels (electricity, pipeline gas, diesel, etc.) over time • Hourly electricity load shape • Demand-side equipment cost	RIO returns optimized supply-side decisions to EP: • Electricity sector portfolios, including renewable mix, energy storage capacity & duration, capacity for reliability, transmission investments, etc. • Biomass allocation across fuels

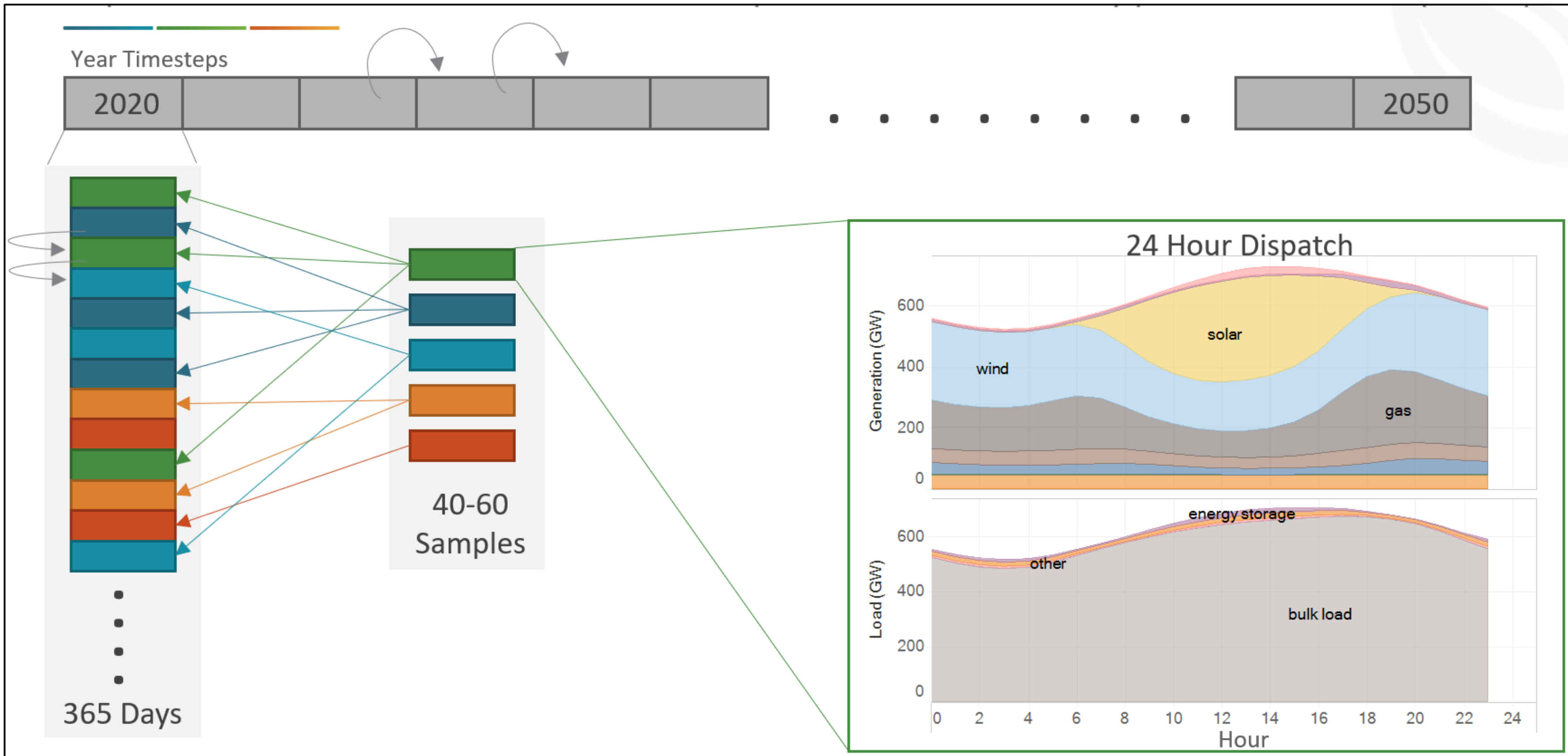




Comprehensive, bottom-up energy system modeling suite purpose-built for long-term decarbonization analysis:

- All commercialized energy supply technologies w/cost projections
- 80 demand subsectors (e.g., lighting, space heat) & 360 demand-side technologies (e.g., LEDs, heat pumps) w/cost projections

Operations and investment decisions are co-optimized iteratively across the study period to find optimal, reliable emissions-compliant portfolio.



RIO decisions variables and outputs

Hours

24 hr * 40 – 60 sample days
= 960 – 1440 hr

Decision Variables	Key Results
Generator Dispatch	Hourly Dispatch
Transmission Flows	Transmission Flows
Operating Reserves	Market Prices
Curtailment	Curtailment
Load Flexibility	

Days

365 days * 1-3 weather years
= 365 – 1095 days

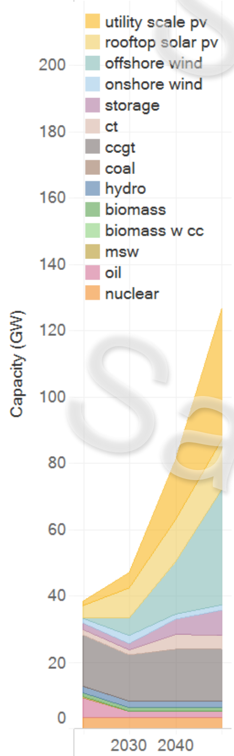
Decision Variables	Key Results
Fuel Energy Balance and Storage	Daily Electricity Balances
Long Duration Electricity Storage	Daily Fuel Balances
Dual Fuel Generator Blends	

Years

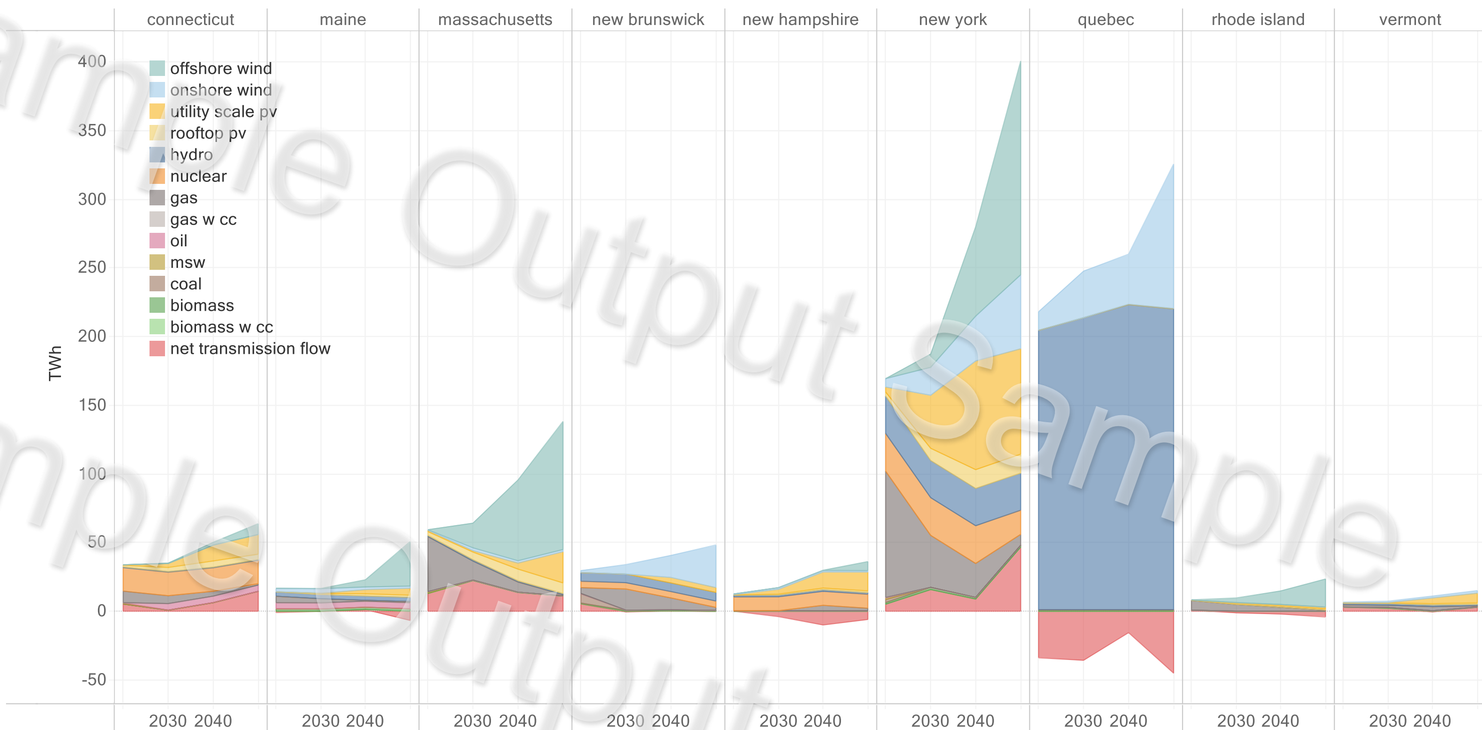
30 yr study / 2 – 5 yr timestep
= 6 – 15 years

Decision Variables	Key Results
Emissions from Operations	Total Annual Emissions
RPS Supply and Demand	RPS Composition
Capacity Build, Retirement & Repower	Incremental Build, Retirement, & Repower
	Thermal Capacity Factors
	Annual Average Market Prices
	Marginal Cost of Fuel Supply

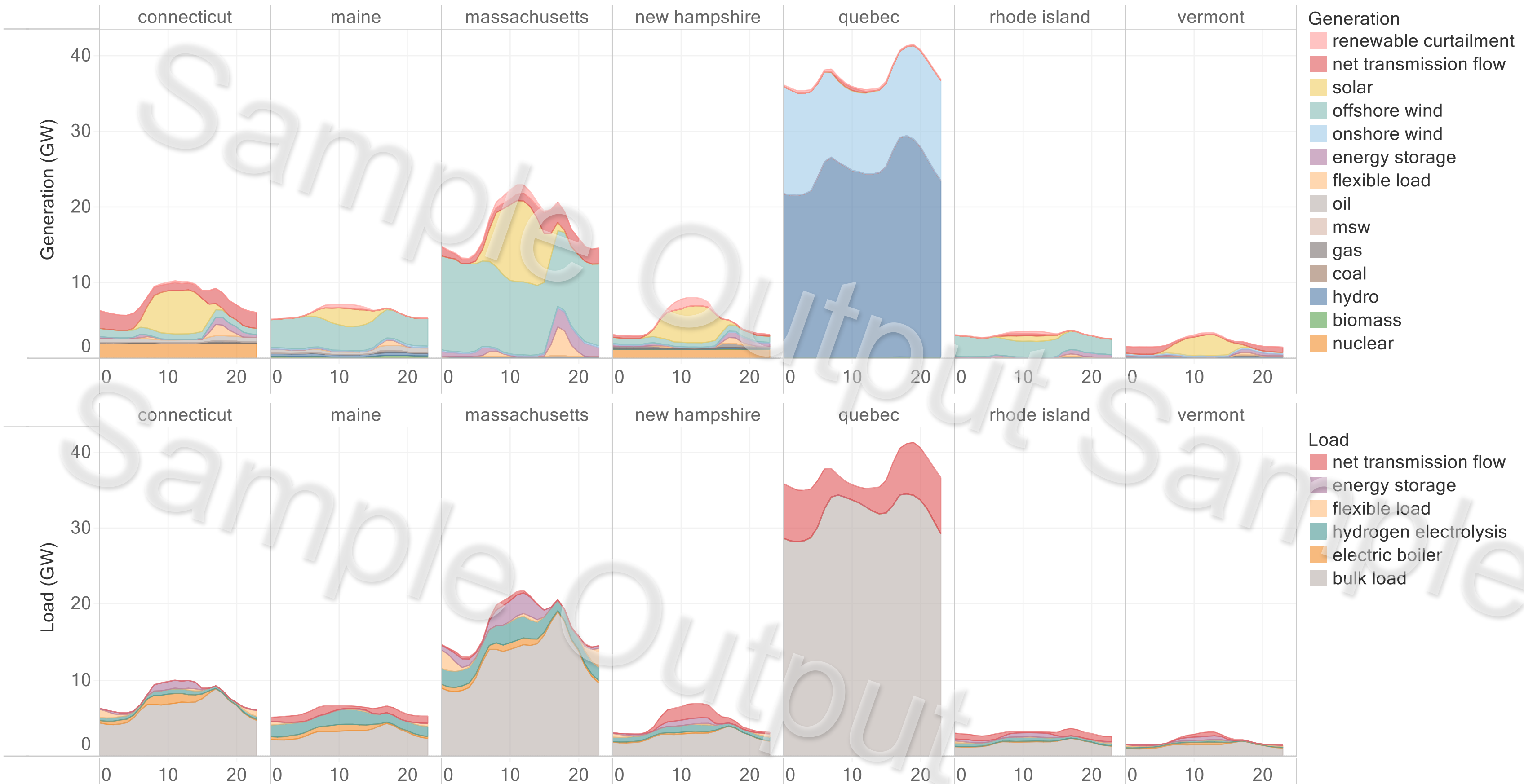
Installed Capacity



Supplied Generation



Hourly System Operations



Transmission

Timing & Impact

- Review initial results of long-range 2050 scenario analysis (Now)
  - More than a half-dozen, complete scenarios
  - Detailed total cost analysis
  - Driving MA policy and action for 2020s
- Work through NESCOE to share full results with colleagues in all New England states (June – Aug.)
  - Relevant to discussion re: achievement of state climate laws
- Full public release expected this Fall (Sept. – Oct.)

2050 Roadmap Website: https://www.mass.gov/info-details/ma-decarbonization-roadmap

Contact: David Ismay, Undersecretary for Climate Change

david.ismay@mass.gov

(617) 626-1144

Analytical Framework - Grid Transformation Analysis

Joint RC/MC Teleconference Meeting
July 1, 2020

Brian Forshaw
Energy Market Advisors LLC

Energy Market Advisors LLC

Overview

- *ISO-NE Objectives*
- *Overarching Assumption/Focus of Presentation*
- *Proposed Analytical Framework*
- *Analytical Tools*
- *Questions & Comments*

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ISO-NE Objectives

- The current ISO objectives were initially developed in the late 1990s when we were transitioning from a cost-based construct to an offer-based construct.
- What has been missing is consideration of how these objectives have led to the situation we are in today.
- We need to consider whether new objectives might be necessary to achieve the outcomes anticipated desired by consumers and state policymakers.

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Focus & Overarching Assumption

- *Our focus is on developing an analytical framework that can be applied no matter what assumptions and resource mix scenarios are assumed.*
- *Overarching assumption is that resources to meet regional energy and environmental policies will be developed irrespective of how they participate in the wholesale markets.*
- *Leave it to the the Committees figure out how to identify the mix of resources & other assumptions to meet these objectives.*

Proposed Analytical Framework

- *Under the current Market Rules there are 2 ways that resources can interconnect and participate in the wholesale markets.*
  - *Resources with capacity network interconnections (CNRIS) can participate in the Capacity, Energy & Ancillary Service markets.*
  - *Resources with minimum interconnection service (NRIS) can only participate in the Energy & Ancillary Service markets*

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Proposed Analytical Framework (cont.)

- *The Grid Transition Analysis should consider the two options that policy resources have for interconnecting and participating in the wholesale markets across all scenarios and cases*
  - *All policy resources would be CNRIS and participate in Capacity, Energy, and Ancillary Service markets.*
  - *All policy resources would be NRIS and only participate in the Energy & Ancillary Service markets.*

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Proposed Analytical Framework (cont.)

- *If the policy resource cannot get a CSO through the FCA (either due to the MOPR or the CASPR test price) or if the cost of a CNRIS is too high, NRIS may well become the preferred outcome.*
- *Resources participating as CNRIS and NRIS can have different implications for consumer costs, payments to resources, system operations, resource adequacy, and other metrics.*

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Proposed Analytical Framework (cont.)

- *It appears that most have assumed all resources would be CNRIS and participate in all wholesale markets.*
- *While NRIS resources may need additional non-wholesale market support, understanding the broader implications will be helpful in evaluating potential "gaps" in the market.*
- *This approach is consistent with the ESI Condition Cases (Frequently, Infrequently, and Extended Stress Cases).*

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Analytical Tools

- ISO does not currently have a tool to develop estimated Forward Capacity Market prices in its planning studies.
  - This has been an issue in interpreting the results from previous Economic Studies.
- To help evaluate the implications of various resource mixes, a capacity “optimization” tool should be developed to help evaluate both competitive entry and exit from the markets under the future policy resource scenarios.

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Questions?

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INPUT OF ADVANCED ENERGY ECONOMY ON *TRANSITION TO THE FUTURE GRID* STUDY

NEPOOL Joint MC/RC Meeting

July 1, 2020

About Advanced Energy Economy

- AEE represents **more than 100 companies** and organizations that span the advanced energy industry and its value chains.
- **Technologies represented** include energy efficiency, demand response, solar photovoltaics, solar thermal electric, wind, energy storage, electric vehicles, advanced metering infrastructure, transmission and distribution efficiency, fuel cells, hydro power, advanced nuclear power, combined heat and power, and enabling software.
- Used together, these technologies and services will create and maintain a **higher-performing energy system**—one that is reliable and resilient, diverse, cost-effective, and clean—while also improving the availability and quality of customer-facing services.

Overview of AEE Perspective

Start now, and initiate **discussion of potential market reforms** simultaneously

Consider the **path from A to B,** not just what happens when we reach point B

Ensure analysis is robust and prioritizes **actionable insights** through an efficient process

AEE's input on the Future Grid Study - Sept. 2019*

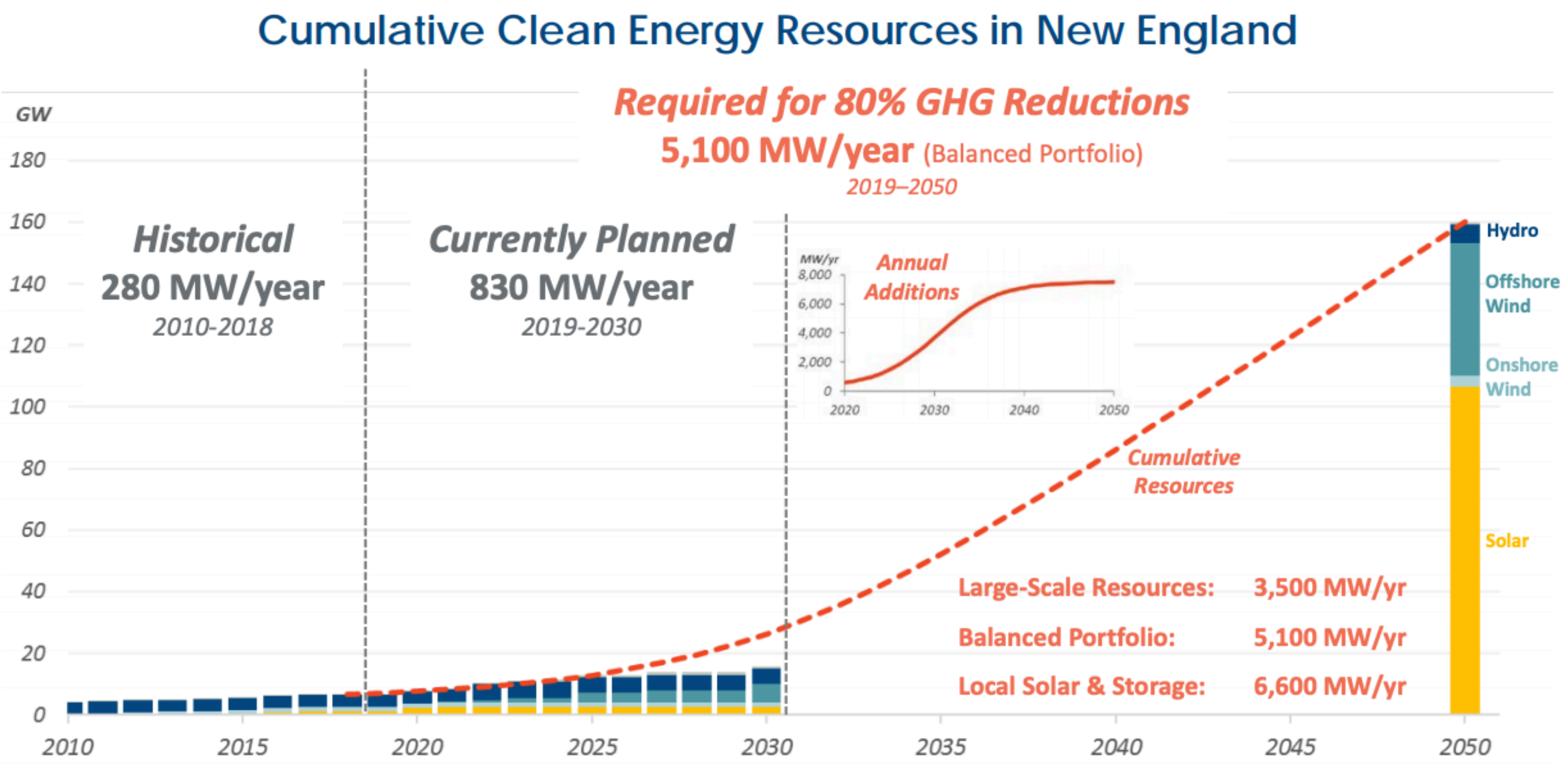
"As… market and policy drivers move the region to become more dependent on a mix of distributed energy resources, variable renewable energy generation, and load reduction and dynamic load shifting, ***it will be important to ensure that these and other advanced energy resources are able to fully participate*** in the [ISO-NE markets].

… as technology advances and the economics of the existing fleet change, ***a comprehensive look at barriers to participation faced by non-incumbent resources,*** in particular, will ensure that they are able to compete to provide all the wholesale services they are technically capable of providing and that a reliable system requires.

… as the resource mix shifts ***grid operators and planners may need different tools*** to maintain reliability in both day-to-day operations and long-term planning."

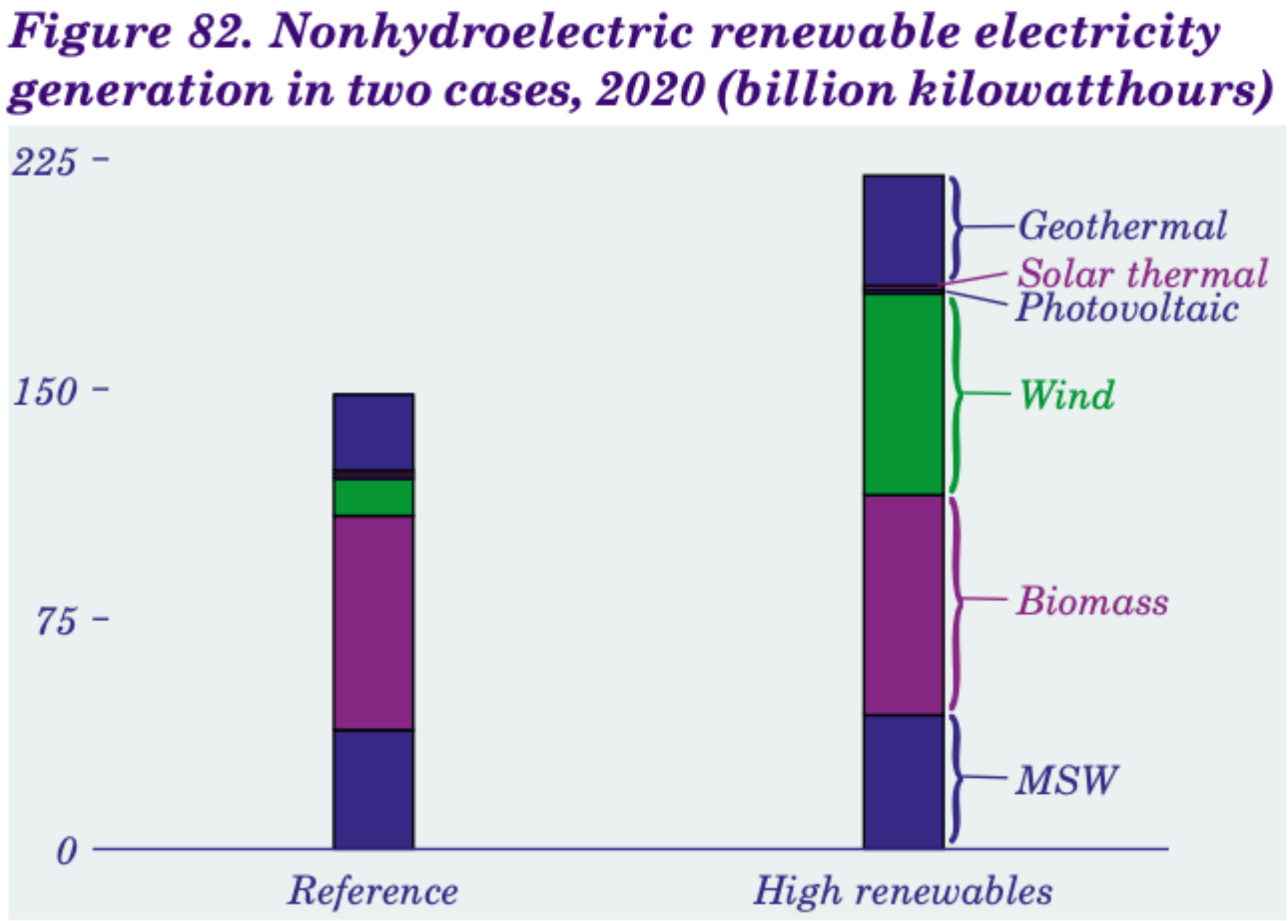
*Excerpts from letter to ISO-NE, shared with NEPOOL PC, emphasis added.

There is a path to 2050 goals, but it departs from BAU



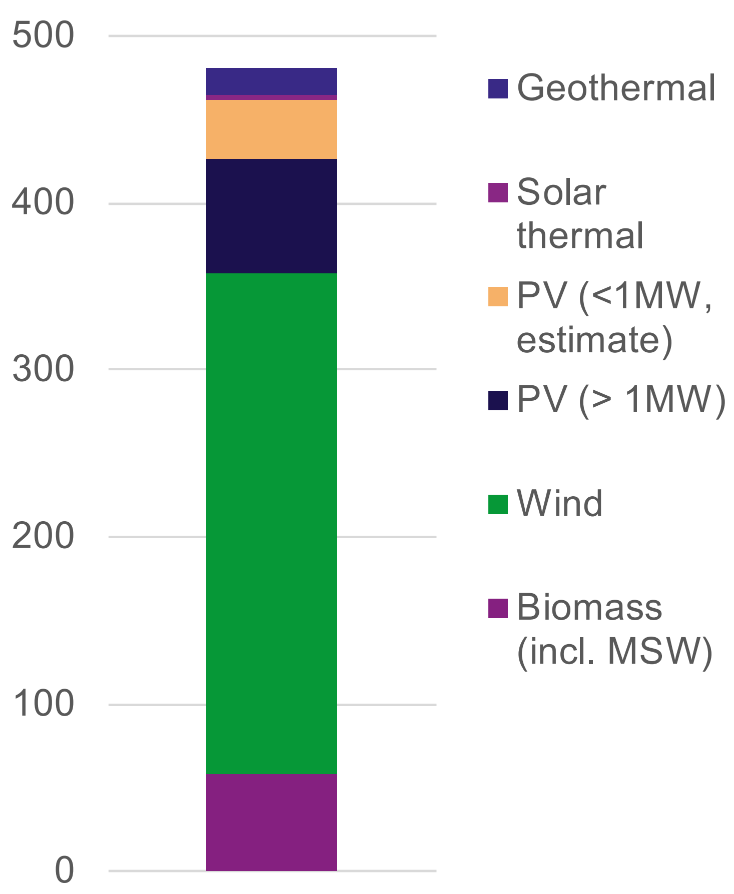
Source: The Brattle Group (2019)

Good news: Technology consistently outpaces projections



Source: EIA AEO 2000

Actual 2019 renewable electricity generation (billion kilowatthours)



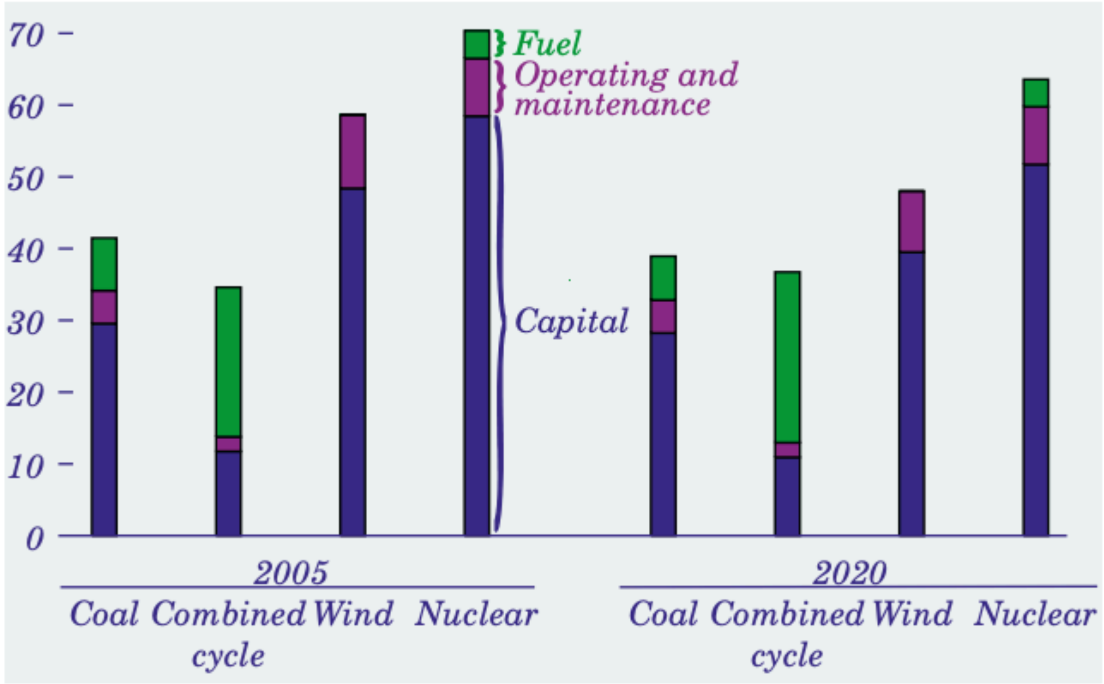
Source: EIA 2020
https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

In 2000, EIA projected **12 billion kWh wind** and **1.3 billion kWh solar PV** in 2020.

Actual data from 2019 shows **300 billion kWh wind** and **104 billion kWh solar PV.**

Generation costs have also fallen faster than expected

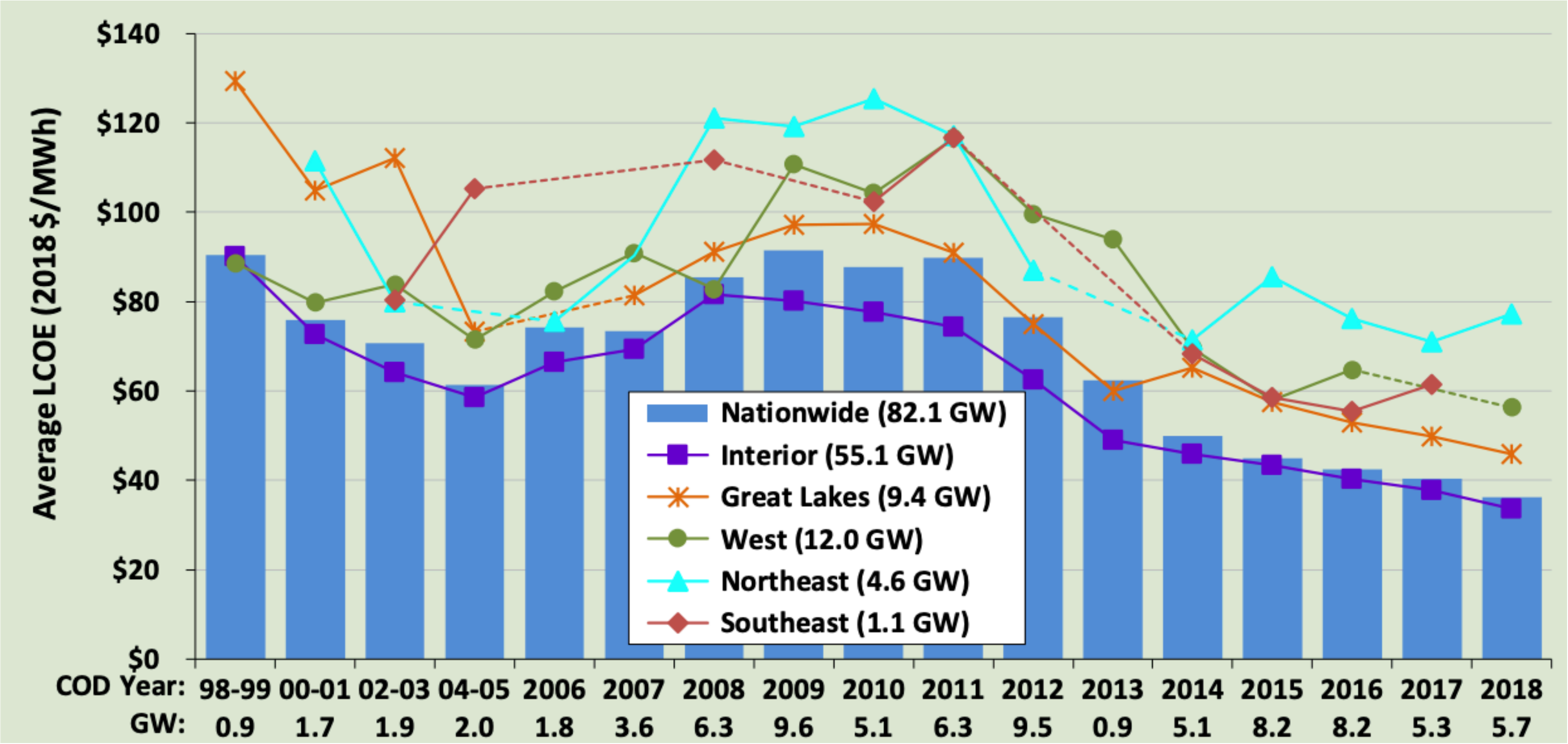
Figure 72. Electricity generation costs, 2005 and 2020 (1998 mills per kilowatthour)



Projected 2020 Wind Cost: ~$77/MWh (adjusted for inflation)

Source: EIA AEO 2000

Generation-weighted average wind LCOE values (excludes PTC)



Actual 2018 Wind Cost: ~$36/MWh

Source: DOE 2018 Wind Technologies Market Report

Meanwhile, technical capabilities have evolved

Service	Market Procured and Compensated Service?	Wind Can Technically Provide?[a]	Wind Currently Provides in U.S.?	Requires Pre-Curtailment for Wind to Provide?
Capacity	Y	Y	Y	N
Energy	Y	Y	Y	N
Inertial Response	N	Y	N/A	No[b]
Primary Frequency Response	Required but not compensated – proposals only	Y	Limited	Y
Fast Frequency Response	N – proposals only	Y	Limited	Y
Regulating Reserves	Y	Y	Limited	Y
Contingency – Spinning	Y	Y	Limited	Y
Contingency – Non-spinning	Y	Y	No	Y
Contingency – Replacement	Y	Maybe	No	Y
Ramping Reserves	Y (some locations)	Y	Limited	Y
Voltage Support	Y – cost of Service	Y[c] – location dependent	Limited	N
Black-Start	Y – cost of Service	Unclear, location dependent	No	N

Grid Services and Provision from Wind

Source: NREL 2019

- Studies show that inverter-based resources like wind, solar, and batteries *can* supply a range of grid services, if incentivized and integrated accordingly

https://www.nrel.gov/docs/fy19osti/72578.pdf

AEE's Key Question & Overarching Recommendations

Will the markets, as designed today, gets us to the future and meet future needs in a technology-neutral way?

1. Allow for study and discussion of the **transition** to the future, in addition to the end state
   - Gaps in market design to *maintain* a reliable system when a future resource mix is already in place likely differ from gaps or barriers to *achieve* that future mix
   - Could be studied as part of the Future Grid Study or in parallel
2. Provide for iterative, simultaneous discussion of **potential market reforms**
   - Study results will inform market reform discussions—the reverse can also be true if discussions occur in tandem
   - Reforms will take a long time to consider and implement; the process should start now
3. Ensure the study process produces **robust and actionable** results
   - Specific recommendations are outlined on subsequent slides

Specific Study Recommendations – Study Assumptions

- **Scenarios:**
  - All study scenarios should be consistent with achievement of current state policies
  - Some scenarios should assume that states will set *more* stringent targets
- **Inputs:**
  - Inputs should acknowledge the rate of technology change, which tends to outpace projections
  - Inputs should consider the potential for technical breakthroughs (e.g., Brattle's NYISO study uses RNG prices as proxy for a range of potential technologies, including hydrogen, flow batteries, gravity storage, and RNG)
  - Inputs should acknowledge the two-way impact of electrification of heating and transportation, i.e., consider both load *growth* and increased load *flexibility*

Specific Study Recommendations – Study Focus

- Identify **grid services and operational tools** needed to address reliability gaps, not specific technologies needed to deliver those services
  - A focus on services will allow for innovation, e.g., IBRs now provide various reliability services, and are technically capable of providing others
    - Frequency regulation offers a recent example of a grid service that has been defined and is now procured on a technology-neutral basis (FERC Order No. 755)
  - Should include assessment of whether markets are equipped to make full use of demand flexibility and demand-side resource participation
- Focus study on **developing new insights** needed to inform market reform discussions
  - Focus on the key questions (e.g., Gordon van Welie March 10 presentation)
  - Build on what we already know (as discussed by NESCOE May 27)
  - Trying to "intercept the asteroid" (Pete Fuller's May 27 presentation) will add time and complexity, and is not needed to identify market gaps

Specific Study Recommendations – Study Resources

- Rely on **studies already completed** and/or underway in New England
  - NESCOE May 27th presentation and NEPOOL Future Grid Library
- Incorporate **lessons from elsewhere**
  - How are other countries / regions handling higher penetrations of RE and DERs?
  - What ideas or technologies are being explored elsewhere?
  - NYISO study process: NYISO's initial *Grid in Transition* study identified near-term market gaps for stakeholder discussion, while The Brattle Group is working on a detailed longer-term analysis
  - MISO's Renewables Integration Impact Assessment (RIIA) is looking at the transition to increasing levels of RE over time to identify grid services and infrastructure needs

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Future Grid – Further Thoughts on a Path Forward

NEPOOL MC/RC – July 1, 2020

Peter D. Fuller

Presented with the endorsement of NEPOOL Members NRG Energy and Sunrun

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Overview

- **Our themes from last month:**
  - **Will our current market designs support a <u>reliable</u>, <u>low-carbon</u> system? And if not, what should we do about it?**
  - **Any 'gap analysis' should be looking for directional indicators, not precise specifications**
  - **Begin a parallel effort to educate each other and vet potential solution options**
- **Today's topics:**
  - **Dissecting the big questions**
  - **Identifying gaps is an input, not an output**
  - **Given what we already know, the general outlines of the 'gaps' are evident**
  - **Collaborative investigation of solution options → parallel track**

Dissecting the Big Questions

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- **Will our current market designs support a <u>reliable</u>, <u>low-carbon</u> system? And if not, what should we do about it?**
  - **'current market designs' – LMP-based energy market, co-optimized reserves (and ESI), forward capacity**
  - **'support' – will these markets produce sufficient revenues for investors and resource operators to commit their capital, engage their energy demand, or develop innovative technologies and business models to take part in contributing to balancing supply and demand?**
  - **'<u>reliable</u>' – ensuring the system can successfully balance supply and demand at all relevant time-scales – momentary to hourly to daily to seasonal to annual to several years forward**
  - **'<u>low carbon</u>' – regardless of the precise metric or state policy target, the future power system must have substantially lower net carbon emissions than today's**
  - **'what should we do' – what system and resource characteristics and capabilities are going to be important and valuable in that future system, especially those things that are not explicitly recognized as important/valuable in today's markets?**

There is no model that will ‘identify gaps’

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- Models simulate what is or what might be, not what isn’t
- In order to get a model to help us identify gaps in our markets, we need to hypothesize what those gaps are and use models to test our hypotheses
- A good example – the recent NESCOE Economic Study of Ancillary Services
  - The study request asked ISO to look at “new grid opportunities [that] may be identified to address challenges, including load following, regulation, operating reserves, and operation during low-load periods …”
  - ISO analyzed the ancillary services we are familiar with as well as other physical quantities that ISO measures and tracks, and found that in many respects the existing products and quantities are insufficient to support a high-renewables system
  - In addition to potentially more of our existing A/S and potentially new ones, the study results also point to ‘balancing’ as a key system function that may be challenged in a high-renewable future

Hypothesis – Where are the gaps likely to be?

- What system characteristics and capabilities do we take for granted today that may be in short supply in a future with a high-renewable resource mix?
  - Rotating inertia for stability
  - Rapid and frequent ramping capability to adapt to changes in net demand
  - Energy availability in all seasons
  - Seamless ability to integrate distributed resources and flexible demand
- What capabilities are becoming technically and economically feasible that could alter future system dynamics?
  - Grid-scale energy storage with fast response times
  - Distributed resources and demand response (both dispatchable and autonomous)
  - Electrification of transportation and heating sectors
  - Advanced inverters and power electronics

What gaps do we already know exist?

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- The value of carbon, or of avoiding carbon and other GHG emissions
  - Today's markets do not include a value for carbon commensurate with the value that state policies imply for it
- Ancillary services
  - A more distributed, digital and inverter-based fleet has different physics than the 20th century resource mix
    - Where will system inertia and stability come from?
    - How will the system handle extended periods of no wind or sun?
    - What other aspects of system operability and reliability have we taken for granted that will need to be explicitly valued in the future?
- System Architecture
  - How do we effectively integrate distributed resources into planning and operations?

Shared education and solution vetting

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- At the August meeting we hope to begin discussions on these and other topics -
  - Carbon
    - Carbon fee/price/tax? Carbon cap-and-trade/invest? Electric sector only? Broader application to other sectors?
    - Forward Clean Energy Market
      - Relationship to RPS? Relationship to FCM and other ISO markets? Relationship to existing contracts? Roles of ISO, states, others?
  - Ancillary Services
    - New products? Re-defined/expanded products? How to establish quantity requirements? Role of NPCC/NERC?
  - There may be other options to discuss, and there are certainly countless more questions on each of them that warrant discussion even before we know the full results of the gap study

Next Steps

- Qualitative inventory of ancillary service and other ‘gaps’ as hypotheses for study
- Draw on existing studies of high-renewable systems as the basis for exploring and confirming those gaps
- Interactive collaborative sessions to explore sources of value in a <u>reliable</u> <u>low-carbon</u> system

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