DECEMBER 14, 2023

Introduction to ISO New England System Planning

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ISO New England's *Mission and Vision*

Mission: *What we do*

Through collaboration and innovation,
ISO New England plans the transmission system, administers the region's wholesale markets, and operates the power system to ensure reliable and competitively priced wholesale electricity

Vision: *Where we're going*

To harness the power of competition and advanced technologies to reliably plan and operate the grid as the region transitions to clean energy

*The ISO's new **Vision** for the future represents our long-term intent and guides the formulation of our Strategic Goals*

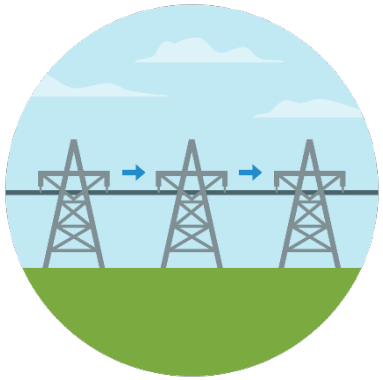
ISO New England (ISO) Has More Than Two Decades of Experience Overseeing the Region's Restructured Electric Power System

- **Regulated** by the Federal Energy Regulatory Commission
- **Reliability Coordinator** for New England under the North American Electric Reliability Corporation
- **Independent** of companies in the marketplace and **neutral** on technology

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

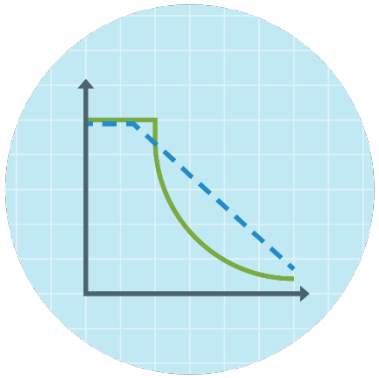
Grid Operation

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



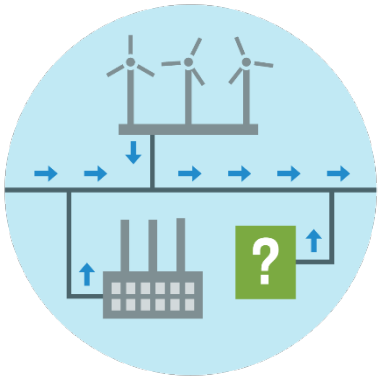
Market Administration

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

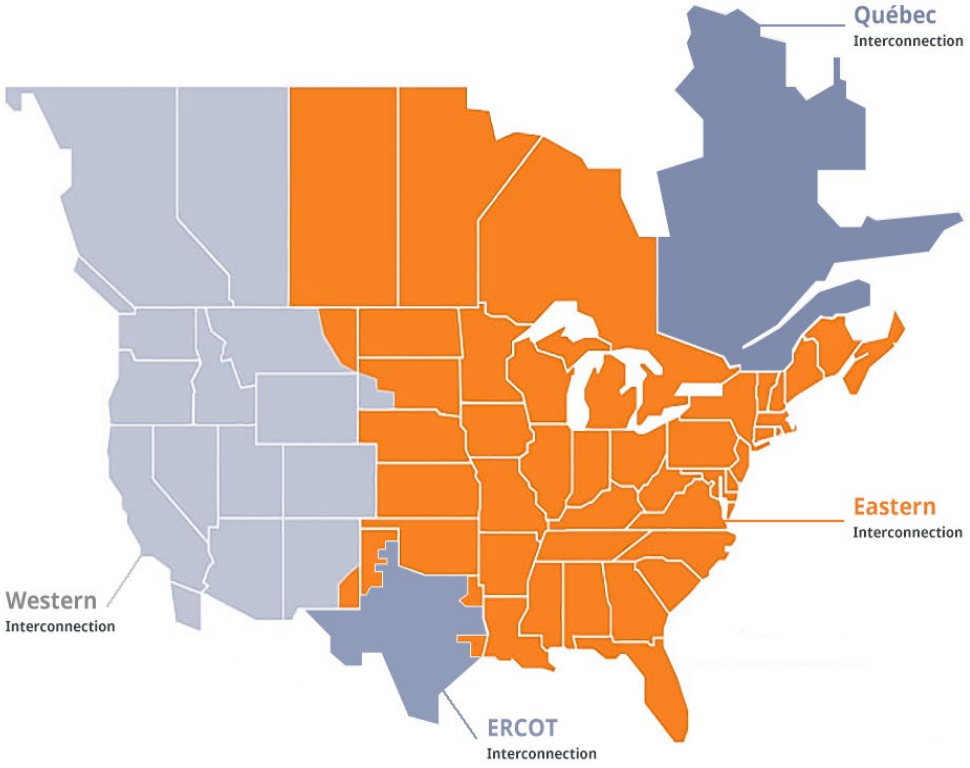
Topics

- 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

New England's Power Grid Is Part of a Larger Electric Power System

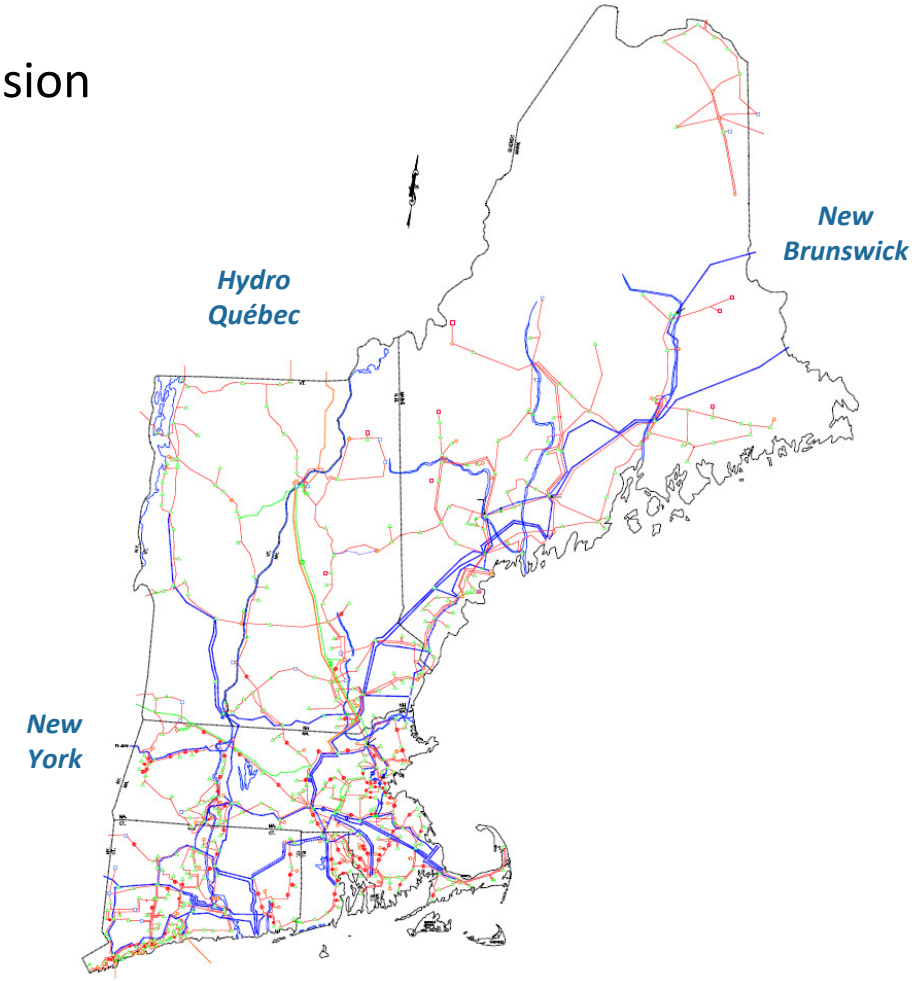
- Part of the **Eastern Interconnection**, one of four large power grids in North America
  - Interconnected through primarily alternating current (AC) transmission
- Tied to **Québec** only through direct current (DC) transmission
- 2003 blackout ushered in wide-area monitoring and **mandatory** reliability standards
- Subject to reliability standards set by **NERC** and **NPCC***



* North American Electric Reliability Corporation (NERC) and Northeast Power Coordinating Council (NPCC)

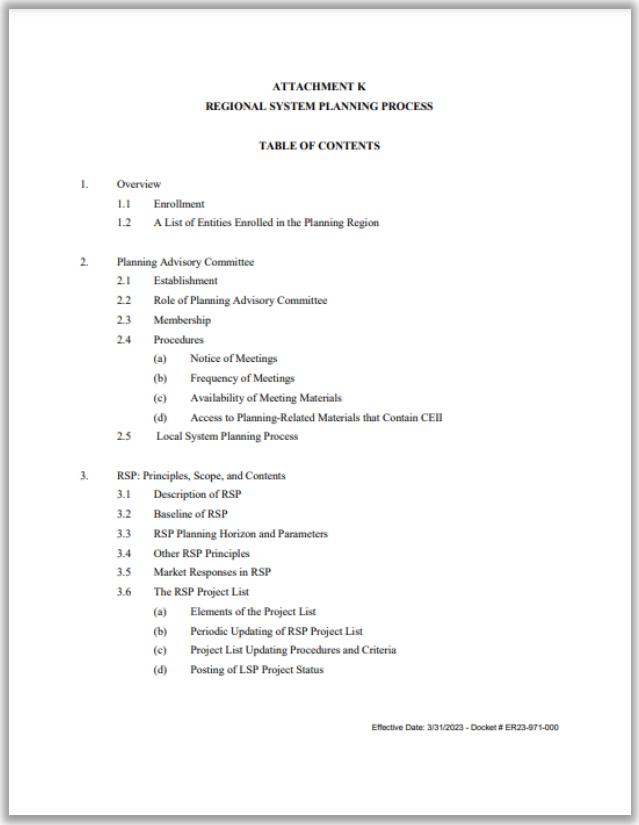
New England's Transmission Grid Is the Interstate Highway System for Electricity

- **9,000 miles** of high-voltage transmission lines (primarily 115 kV and 345 kV)
- **13 transmission interconnections** to power systems in New York and Eastern Canada
- **14%** of region's energy needs met by imports in 2022
- **$12 billion** invested to strengthen transmission system reliability since 2002; **$1.4 billion** planned
- Developers have proposed multiple transmission projects to access **non-carbon-emitting resources** inside and outside the region



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
  - Longer-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

Existing and Future Resource Development in Areas of Need

Fuel-Related Risks to System Reliability

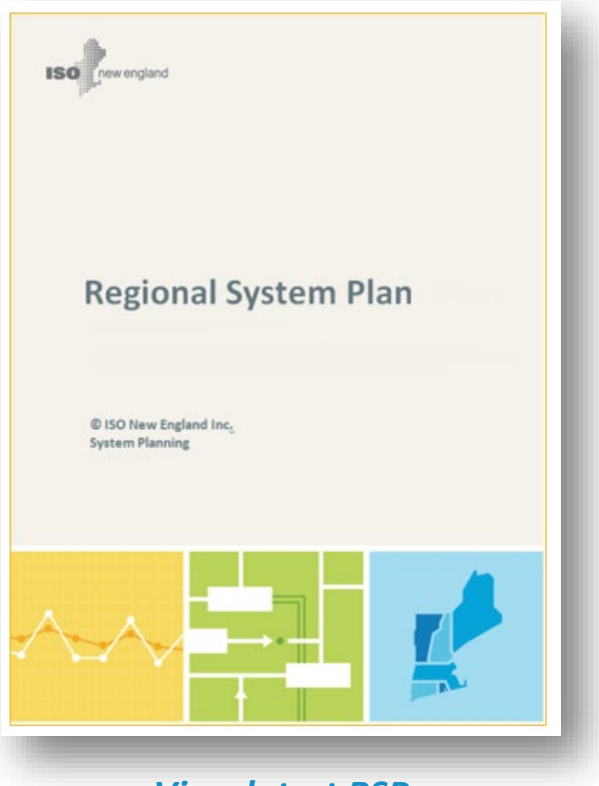
Existing and Pending Environmental Regulations

Projections of Capacity and Operating Reserves Needs

Federal, State, and Regional Initiatives

Transmission System Needs, Solutions, and Cost Considerations

Interregional Planning

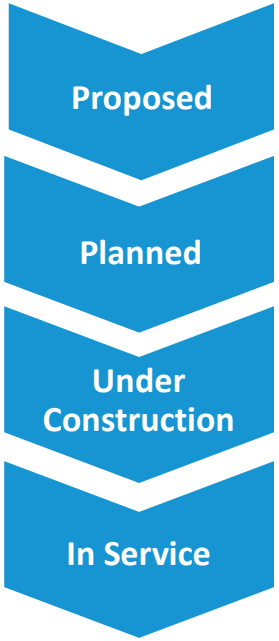


View latest RSP

Regional System Plan (RSP) Project List

- Contains proposed regulated transmission solutions that address needs identified from completed Needs Assessments and Public Policy Transmission Studies
  - 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/

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
- 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 on the ISO website
- Information is made available to stakeholders through equipment owner presentations at the PAC

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 New York, New England, Ontario, Quebec, New Brunswick, and Nova Scotia
- ISO New England (ISO)
  - Reliability standards for New England area pool transmission facilities (PTF)

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

NPCC, Inc.

ISO new england

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

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
- Performing Longer-Term Transmission Studies
- Conducting interregional planning activities

RESOURCE ADEQUACY

Overview of Resource Adequacy

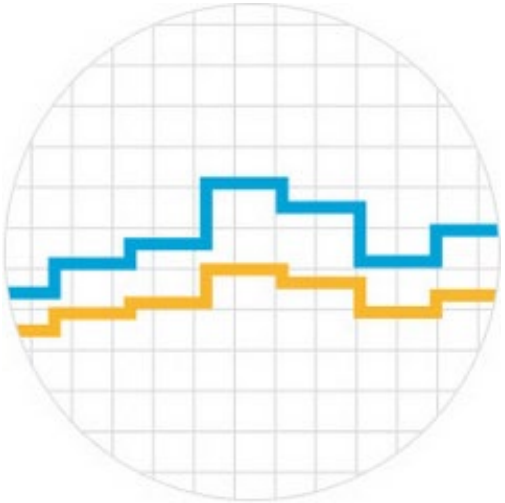
- Identify amount and location of resources the system needs to ensure resource adequacy (RA) and how the region meets short-term needs
- Planning to maintain resource adequacy requires:
  - Forecasts of future electricity demand
  - Installed Capacity Requirement (ICR) calculations
  - Qualification 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

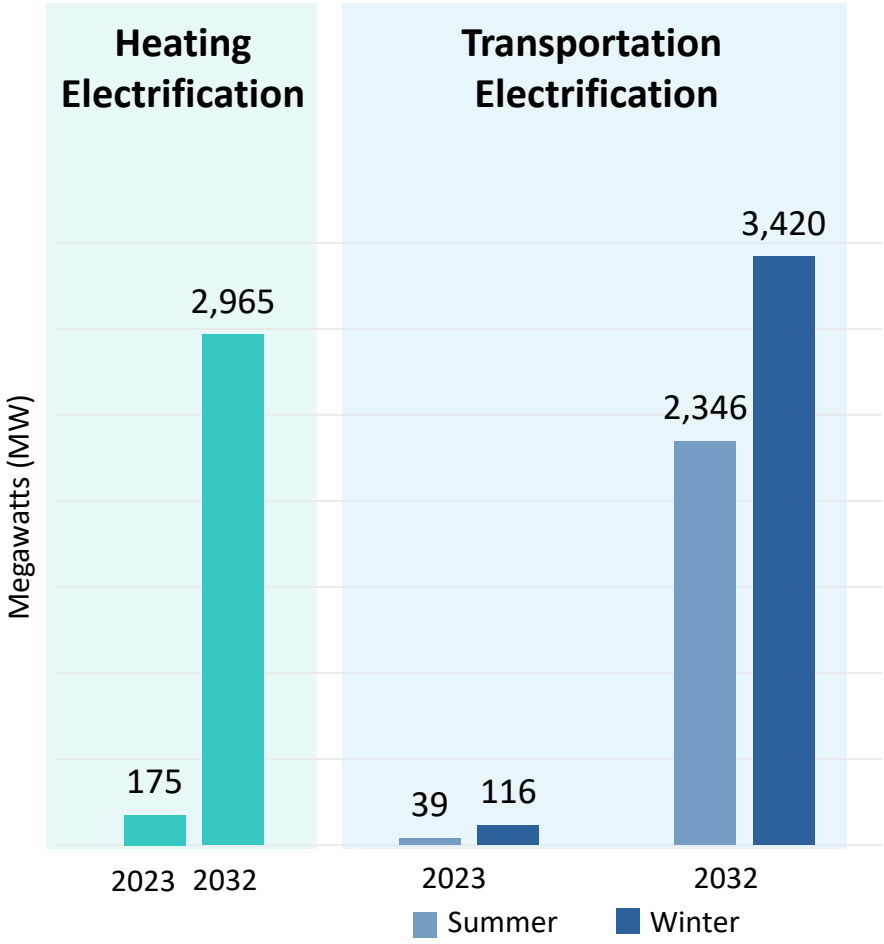
- The ISO began including forecasted impacts of heating and transportation electrification on state and regional electric energy and demand in the 2020 CELT report
- In New England by 2032, the ISO forecasts that there will be:

  >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)

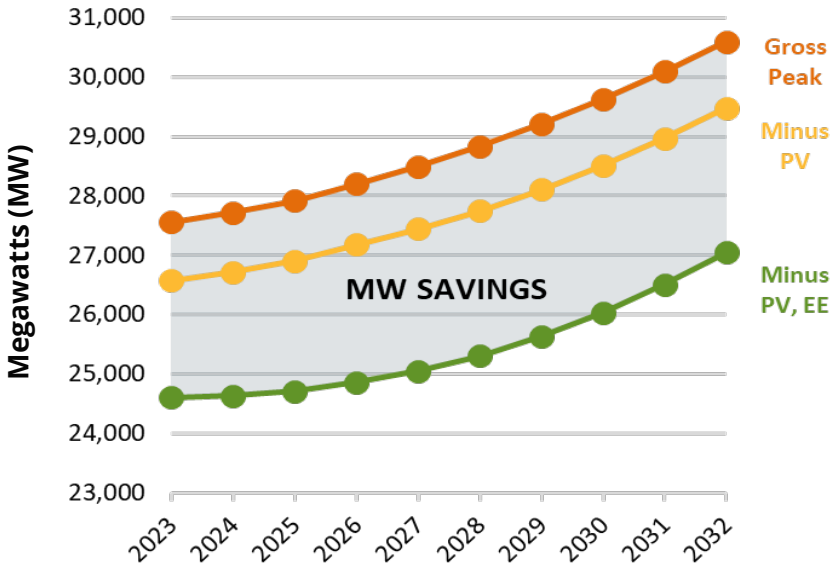


Sources: ISO New England 2023-2032 Forecast Report of Capacity, Energy, Loads, and Transmission (2023 CELT Report) (May 2023), Final 2022 Transportation Electrification Forecast, and Final 2022 Heating Electrification Forecast

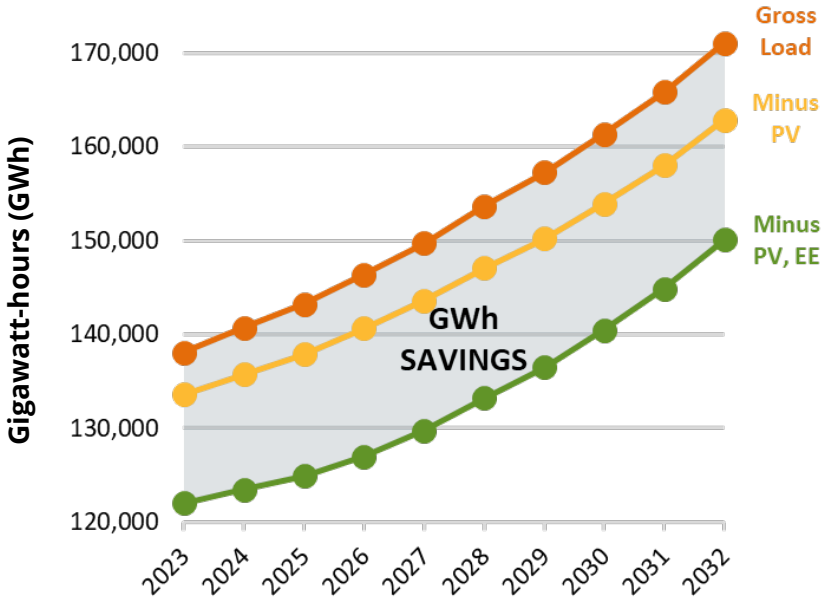
Peak Demand and Annual Energy Use

Energy Efficiency and Behind-the-Meter Solar Impact

Projected Summer Peak Demand (MW)
With and Without EE and PV Savings



Projected Annual Energy Use (GWh)
With and Without EE and PV Savings



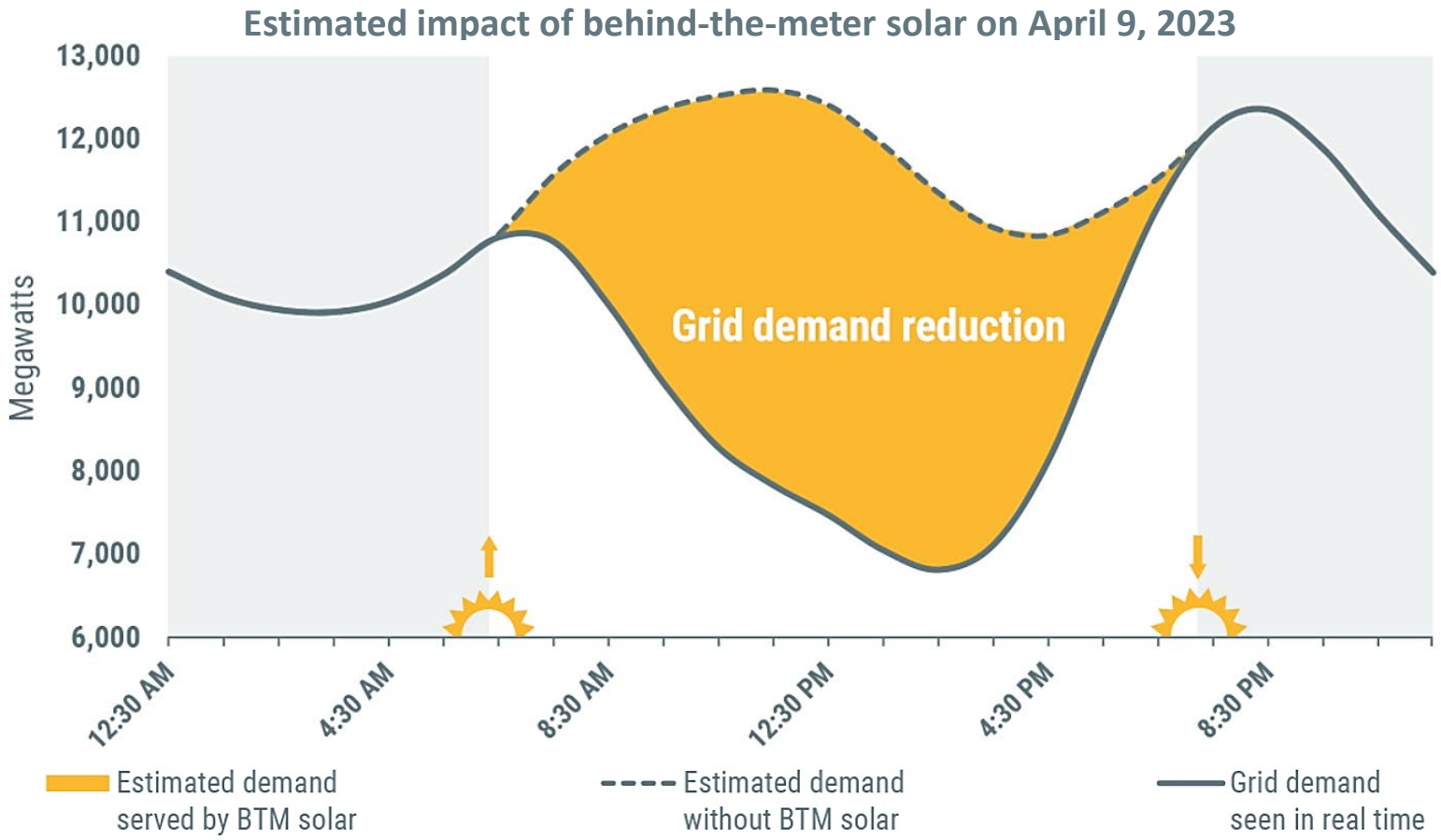
The gross peak and load forecast

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 94° F).

Solar Resources Impact Demand on the Region's Electric Grid

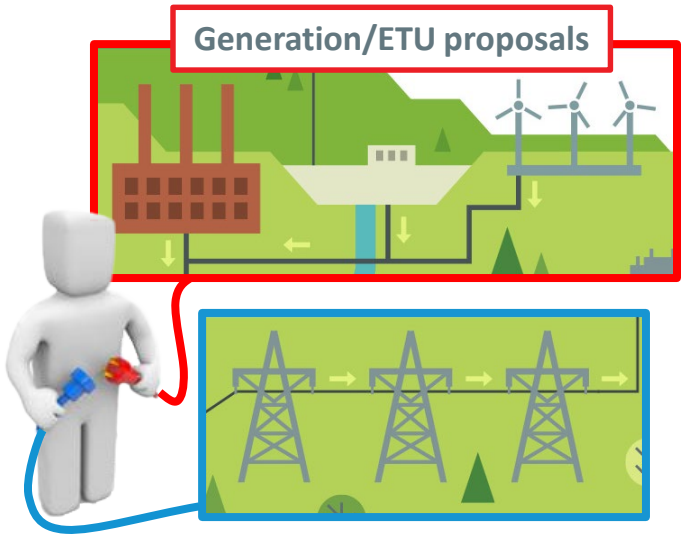


Source: ISO Newswire Article from April 11, 2023, New England again sets record for low demand on regional power system - ISO Newswire

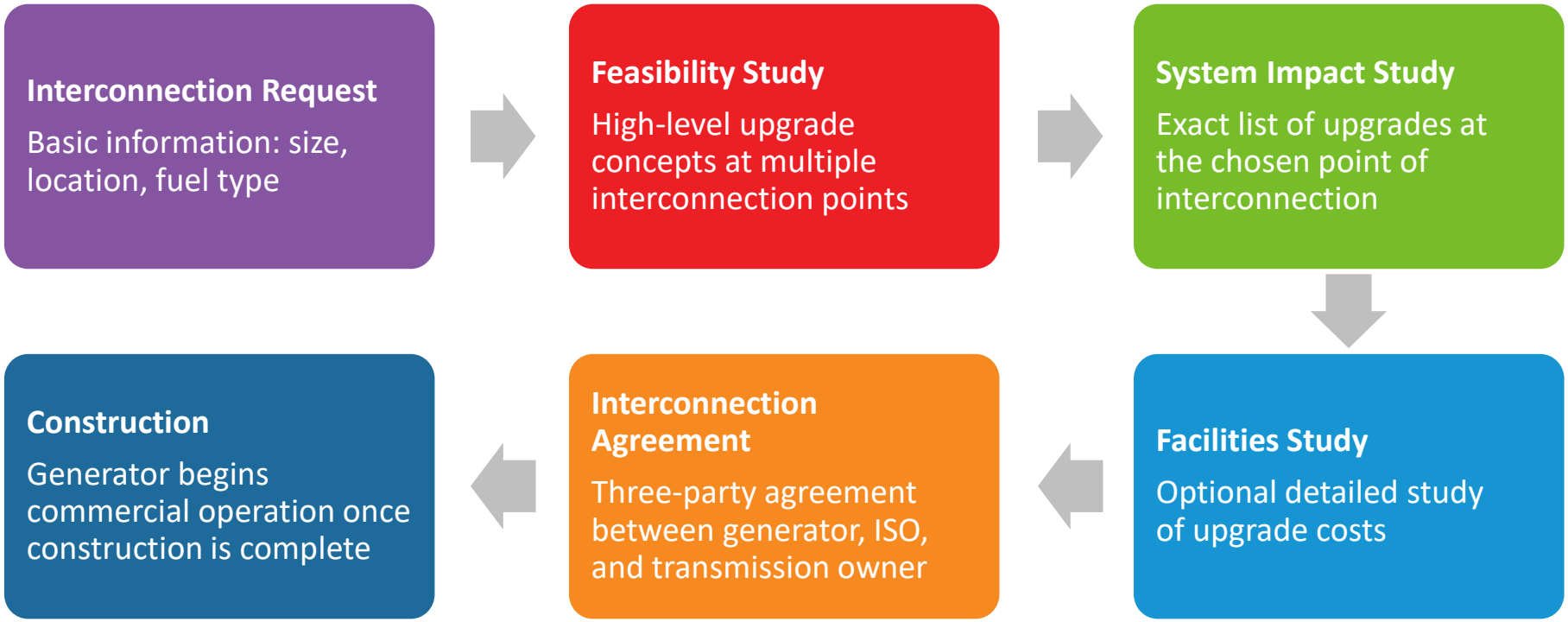
Connecting Resources to the Power System

ISO administers the FERC-jurisdictional 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



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

Changes to the Interconnection Process are in development to comply with FERC Order 2023. For more information, visit Committees and Groups > Key Projects > Order No. 2023 Key Project

Interconnection Queue – Additional Perspectives

- Progress of Proposals in the Interconnection Queue:
  - As of December 2023, the ISO has completed System Impact Studies (SIS) for 11,478 MW of proposed generation in the Queue
  - Expected dates of commercial operation range through 2028
  - These projects may be in various stages of development, such as:
    - Awaiting local permitting and siting decisions
    - Managing supply chain issues
    - Pending selection in state RFPs
    - Seeking financing
    - Or managing other development processes outside of the ISO's role

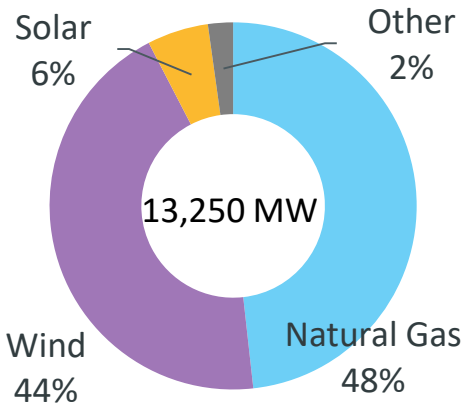
- Attrition in the Queue:
  - Historically, customers seeking to interconnect to the grid have withdrawn almost 70% of the proposed generating capacity (megawatts) in the Queue

Sources: ISO Generator Interconnection Queue, FERC Jurisdictional Proposals; For more information visit System Planning > Interconnection Service > Interconnection Request Queue;

The ISO Generator Interconnection Queue Provides a Snapshot of Resource Proposals

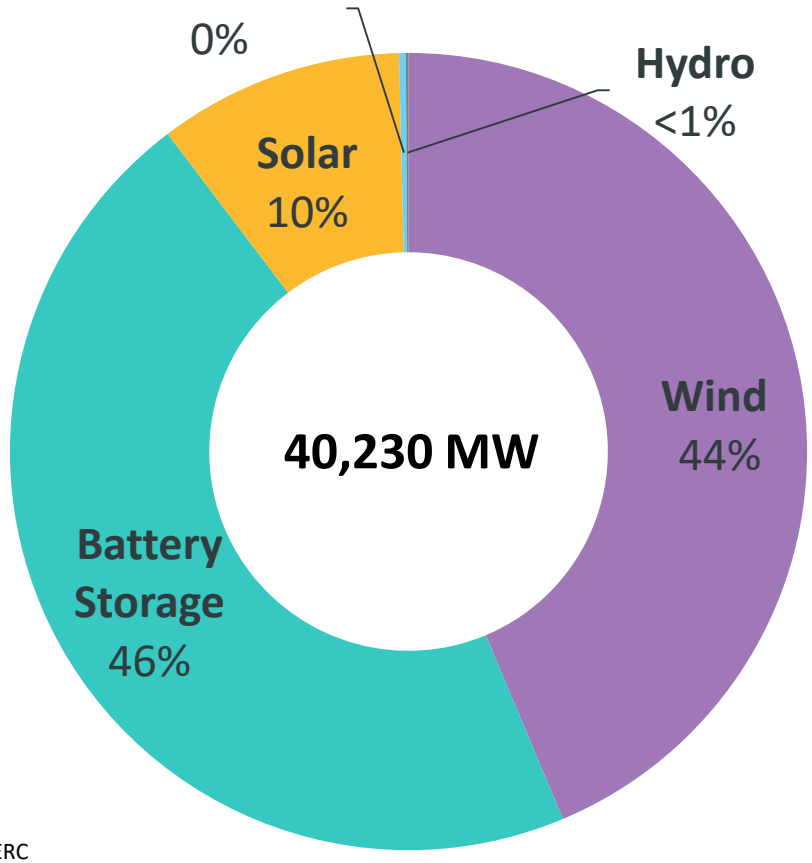
Dramatic shift in proposed resources from natural gas to battery storage and renewables

Then



June 2017

Now



November 2023

Offshore Wind

CT	2,400 MW
MA	11,941 MW
RI	704 MW

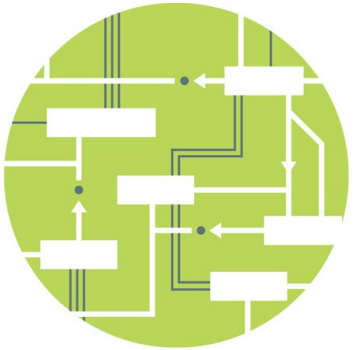
Onshore Wind

ME	2,522 MW

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

TRANSMISSION PLANNING

Regional Transmission Planning



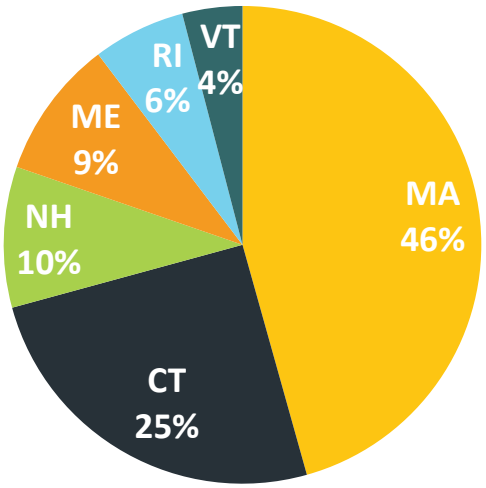
- ISO New England is responsible for planning the regional transmission system over the ten-year planning horizon
  - Summarized in Regional System Plan
  - Stakeholder engagement through Planning Advisory Committee

- 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 and will be final in early 2024

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

ISO-NE identifies a need for a project

↓

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 upgrades facilitate resource transformation, which helps the states achieve their environmental objectives
  - New resources have been able to interconnect without significant upgrades
  - Older, less efficient resources can retire

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 Competitive Solution process is followed if the need is greater than three years from the time the Needs Assessment is completed or if the solution is likely to be a Market Efficiency Transmission Upgrade (METU)
  - The Solutions Study process is followed if the need is three years or less from the time the Needs Assessment is completed

An Additional Part of the Process…

- ISO confirms that the project has no significant adverse impact on other transmission or generation facilities (pursuant to section I.3.9 of the Tariff)
- Once approved, the project may proceed to construction
  - Other processes are likely before construction begins, such as siting
- Project is added to the base model for all subsequent study work
  - Needs Assessments
  - New interconnections (resource and ETUs)

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 and mandates related to energy and environmental objectives
- Individual states and NESCOE provide input during the planning process
- ISO New England has a process to conduct Longer-Term Transmission Studies (LTTSs) requested by NESCOE to identify high-level concepts of transmission infrastructure that could meet a New England state's energy policy, mandate, or legal requirement
  - Study assumptions are based on state-identified scenarios and timeframes, which may extend beyond the ten year planning horizon

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)

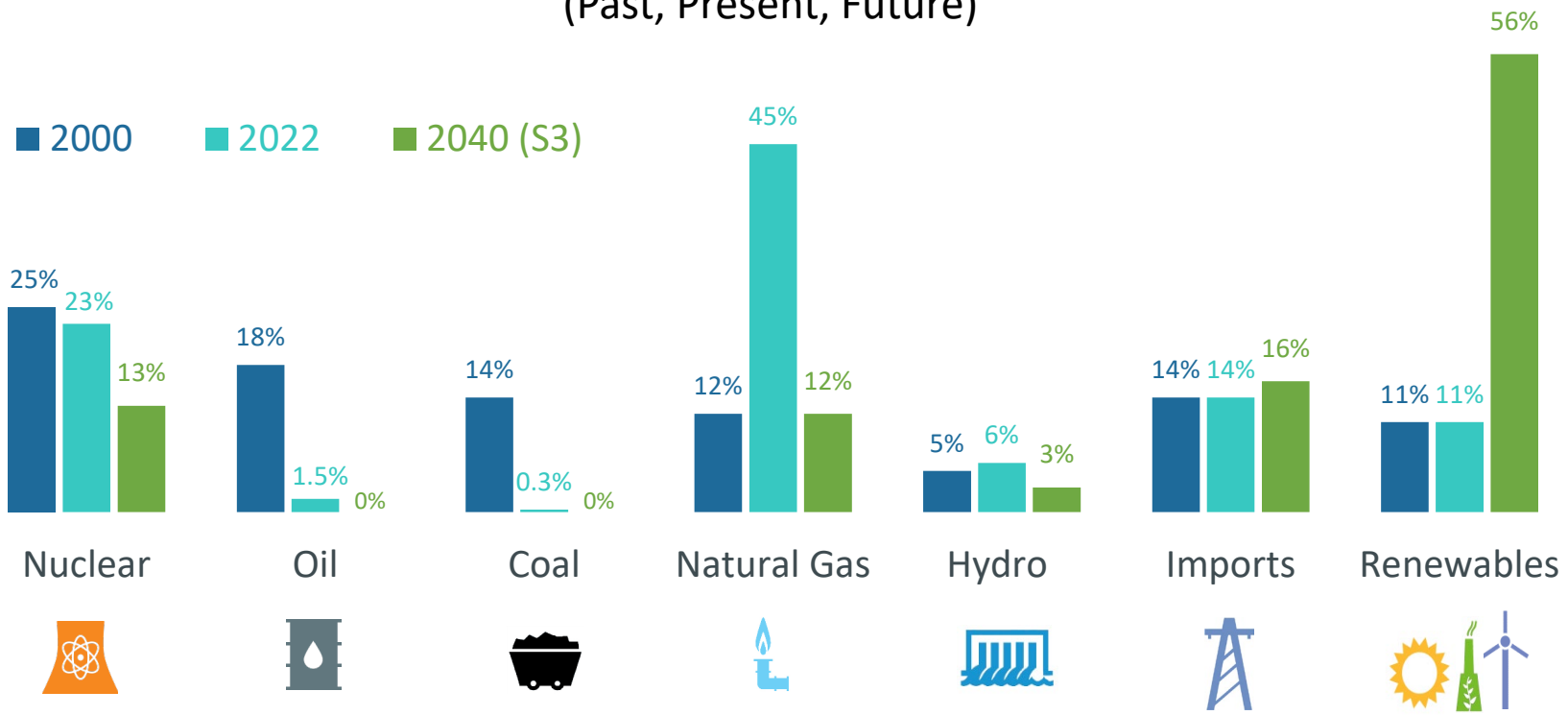
Inter-Area Planning Stakeholder Advisory Committee (IPSAC)

A LOOK AT THE FUTURE

Dramatic Changes in the Energy Mix

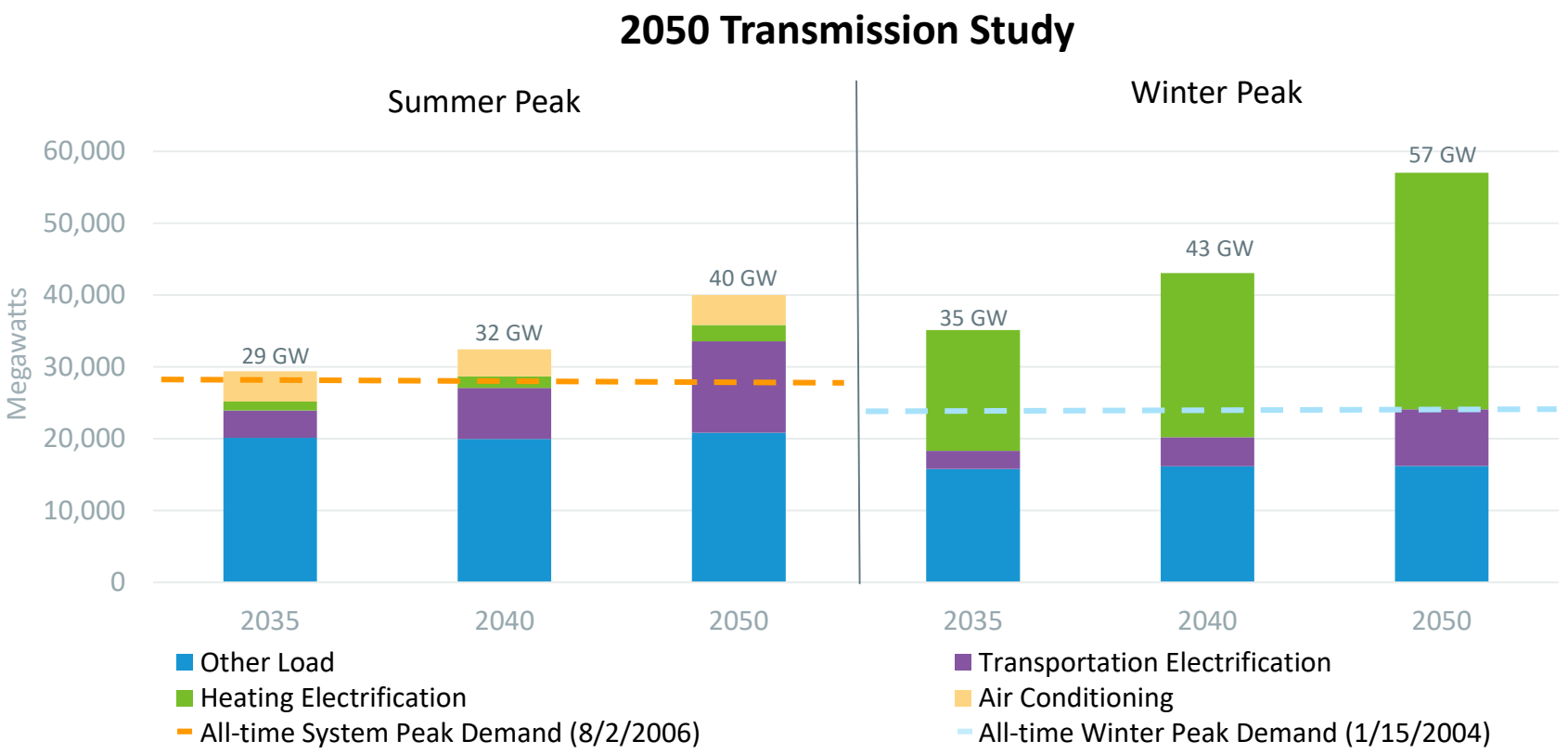
New England made a major shift from coal and oil to natural gas over the past two decades, and is shifting to renewable energy in the coming decades

Percent of Total **Electric Energy** Production by Source
(Past, Present, Future)



Source: ISO New England Net Energy and Peak Load by Source; data for 2022 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



Source: ISO New England 2050 Study Draft Report. The future scenarios in the 2050 Study were based on the All Options Pathway in Massachusetts' Deep Decarbonization Roadmap report, published in December 2020.

System Needs Going Forward

- Steady state
  - In the short run, steady state (thermal and voltage) needs are likely to be driven by 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)

There Are Four Pillars Necessary to Support a Successful Clean Energy Transition

1

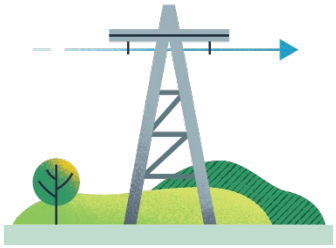
Significant amounts of clean energy to power the economy with a greener grid

2

Balancing resources that keep electricity supply and demand in equilibrium

3

Energy adequacy—a dependable energy supply chain and/or a robust energy reserve to manage through extended periods of severe weather or energy supply constraints

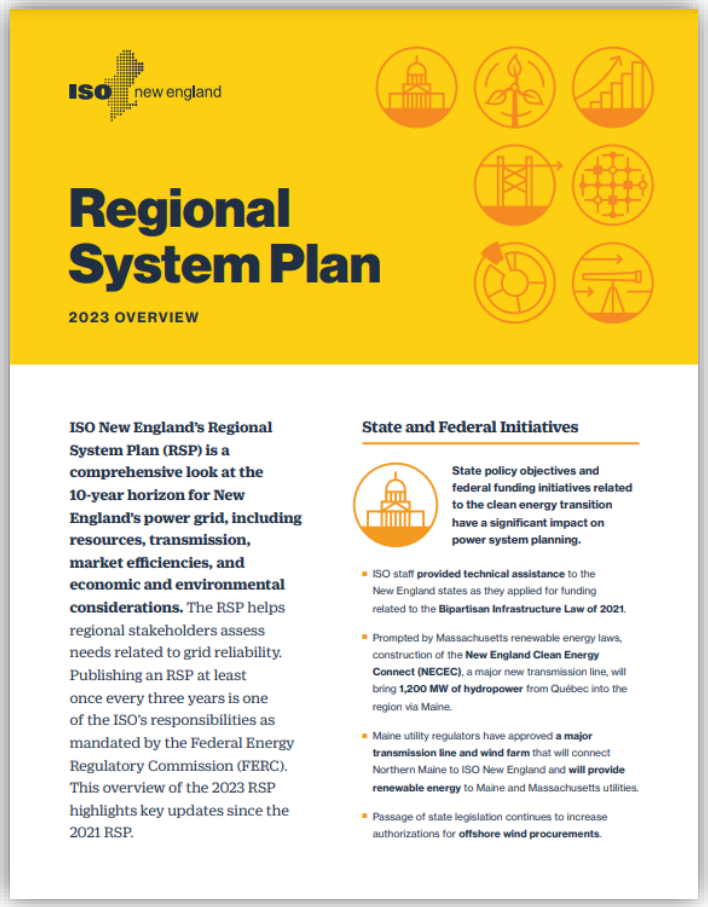


4

Robust transmission to integrate renewable resources and move clean electricity to consumers across New England

Regional System Plan Public Meeting

- Through an open stakeholder process, the ISO is responsible for the development of long-range plans to address future system needs over the ten-year planning horizon
  - Summarized in a Regional System Plan (RSP)
- ISO New England hosted a public meeting to discuss the 2023 Regional System Plan on November 1
  - A recording of the meeting is available on our website


ISO new england

Regional System Plan

2023 OVERVIEW

ISO New England's Regional System Plan (RSP) is a comprehensive look at the 10-year horizon for New England's power grid, including resources, transmission, market efficiencies, and economic and environmental considerations. The RSP helps regional stakeholders assess needs related to grid reliability. Publishing an RSP at least once every three years is one of the ISO's responsibilities as mandated by the Federal Energy Regulatory Commission (FERC). This overview of the 2023 RSP highlights key updates since the 2021 RSP.

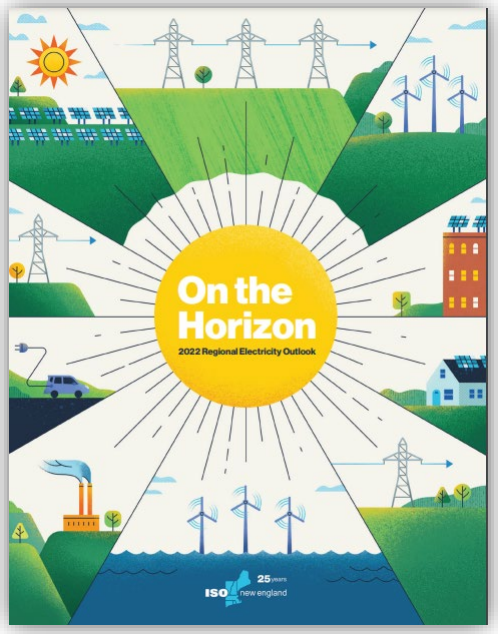
State and Federal Initiatives

State policy objectives and federal funding initiatives related to the clean energy transition have a significant impact on power system planning.

- ISO staff **provided technical assistance** to the New England states as they applied for funding related to the **Bipartisan Infrastructure Law of 2021**.
- Prompted by Massachusetts renewable energy laws, construction of the **New England Clean Energy Connect (NECEC)**, a major new transmission line, will bring **1,200 MW of hydropower** from Québec into the region via Maine.
- Maine utility regulators have approved **a major transmission line and wind farm** that will connect Northern Maine to ISO New England and **will provide renewable energy** to Maine and Massachusetts utilities.
- Passage of state legislation continues to increase authorizations for **offshore wind procurements**.

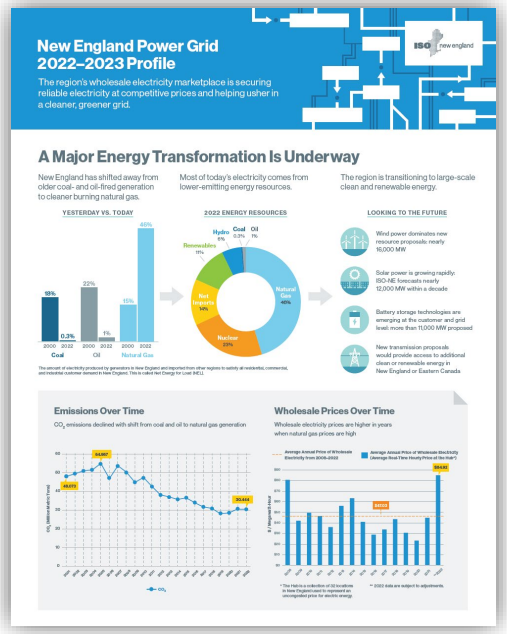
Regional System Plan 2023 Summary

ISO New England Releases Several Publications



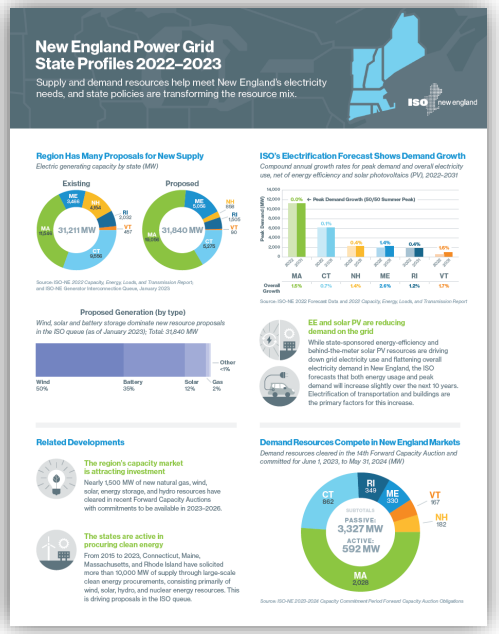
2022 Regional Electricity Outlook

Provides an in-depth look at New England's biggest challenges to power system reliability, the solutions the region is pursuing, and other ISO New England efforts to improve services and performance



New England Power Grid Profile

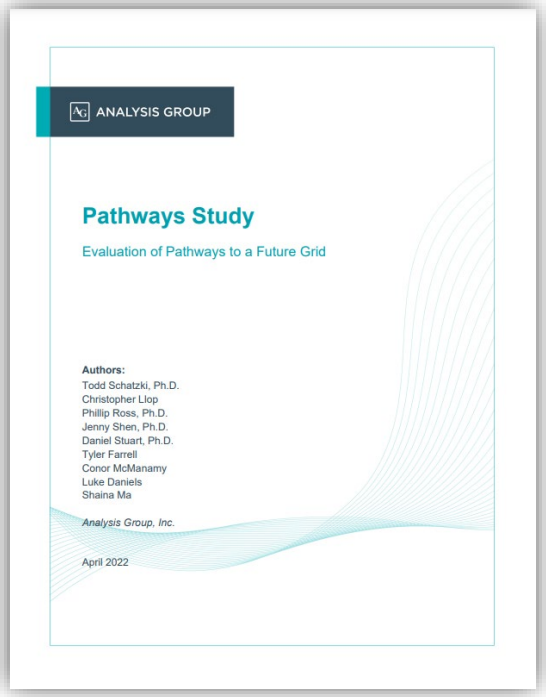
Provides key grid and market stats on how New England's wholesale electricity markets are securing reliable electricity at competitive prices and helping usher in a cleaner, greener grid



New England State Profiles

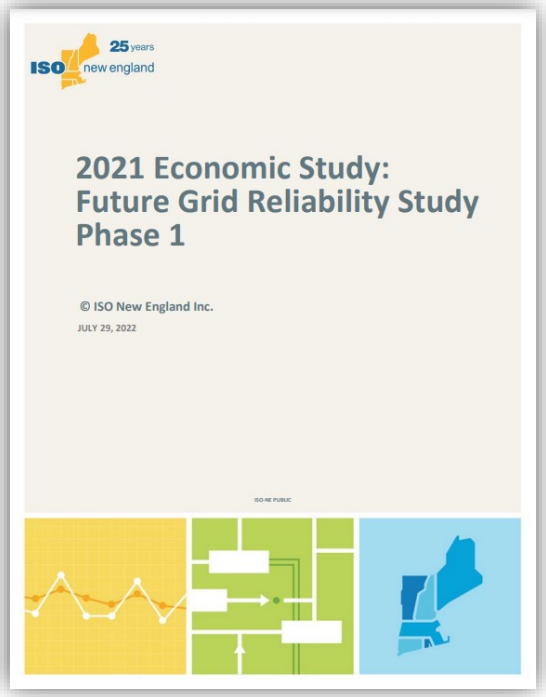
Provides state-specific facts and figures relating to supply and demand resources tied into the New England electric grid and state policies transforming the resource mix in the region

Previous ISO New England Public Webinars



[Pathways Study Public Meeting]

In June 2022, ISO New England hosted a webinar on *Evolution of Pathways to a Future Grid*– a study of potential wholesale market design frameworks that would allow New England to meet its decarbonziation goals.



[Future Grid Reliability Study Public Meeting]

In October 2022, ISO New England hosted a webinar on the *2021 Economic Study: Future Grid Reliability Phase 1* – the study evaluates how a 2040 grid could perform with a shift to largely renewable resources and a large increase in demand associate with electrification the heating and transportation sectors.

Questions