July 28, 2023
WebEx

Introduction to ISO New England System Planning

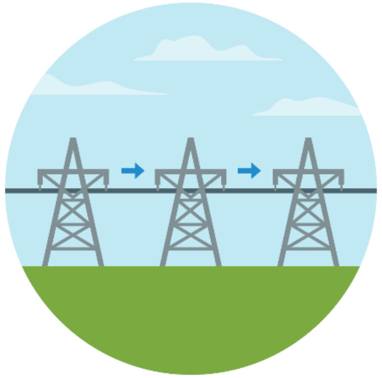
Clean Energy Transmission Working Group (CETWG)

Brent Oberlin
Director, Transmission Planning

ISO New England’s Three Critical Roles to Ensure Reliable Electricity at Competitive Prices

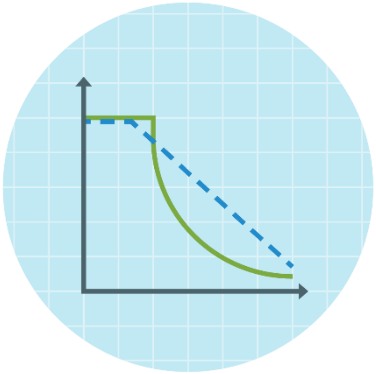
Grid Operation

Coordinate and direct the flow of electricity over the region’s high-voltage transmission system



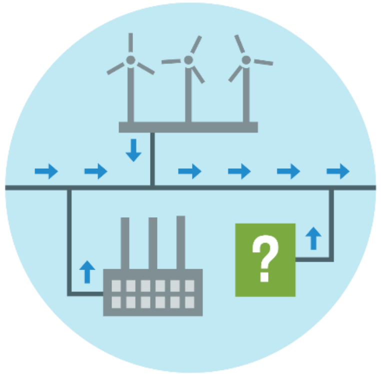
Market Administration

Design, run, and oversee the markets where wholesale electricity is bought and sold



Power System Planning

Study, analyze, and plan to make sure New England's electricity needs will be met over the next 10 years



Things We Don’t Do

- Handle retail electricity
- Own power grid infrastructure
- Have a stake in companies that own grid infrastructure
- Have jurisdiction over fuel infrastructure
- Have control over siting decisions

Topics

Overview of System Planning

Resource Adequacy

Transmission Planning

Selection of the Solutions Process

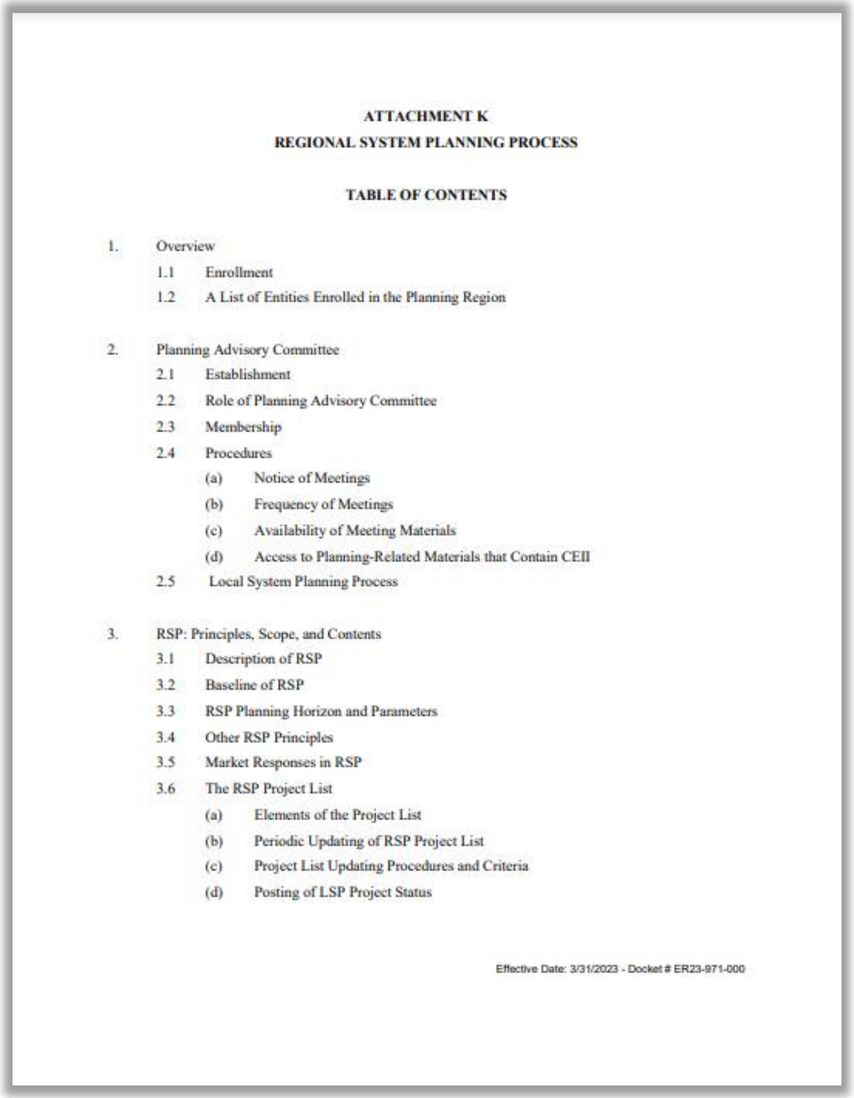
Coordination of Long Term Planning

A Look at the Future

OVERVIEW OF SYSTEM PLANNING

Open Access Transmission Tariff Attachment K

- Describes the regional system planning process
- Outlines ISO and stakeholder responsibilities
- Defines key transmission planning process components/requirements
  - Planning Advisory Committee (PAC)
  - Regional System Plan (RSP); scope and contents
  - Needs Assessment description
  - Solutions Study description
  - Competitive Solution process
  - Long-term Transmission study process
  - RSP Project List



ATTACHMENT K
REGIONAL SYSTEM PLANNING PROCESS

TABLE OF CONTENTS

Effective Date: 3/31/2023 - Docket # ER23-971-000

Biennial Regional System Plan

To predict system needs 10 years out, the Regional System Plan (RSP) considers:

Forecasts of Electric Energy, EE, and PV

Capacity and Energy

Fuel-Related Risks to System Reliability

Projections of Capacity and Operating Reserves Needs

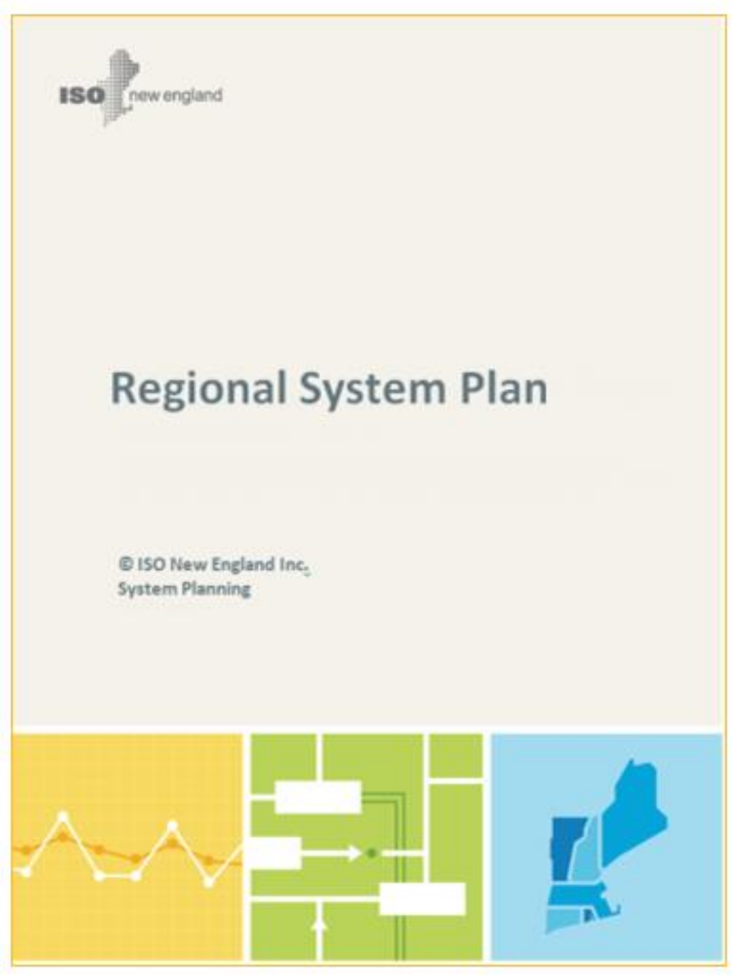
Transmission System Needs, Solutions, and Cost Considerations

Existing and Future Resource Development in Areas of Need

Existing and Pending Environmental Regulations

Federal, State, and Regional Initiatives

Interregional Planning



View latest RSP

Regional System Plan (RSP) Project List

Contains proposed regulated transmission solutions that address needs identified from completed Needs Assessments

- Reliability Transmission Upgrades (RTU)
- Market Efficiency Transmission Upgrades (METU)
- Public Policy Transmission Upgrade (PPTU)

Includes other changes to the system as a result of:

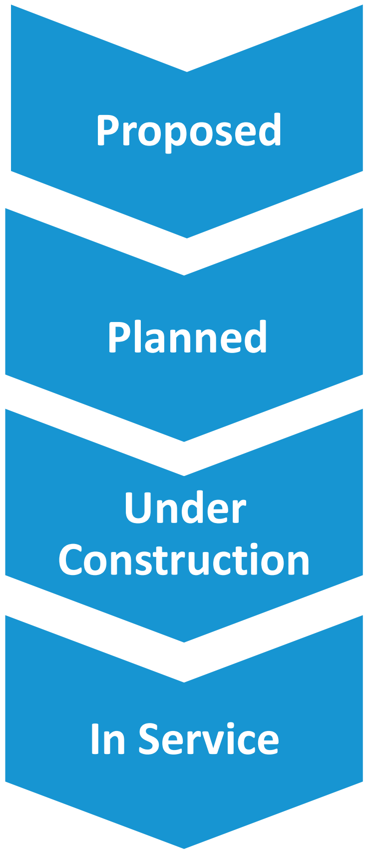
- Generator Interconnections
- Elective Transmission Upgrades

Updates to the list occur 3 times annually

- Spring (typically March)
- Summer (typically June)
- Late Fall (typically October)

Reviews and discussions at PAC meetings; final version posted to the ISO website

RSP Project List Classifications



Note: Projects may be cancelled if they are no longer needed

See: https://www.iso-ne.com/system-planning/system-plans-studies/rsp/

RSP Project List

June 2023 ISO-NEW ENGLAND Project Listing Update - ISO-NE Public

Primary Driver	Part#	Project ID	State	Primary Equipment Owner	Other Equipment Owner(s)	Footnote Number	Projected In-Service Month/Year	Major Project	Project	Mar-23 Status	Jun-23 Status	Is the project Grandfathered on May 18, 2015	PPA (I.3.9) Approval	TCA Approval	Mar-23 Estimated PTF Costs	Jun-23 Estimated PTF Costs
TABLE A																
MAINE																
Elective Upgrade	4a	1816	ME	Central Maine Power Company			12/2024	Queue Position 639	Construct new Coopers Mills to Maine Yankee 345 kV line	Planned	Planned		7/9/2020	NR	NR	NR
Elective Upgrade	4a	1817	ME	Central Maine Power Company			12/2024	Queue Position 639	Install 2nd Larrabee Road 345/115 kV autotransformer	Planned	Planned		7/9/2020	NR	NR	NR
Elective Upgrade	4a	1819	ME	Central Maine Power Company			12/2024	Queue Position 639	Construct 207 miles of new 320 kV symmetrical monopole HVDC transmission line from Appalaches Substation in Saint-Adrien-d'Irlande, Quebec to Merrill Road Substation in Lewiston, ME.	Planned	Planned		7/9/2020	NR	NR	NR
Elective Upgrade	4a	1820	ME	Central Maine Power Company			12/2024	Queue Position 639	Construct a new HVDC Converter Terminal at Merrill Road Substation.	Planned	Planned		7/9/2020	NR	NR	NR
Elective Upgrade	4a	1821	ME	Central Maine Power Company			12/2024	Queue Position 639	Construct 1.6 miles of new 345 kV AC transmission line from Merrill Road 345 kV Substation to Larrabee Road 345 kV Substation.	Planned	Planned		7/9/2020	NR	NR	NR
Generator Interconnection Upgrade	2a	1865	ME	Central Maine Power Company			10/2024	Queue Position 931	Install a 115 kV circuit breaker at the Roxbury substation bus #1 adjacent to the KGT1-1 breaker.	Planned	Planned		12/14/2020	NR	NR	NR
Reliability Upgrade	1a	1882	ME	Central Maine Power Company			12/2024	UME 2029 Solution	Rebuild 21.7 miles of the existing 115 kV line Section 80 Highland – Coopers Mills 115 kV line	Planned	Planned		5/24/2022	No	$63,600,000	$63,600,000
Reliability Upgrade	1a	1886	ME	Versant Power			06/2024	UME 2029 Solution	Install a +50/-25 MVAR synchronous condenser at Boggy Brook 115 kV substation, and install a new 115 kV breaker to separate Line 67 from the proposed solution elements	Planned	Under Construction		2/16/2022	No	$40,000,000	$40,000,000
Reliability Upgrade	1a	1887	ME	Versant Power			06/2024	UME 2029 Solution	Install a 25 MVAR reactor at Boggy Brook 115 kV substation	Planned	Under Construction		2/16/2022	No	$4,000,000	$4,000,000
Reliability Upgrade	1a	1888	ME	Versant Power			06/2024	UME 2029 Solution	Install a 10 MVAR reactor at Keene Road 115 kV substation	Planned	Planned		2/16/2022	No	$6,700,000	$6,700,000
Reliability Upgrade	1a	1889	ME	Versant Power			12/2023	UME 2029 Solution	Install three remotely monitored and controlled switches to split the existing Orrington reactors between the two Orrington 345/115 kV autotransformers	Planned	Planned		2/16/2022	No	$1,000,000	$1,000,000
Generator Interconnection Upgrade	2a	1890	ME	Versant Power			11/2024	Queue Position 760	Addition of a new 115 kV Switching Station on line 52 between Deblois and Epping	Planned	Planned		7/1/2021	NR	NR	NR
Generator Interconnection Upgrade	2a	1891	ME	Versant Power			11/2024	Queue Position 760	Addition of a +/-150 MVAR STATCOM at Tunk Lake	Planned	Planned		7/1/2021	NR	NR	NR
Generator Interconnection Upgrade	2a	1892	ME	Versant Power			11/2024	Queue Position 760	Rebuild of 3.25 miles of Line 59 between Epping and Columbia	Planned	Planned		7/1/2021	NR	NR	NR
NEW HAMPSHIRE																

RSP_0623 | RSP_sortable | SEMARI | Greater Boston | Eastern CT 2029 | BAOS | NH 2029 | UME 2029

Note: History columns have been hidden.

Asset Condition

Asset Condition

- Asset condition is not an identified trigger for a Needs Assessment in Section 4.1(a)
- Asset condition issues are issues that must be identified by the equipment owner and cannot be identified by ISO-NE
- RSP Project List shall identify items as:
  - Reliability Transmission Upgrade
  - Market Efficiency Transmission Upgrade
  - Public Policy Transmission Upgrade
  - Elective Transmission Upgrade
  - New generation interconnection
- ISO-NE discontinued capturing asset condition projects on the Project List beyond the effective date of FERC Order 1000 (May 18, 2015), and is capturing them on the Asset Condition List
- Information is made available to stakeholders through equipment owner presentations at the PAC
- Asset Condition List is posted on the ISO website

Reliability Standards Guide Regional Planning

- North American Electric Reliability Corporation (NERC)
  - Reliability standards for bulk electric system in North America
- Northeast Power Coordinating Council (NPCC)
  - Basic criteria for design and operation of bulk power system in the Northeast
- ISO New England (ISO)
  - Reliability standards for New England area pool transmission facilities (PTF)

Standards are used to ensure that the regional transmission system can reliably deliver power to consumers under a wide range of future system conditions

All of our processes are governed by a **FERC-approved tariff**

System Planning Activities

Ensuring Reliable Operations in the Future

Resource Adequacy

- Forecasting regional electric energy use
  - Including energy efficiency and solar photovoltaic
- Determine annual resource needs by:
  - Monitoring resource mix and fuel security, including renewable resource integration
  - Analyzing retirements for reliability impact
- Administering ISO Generation Interconnection Queue
- Administering Forward Capacity Market (FCM)
- Conducting Economic Studies

Transmission Planning

- Performing transmission reliability analysis
- Developing solutions or issuing a request for competitive solutions
- Reviewing transmission costs
- Planning for public policy
- Longer-term Transmission study process
- Conducting interregional planning activities

RESOURCE ADEQUACY

Overview of Resource Adequacy

- Identify **amount** and **location** of resources the system needs to ensure resource adequacy (RA) and *how* the region meets short-term needs
- Planning to maintain resource adequacy requires:
  - Forecasts of future electricity demand
  - Installed Capacity Requirement (ICR) calculations
  - Qualification of resources providing capacity and reserves
  - Operable capacity analyses that consider future scenarios of load forecasts
  - Assessment of ever-changing operating conditions and resource mix
- Yearly system capacity requirements determined through ICR calculation
  - ICR accounts for uncertainties, contingencies, and resource performance under a wide range of existing and future system conditions
- Resource adequacy assessments feed markets and other planning functions

Resource Adequacy Annual Reports

In addition to Regional System Plan (RSP), Resource Adequacy prepares several annual reports to help predict future needs including:

Forecast Report of Capacity, Energy, Loads, and Transmission (CELT Report)

- Provides 10-year projections of load forecast, energy efficiency, photovoltaics, and generator rating for use in power system planning and reliability studies

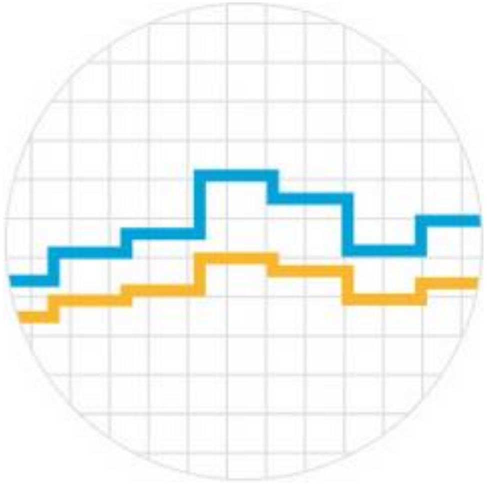
ISO New England Electric Generator Air Emissions Report

- ISO's assessments help determine emission reductions from demand-side management programs, energy efficiency programs, and renewable resource projects within region

Forecasting Regional Electric Energy Use

Energy forecasts are driven by key factors, including:

- Economic activity and outlook
  - A stronger economy tends to increase energy consumption
- Weather and load patterns
- Federal and state policies reducing electricity demand
  - Energy efficiency initiatives
  - Distributed generation, especially photovoltaics
- Federal and state policies increasing electricity demand
  - Electrification of transportation
  - Electrification of home heating



ISO's Electrification Forecast Shows Demand Growth

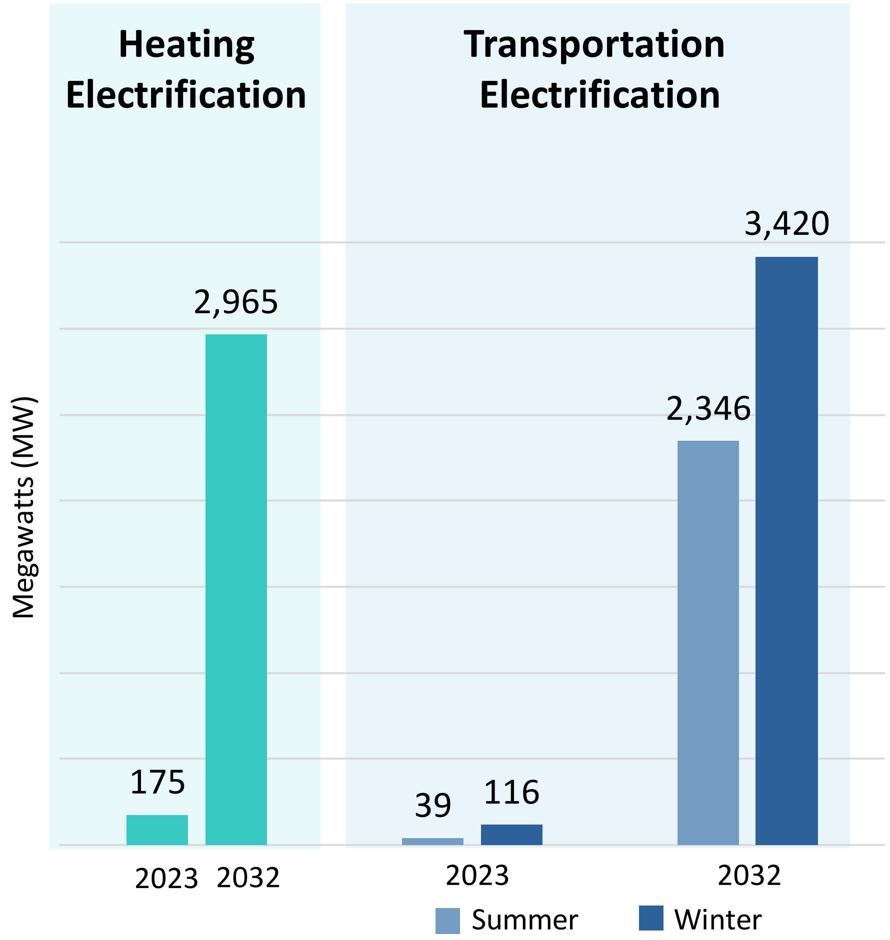
- The ISO began including **forecasted impacts** of heating and transportation electrification on state and regional electric energy and demand in the 2020 CELT report
- In New England by **2032**, the ISO forecasts that there will be:

  >1 M households with heat pumps

  > 600 M square feet of commercial space heated with heat pumps

  ~ 3M light-duty EVs

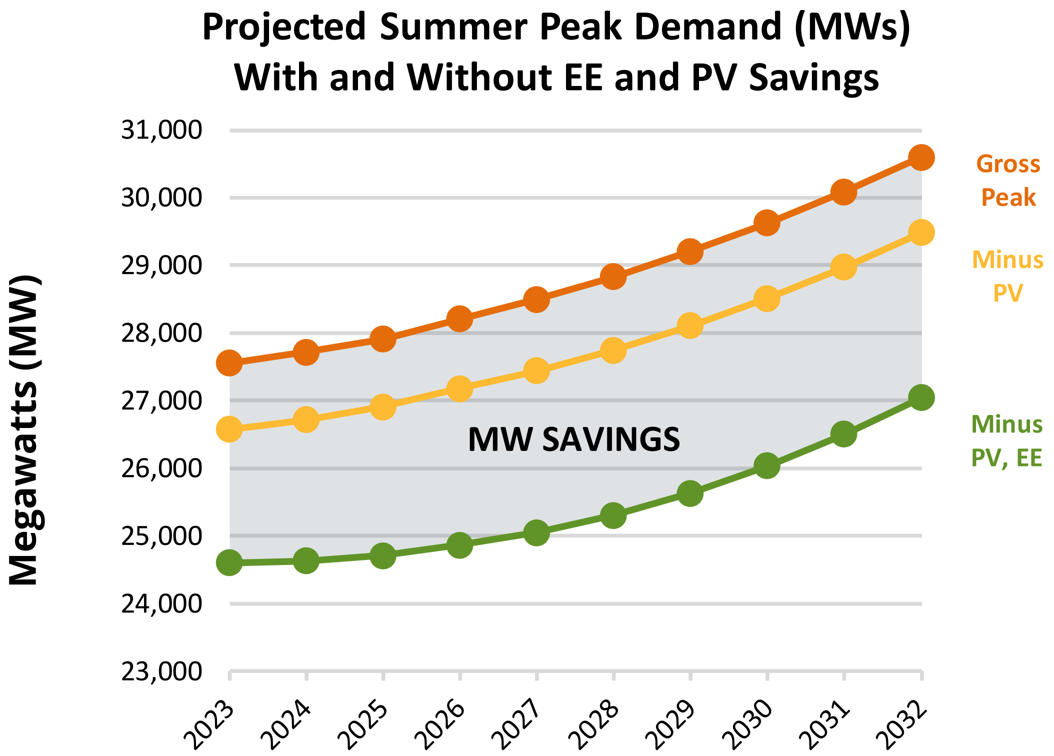
  > 10,000 medium and heavy-duty EVs (includes delivery vehicles, school buses, and transit buses)

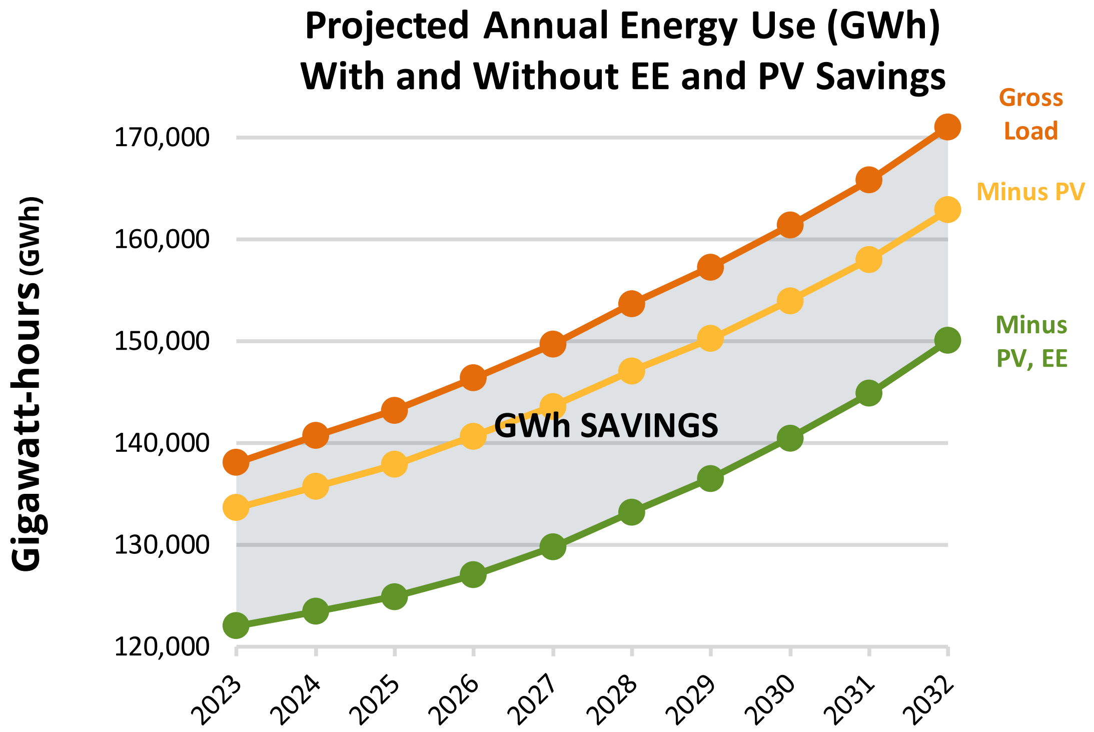


Sources: : ISO New England 2023-2032 Forecast Report of Capacity, Energy, Loads, and Transmission (2023 CELT Report) (May 2023), Final 2022 Transportation Electrification Forecast, and Final 2022 Heating Electrification Forecast

Peak Demand and Annual Energy Use

Energy Efficiency and Behind-the-Meter Solar Impact

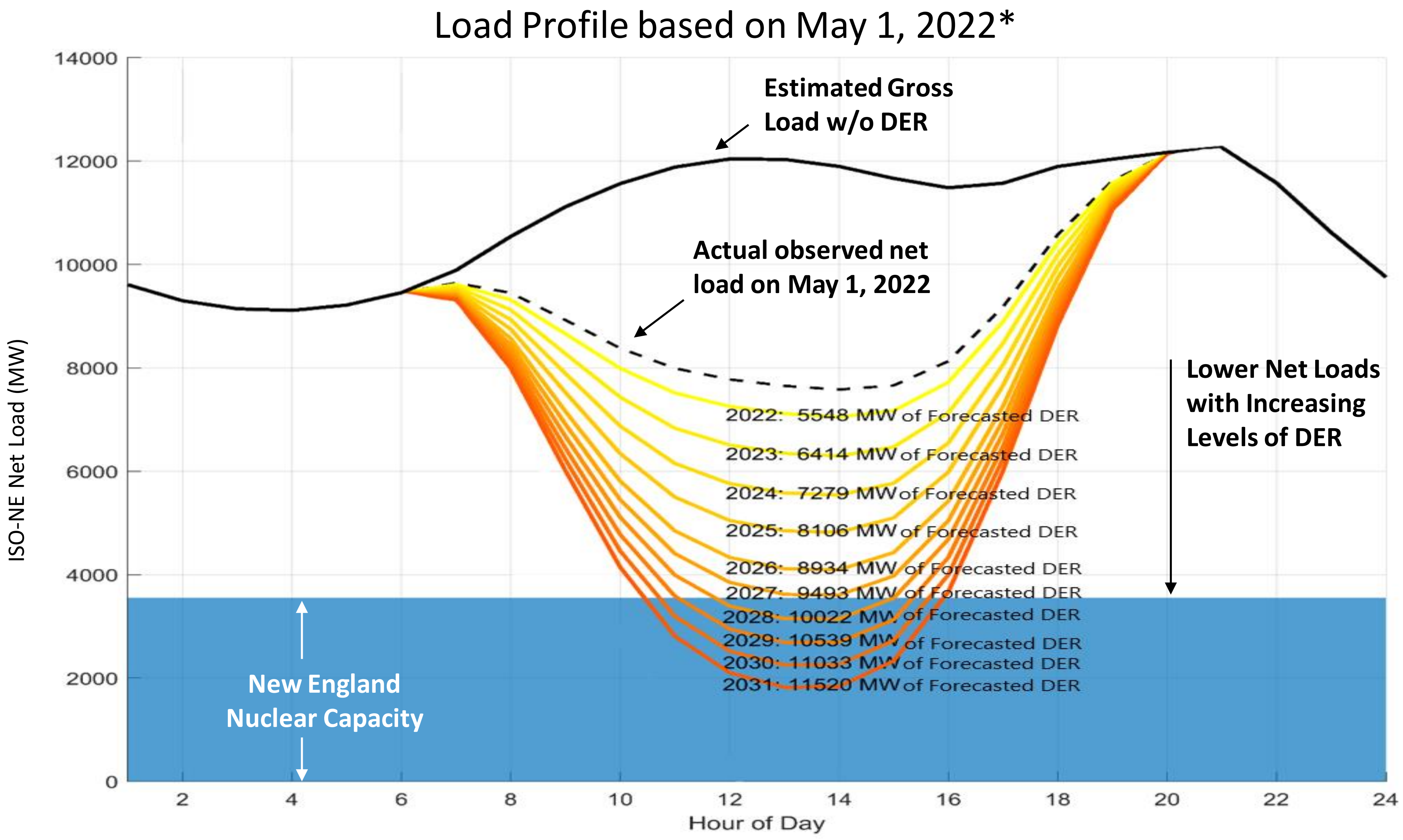




- The gross peak and load forecast
- The gross peak and load forecast minus existing and anticipated "behind-the-meter" (BTM) solar PV resources
- The gross peak and load forecast minus existing and anticipated BTM solar PV and energy efficiency

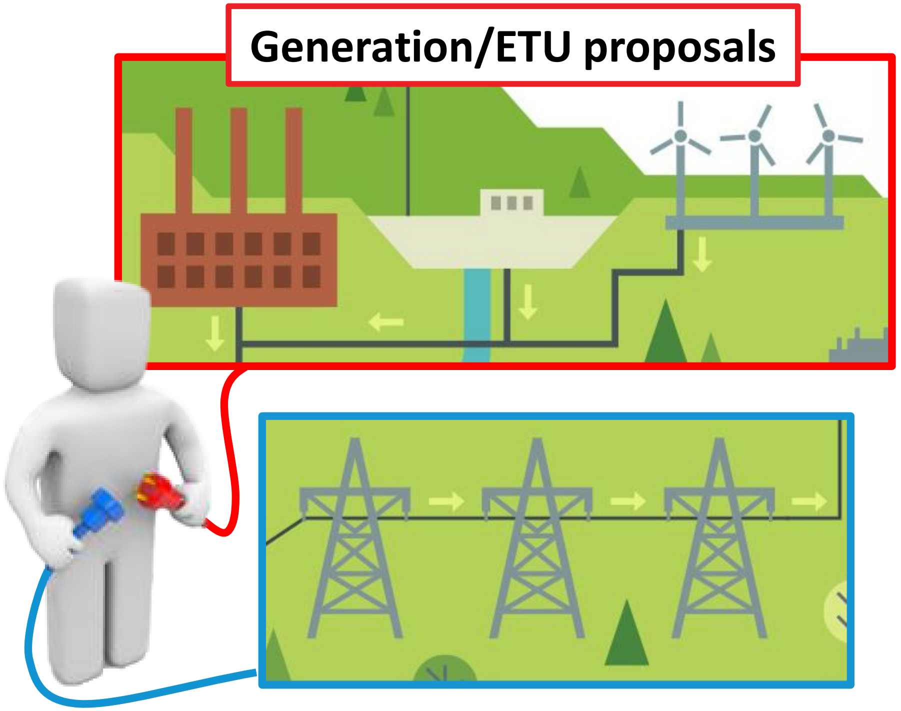
Source: : ISO New England 2023 Forecast Data. Summer peak demand is based on the "90/10" forecast, which accounts for the possibility of above-average summer weather (temperatures of about 94º F).

Projections of Daytime Minimum Loads in New England



Connecting Resources to the Power System

ISO administers the FERC generator interconnection process



Proposals are:

- Maintained in interconnection queue
- Subject to ISO reliability review
- Studied in order received

End result is a three-party interconnection agreement among:

- ISO New England
- Generator/Elective Transmission Upgrade (ETU) project sponsor
- Interconnecting transmission owner

Interconnection Process – Basic Flow

Interconnection Request

Basic information: size, location, fuel type

Feasibility Study

High-level upgrade concepts at multiple interconnection points

System Impact Study

Exact list of upgrades at the chosen point of interconnection

Facilities Study

Optional detailed study of upgrade costs

Interconnection Agreement

Three-party agreement between generator, ISO, and transmission owner

Construction

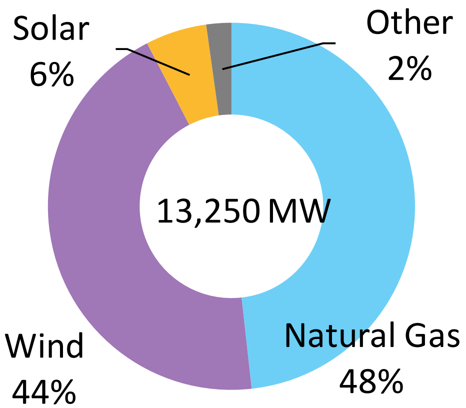
Generator begins commercial operation once construction is complete

For more information about this process, visit Participate > Applications and Status Changes > New or Modified Interconnections

Wind Power Comprises Nearly Half of New Resource Proposals in the ISO Interconnection Queue

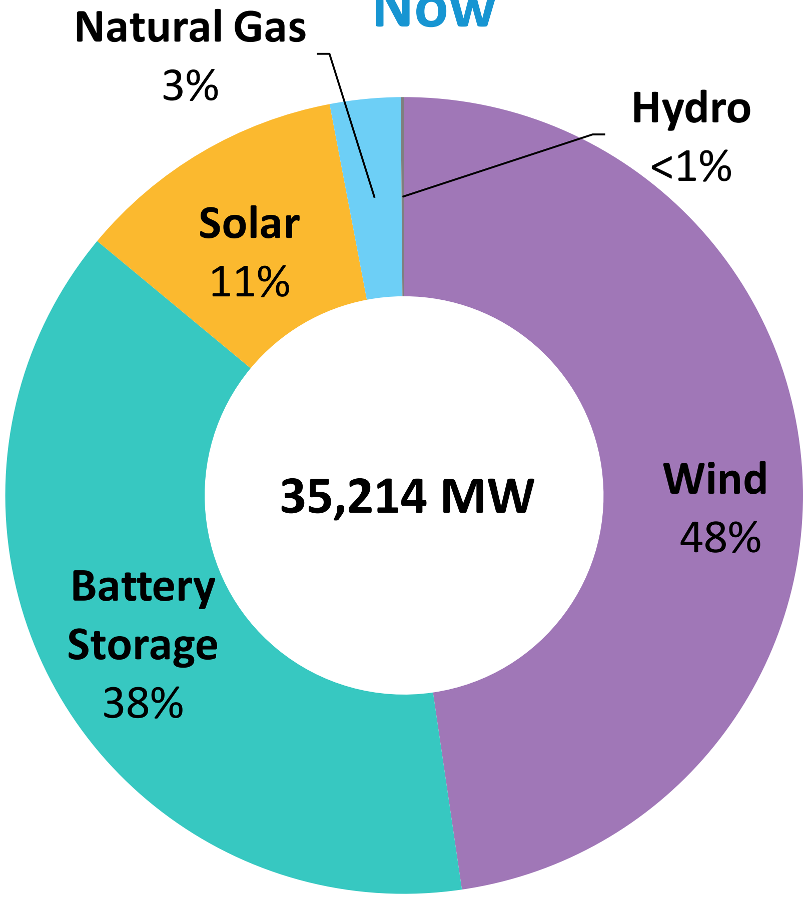
Dramatic shift in proposed resources from natural gas to battery storage and renewables

Then



June 2017

Now



June 2023

Offshore Wind

CT	2,400 MW
MA	11,514 MW
RI	704 MW

Onshore Wind

ME	2,325 MW

Source: ISO Generator Interconnection Queue, FERC Jurisdictional Proposals; Nameplate Capacity Ratings.

Resource Paths to Commercial Operation

FERC Jurisdictional

Interconnection process is ISO's responsibility

Proposed Project

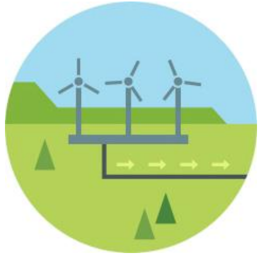
Generator Interconnection Process
- Defined and disciplined
- Clear timelines/milestones
- Average study ~15 months

Forward Capacity Market (FCM)
- Optional participation
- Different timelines/milestones ~40 months

State Interconnection Process
- Each state process is different
- More flexibility in timelines
- Study times vary

Non-FERC Jurisdictional

Interconnection process is transmission owner's responsibility



Commercial Operation

TRANSMISSION PLANNING

Regional Transmission Planning

ISO New England is responsible for planning the regional transmission system over the ten-year planning horizon

- Summarized in Regional System Plan
- Stakeholder engagement through Planning Advisory Committee

ISO New England can select new projects to address *three* categories of transmission system needs:

1. **Reliability projects:** maintaining the ability to deliver bulk power considering load growth, generator retirements, and other future changes
2. **Market Efficiency projects:** reducing energy costs by increasing the ability to obtain power from cheaper sources
3. **Public Policy projects:** expanding the transmission system as needed for the successful implementation of public policy

Introduction to Transmission Planning
3 minute video

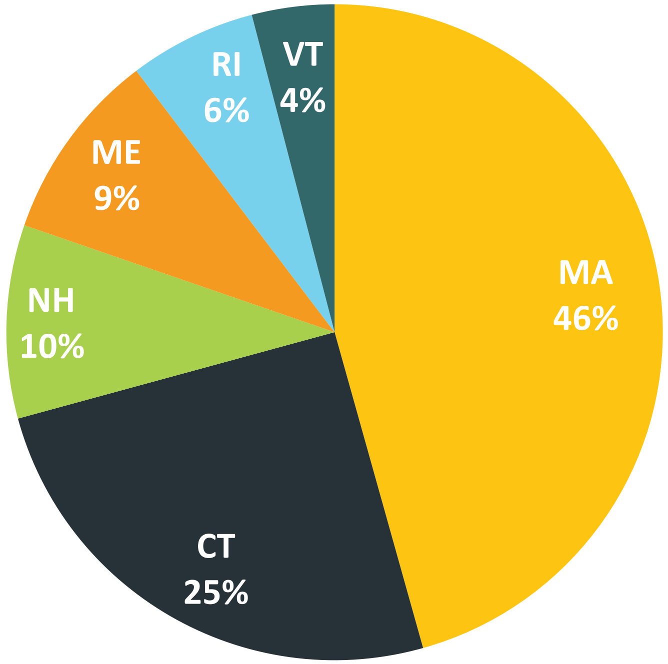
How Are Transmission Costs Allocated?

Each state shares benefits of reliability and market efficiency upgrades

Electricity demand in an area determines its share of cost of new or upgraded transmission facilities needed for reliability or market efficiency

For public policy transmission upgrades

- 30% of costs are allocated on load ratio basis among states with a public policy planning need that the particular project addresses
- 70% of the cost upgrades are spread throughout region



2022 Network Load by State

Longer-Term Transmission Studies

State-Requested Process to Identify Transmission Concepts

- Analyzes future scenarios identified by the New England States Committee on Electricity (NESCOE), based on one or more states' or localities' government requirements, mandates, or policies
- May extend beyond the 10-year planning horizon
- Identifies high-level transmission concepts and, if requested, cost estimates
- ISO-NE's first Longer-Term Transmission Study, the "2050 Transmission Study," began in late 2021

Information on Longer-Term Transmission Studies may be found at:
System Planning > Transmission Planning > Longer-Term Transmission Studies

Elective Transmission Upgrades

Elective Transmission Upgrade (ETU)

- **Upgrade or interconnection** to PTF of New England transmission system
- Voluntarily funded by entity or entities that agreed to pay for all upgrade costs
- Entered into the interconnection queue by project developer, similar to the generation interconnection process
- Not identified as needed for reliability, but studied by ISO to ensure they can interconnect reliably

Comparison of Transmission Project Types

Reliability/Market Efficiency/Public Policy Project

- Need for a project identified
- ↓
- ISO-NE conducts a Solutions Study or RFP to develop a solution
- ↓
- Project cost divided among New England states

Elective Transmission Upgrade

- Developer brings forward a project proposal
- ↓
- ISO-NE conducts a System Impact Study to ensure project can be reliably interconnected
- ↓
- Project cost funded entirely by developer (may seek contracts or an FCM commitment)

Transmission Provides Benefits Beyond Reliability

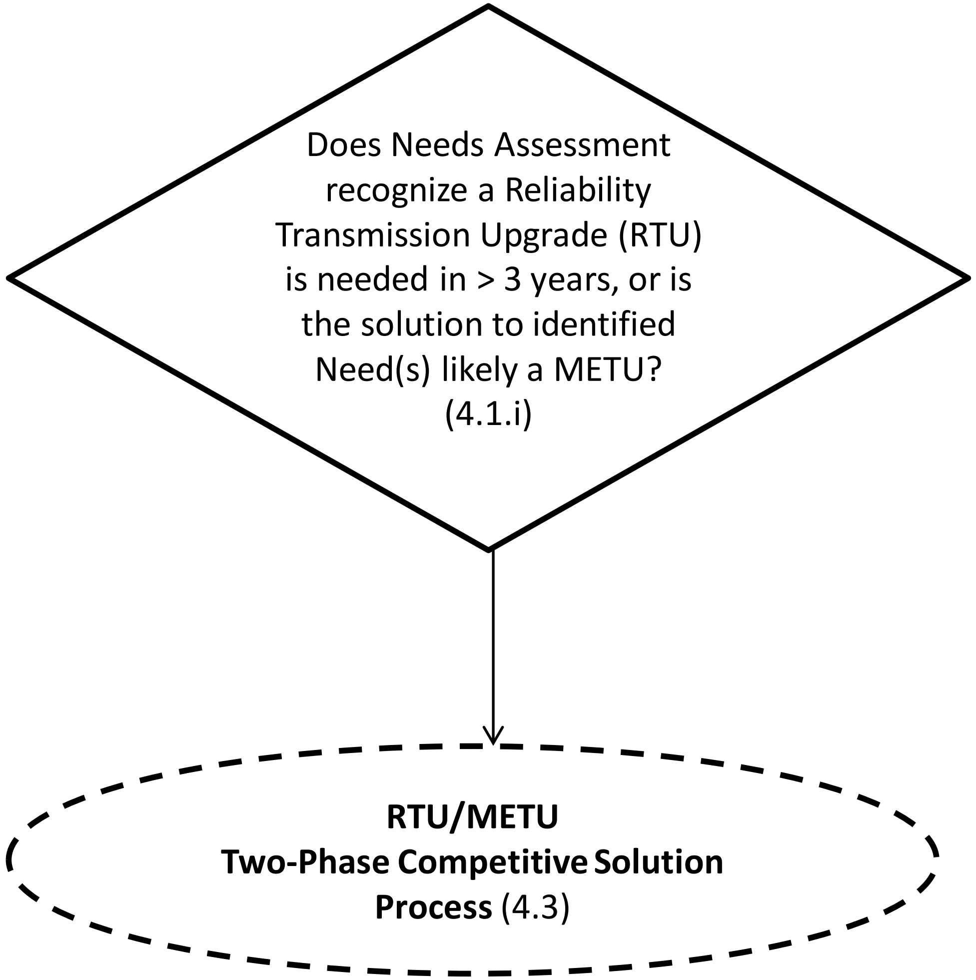
- Transmission has reduced or eliminated out-of-market costs:
  - Reliability agreements with certain generators that were needed to provide transmission support in weak areas of the electric grid
    - These often were older, less-efficient generating resources
  - Uplift charges to run specific generators to meet local reliability needs
- The markets are increasingly competitive: Easing transmission constraints into import-constrained areas has enabled the ISO to dispatch the most economic resources throughout the region to meet customer demands for electricity
- Transmission congestion has been nearly eliminated
- Transmission facilitates resource transformation: Transmission upgrades have allowed older, less efficient resources to retire, which helps the states achieve their environmental objectives

SELECTION OF THE SOLUTIONS PROCESS

Selection of the Solutions Process

- At the conclusion of a Needs Assessment, where needs have been identified, a decision must be made with regard to developing regulated transmission upgrades (solutions) to resolve the needs
- The development of the solution(s) shall be accomplished by either the Solutions Study process or the Competitive Solution process
- The initial determining factor is based on the time sensitivity of each need in the Needs Assessment

The Decision – Competitive Solutions Process

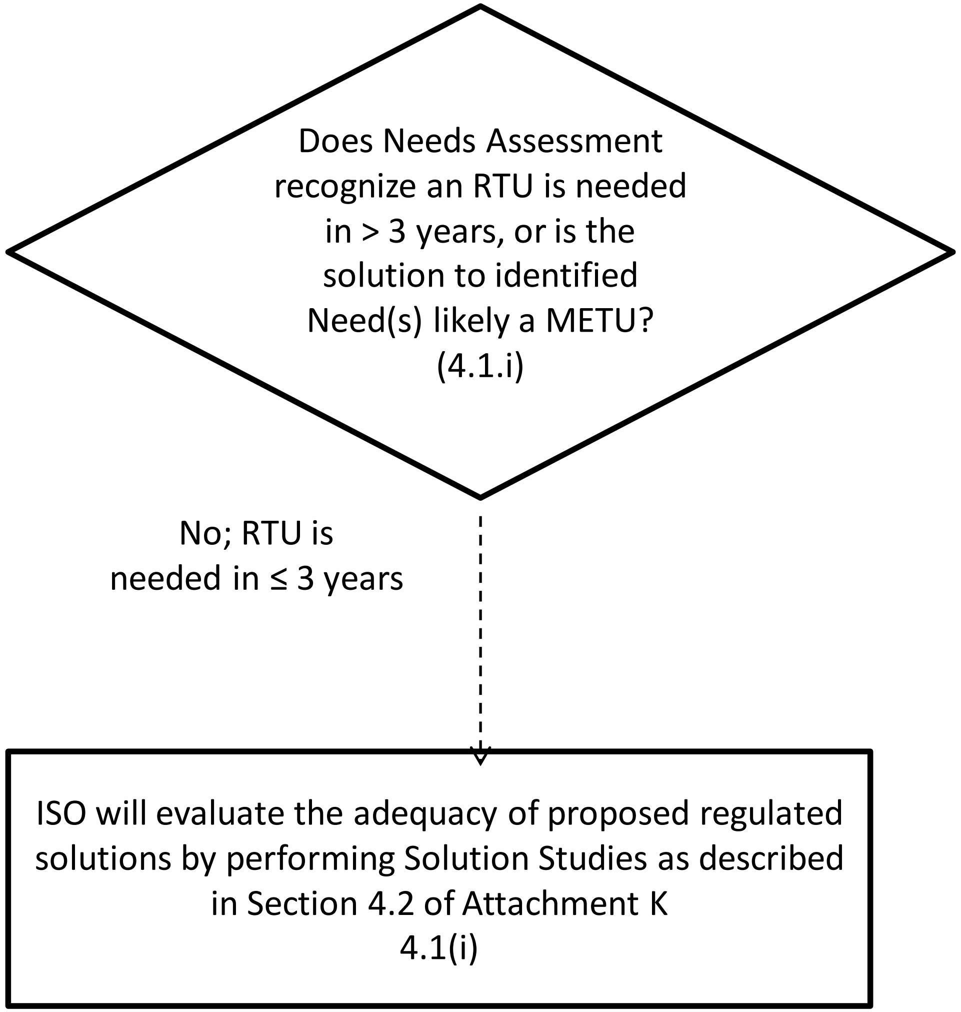


- If a solution is required to solve a need greater than three years from the time the Needs Assessment is completed (final version published), then the Competitive Solution process is utilized to develop and select the solution

- If a Market Efficiency Transmission Upgrade (METU) is likely to be the solution for a need, then the Competitive Solution process shall be followed regardless of the year of need

For more information, visit: https://www.iso-ne.com/system-planning/transmission-planning/competitive-transmission-projects/

The Decision – Solutions Study Process



- If a solution is required to solve a need in three years or less from the time the Needs Assessment is completed, and the solution is not likely to be a METU, then the Solutions Study process is utilized to develop and select the solution*

*Additional requirements are found in Attachment K, Section 4.1(j)

An Additional Part of the Process…

- Project is reviewed pursuant to section I.3.9 of the Tariff
  - No significant adverse impact
  - Proposed Plan Application (PPA) and supporting studies are required
    - Studies do not necessarily use the same assumptions as a Needs Assessment (e.g., need to ensure that energy-only resources are not harmed)
  - Reviewed by Reliability Committee
  - Reviewed by the ISO; if approved, project classified as *planned* on the RSP Project List
- Once approved, may proceed to construction
  - Other processes are likely before actual construction begins, such as siting
- Project is added to the base model for all subsequent study work
  - Needs Assessments
  - New interconnections (resource and ETUs)
- Once the Transmission Owner certifies the project, it is then built into the base models for FCM-related tasks
  - New resource qualification
  - Transfer limits
  - De-list analysis, including retirements

COORDINATION OF LONG-TERM PLANNING

Regional Plans Reflect State Initiatives

States are active in regional planning process and establish their own priorities and planning objectives

- New England states have many goals related to energy and environment
  - Conservation and load management programs
  - Financial incentives for certain types of resources, such as solar photovoltaic generation
  - Renewable portfolio standards
  - Regional cap-and-trade program to control greenhouse gas emissions
- State efforts coordinated by the New England States Committee on Electricity (NESCOE)
- ISO New England’s planning accommodates and coordinates with these goals
  - Load forecasting includes energy efficiency and distributed generation forecasts
  - Public policy transmission upgrades
  - Integrating sponsored policy resources into FCM

ISO New England Planning Supports Inter-Regional Efforts

Inter-regional planning ensures that one area's changes do not negatively impact the reliability of the transmission systems in other areas

Seeks solutions that could cost-effectively address needs in multiple areas

Addresses ongoing trends and changes affecting the entire industry

North American Electric Reliability Corporation (NERC)

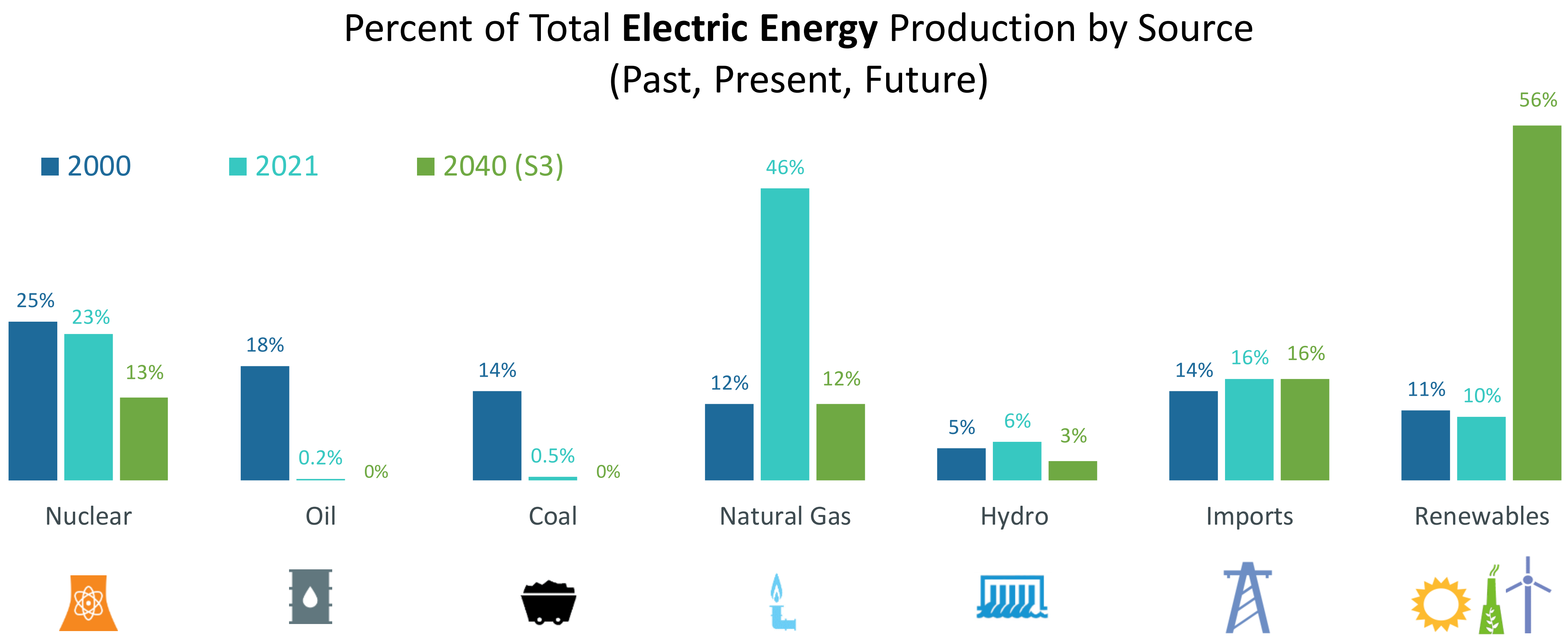
Northeast Power Coordinating Council (NPCC)

Eastern Interconnection Planning Collaborative (EIPC)

Inter-Area Planning Stakeholder Advisory Committee (IPSAC)

A LOOK AT THE FUTURE

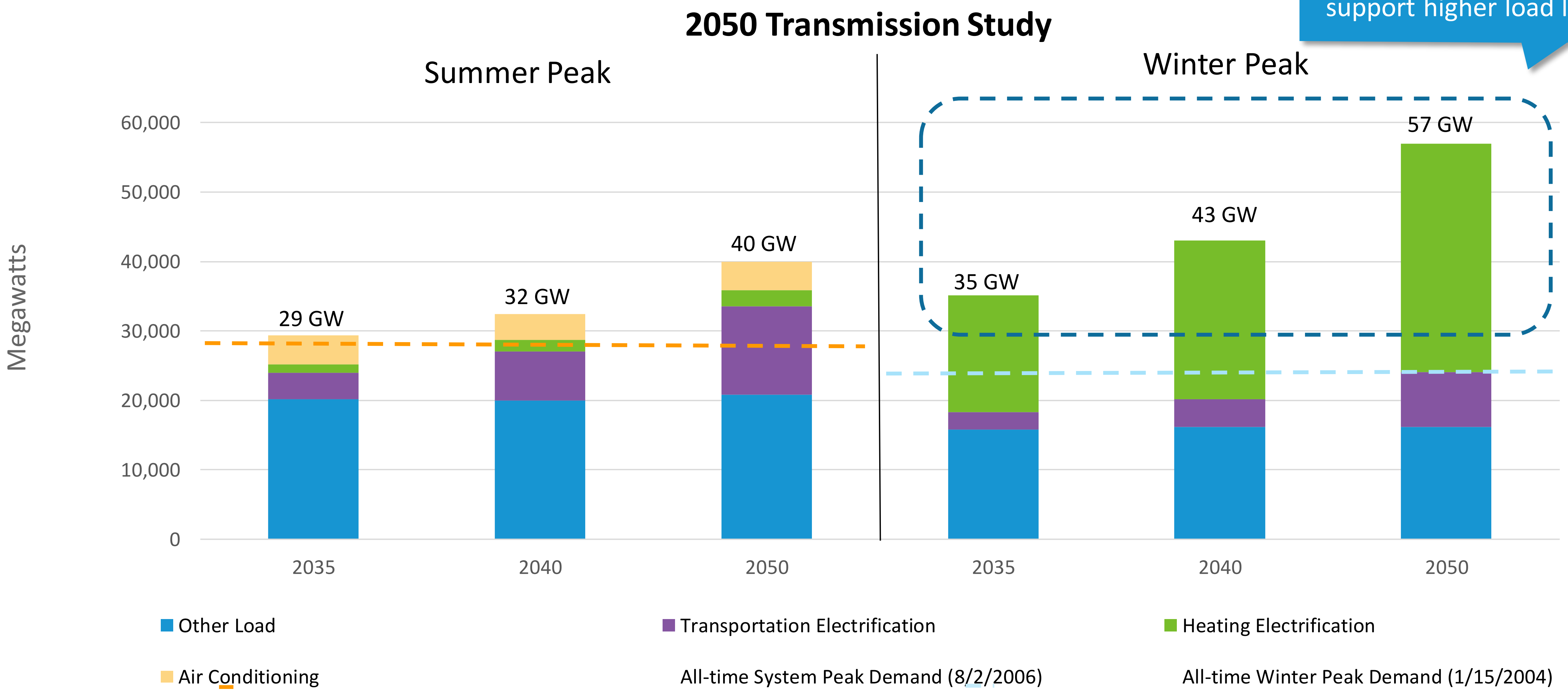
Dramatic Changes in the Energy Mix Are Underway



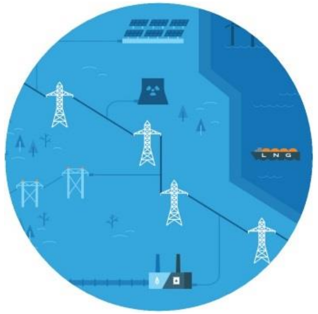
Source: ISO New England Net Energy and Peak Load by Source; data for 2021 is preliminary and subject to resettlement; data for 2040 is based on Scenario 3 of the ISO New England 2021 Economic Study: Future Grid Reliability Study Phase 1. Renewables include landfill gas, biomass, other biomass gas, wind, grid-scale solar, behind-the-meter solar, municipal solid waste, and miscellaneous fuels.

New England System Peak Grows Substantially and Shifts to Winter-Peaking

Region needs to address **energy adequacy** risk to support higher load levels

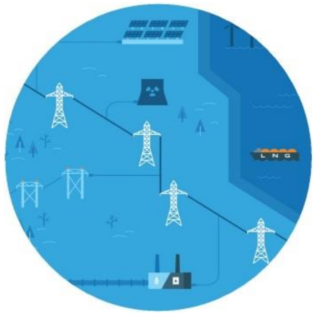


System Needs Going Forward



- Steady state
  - In the short run, steady state (thermal and voltage) needs are likely to be driven retirements
  - In the long run, load forecast changes should drive needs
  - High voltage concerns associated with minimum load conditions will become a bigger concern as EE and PV penetration increases
- Stability
  - Very few system needs have been driven by stability to date
  - This trend is expected to change
  - Nature of the load is changing
    - End-user motors are lighter (less inertia)
    - Purely resistive elements (traditional light bulbs) are being replaced by devices with a much more challenging response (CFL/LED)
  - Load modeling is improving and is showing a more pessimistic system response; likely need for more dynamic voltage support devices
  - Decreased inertia on the system may begin to show concerns

System Needs Going Forward, *continued*



- Short circuit
  - Concerns associated with overdutied equipment may begin to slow as larger, central station generation is replaced with inverter-based generation
  - However, new concerns associated with low short circuit strength may become more prevalent
    - Equipment controls
    - Temporary overvoltages (TOVs)
- Geomagnetic Disturbances (GMD)
  - NERC standard TPL-007 requires the evaluation of the impact of GMD on the system
  - May drive the need for upgrades
- Electromagnetic Transients
  - Ride through concerns with inverter based resources
  - Concerns with low short circuit strength
  - Impact on conventional generators (subsynchronous torsional interactions)

Questions