AUGUST 21, 2023 | GROTON, CT

New England's Changing Resource Mix and Planning for the Future Grid

Northeast Public Power Association
2023 Annual Conference

Gordon van Welie

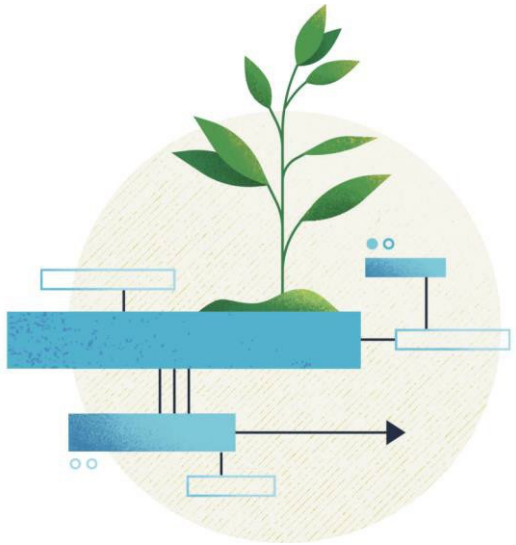
PRESIDENT & CEO

ISO-NE PUBLIC

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

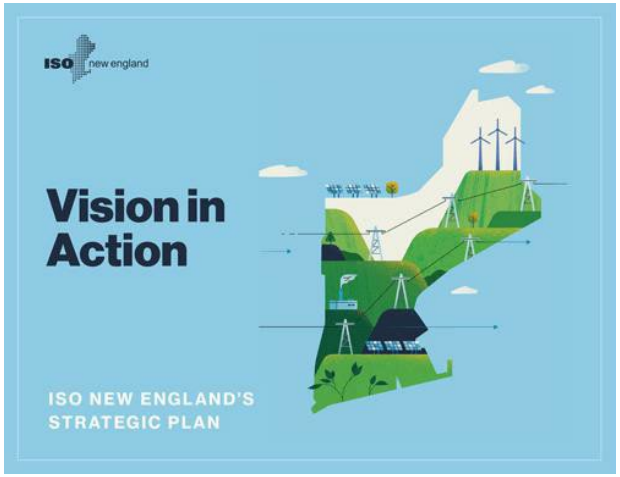


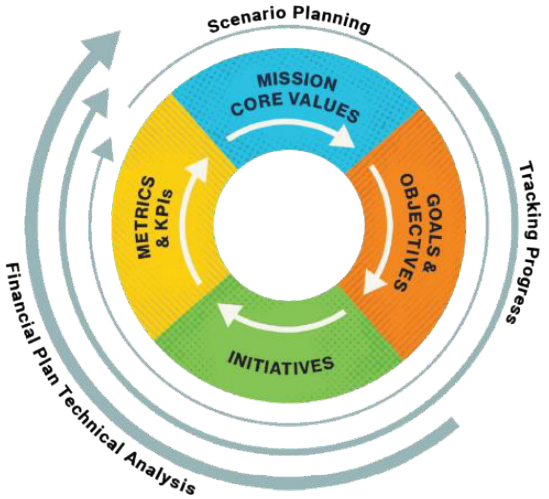
Vision: *Where we're going*

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 **Vision** for the future represents our long-term intent and guides the formulation of our Strategic Goals*

ISO New England's Strategic Plan



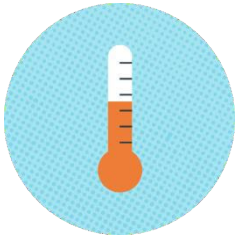


- In October 2022, the ISO released **Vision in Action: ISO New England's Strategic Plan**
- The plan provides insight into how the ISO intends to fulfill its three critical roles during the clean energy transition
- In addition to discussing the ISO's key goals and initiatives, the plan offers perspectives on trends shaping the power industry, including:
  - Changing How the Region Generates and Uses Electricity
  - Changing Weather and Winter Challenges
  - Changing Economy At Home and Around the World

ISO-NE Is a Summer-Peaking System

New England shifted from a winter-peaking system to a **summer-peaking** system in the early 1990s, largely because of the growth of air conditioning and a decline in electric heating

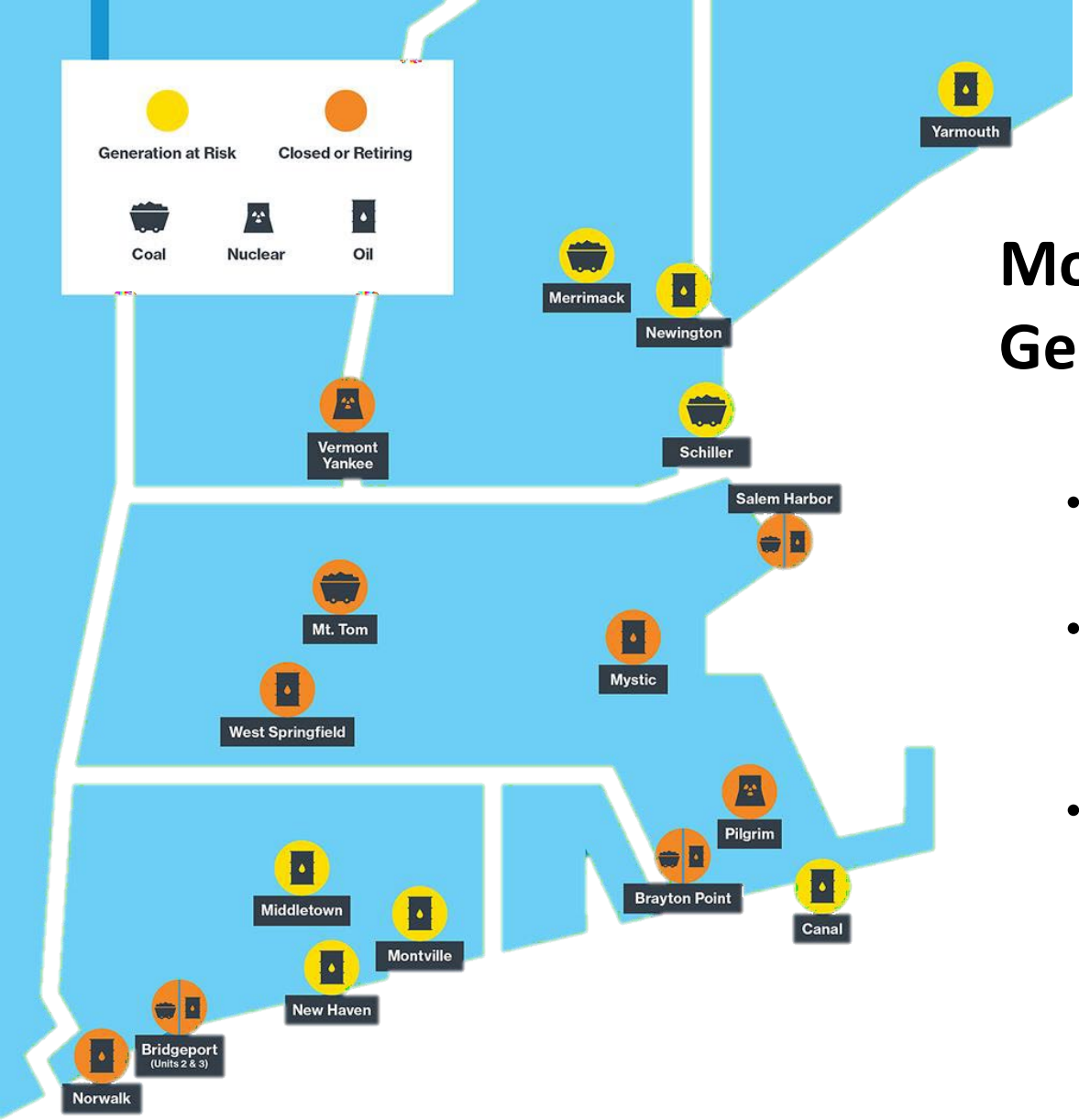
- Peak demand on a normal summer day has typically ranged from 17,500 MW to 22,000 MW
- Summer demand usually peaks on the hottest and **most humid** days and averaged roughly 25,600 MW since 2000



- Region's all-time summer peak demand was **28,130 MW** on **August 2, 2006**

The region is expected to shift back to a **winter-peaking system** with the electrification of heating demand

- Region's all-time **winter** peak demand was **22,818 MW** on **January 15, 2004**



From 2013 to 2022, More Than 5,200 MW of Generation Have Retired

- Include predominantly coal, oil, and nuclear resources
- Another **5,000 MW** of remaining coal and oil are at risk of retirement
- These resources have played an **important** role in recent winters when natural gas supplies are constrained in New England

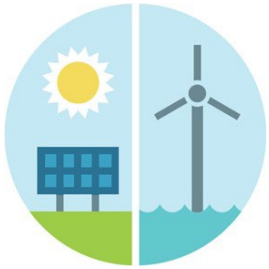
Source: ISO New England Status of Non-Price Retirement Requests and Retirement De-list Bids (April 2023)

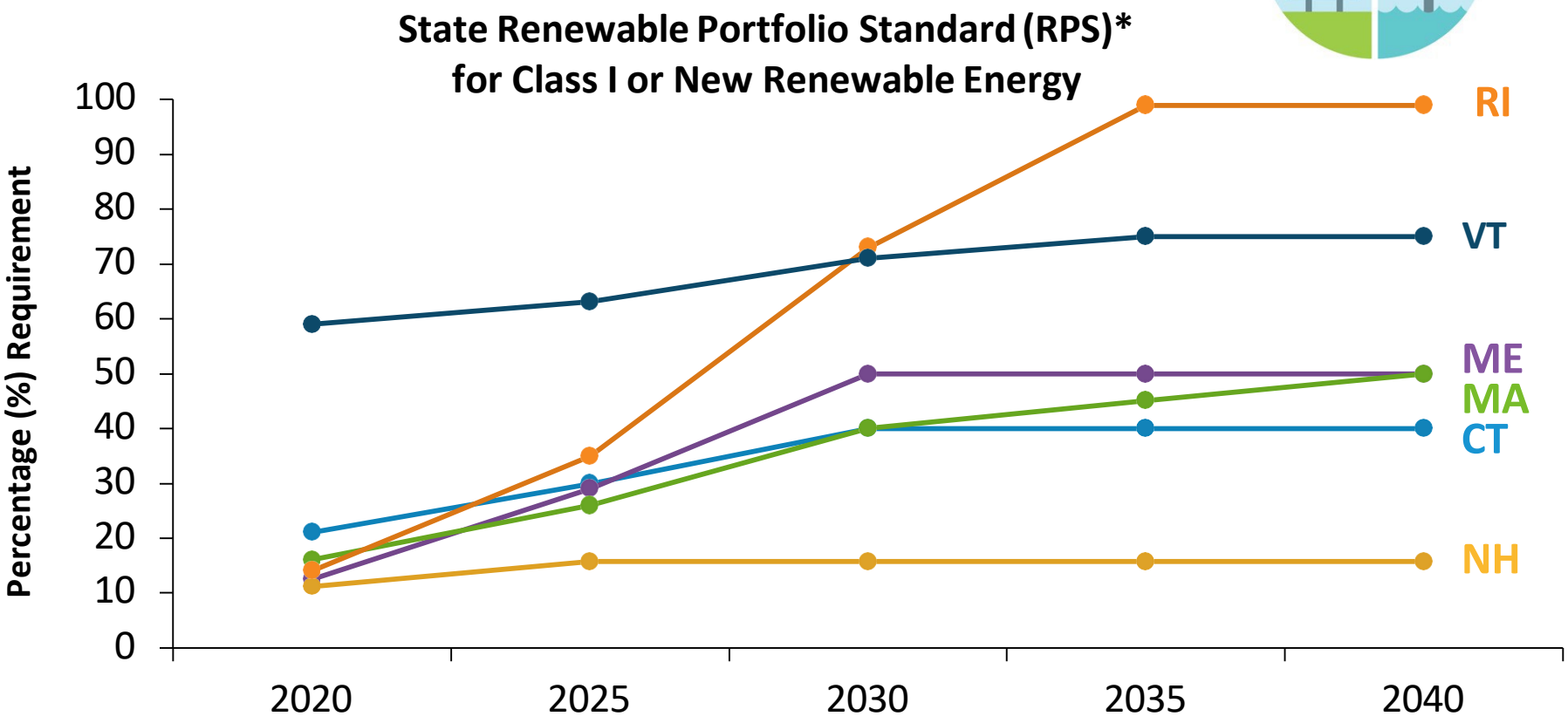
State Laws Target Deep Reductions in CO_2 Emissions and Increases in Renewable and Clean Energy

≥80% by 2050	Five states mandate greenhouse gas reductions economy wide: MA, CT, ME, RI, and VT (mostly below 1990 levels)
Net-Zero by 2050 80% by 2050	MA emissions requirement MA clean energy standard
90% by 2050	VT renewable energy requirement
100% by 2050 Carbon-Neutral by 2045	ME renewable energy goal ME emissions requirement
100% by 2040	CT zero-carbon electricity requirement
100% by 2033	RI renewable energy requirement

Renewable Energy Is on the Rise

State policy requirements are a major driver

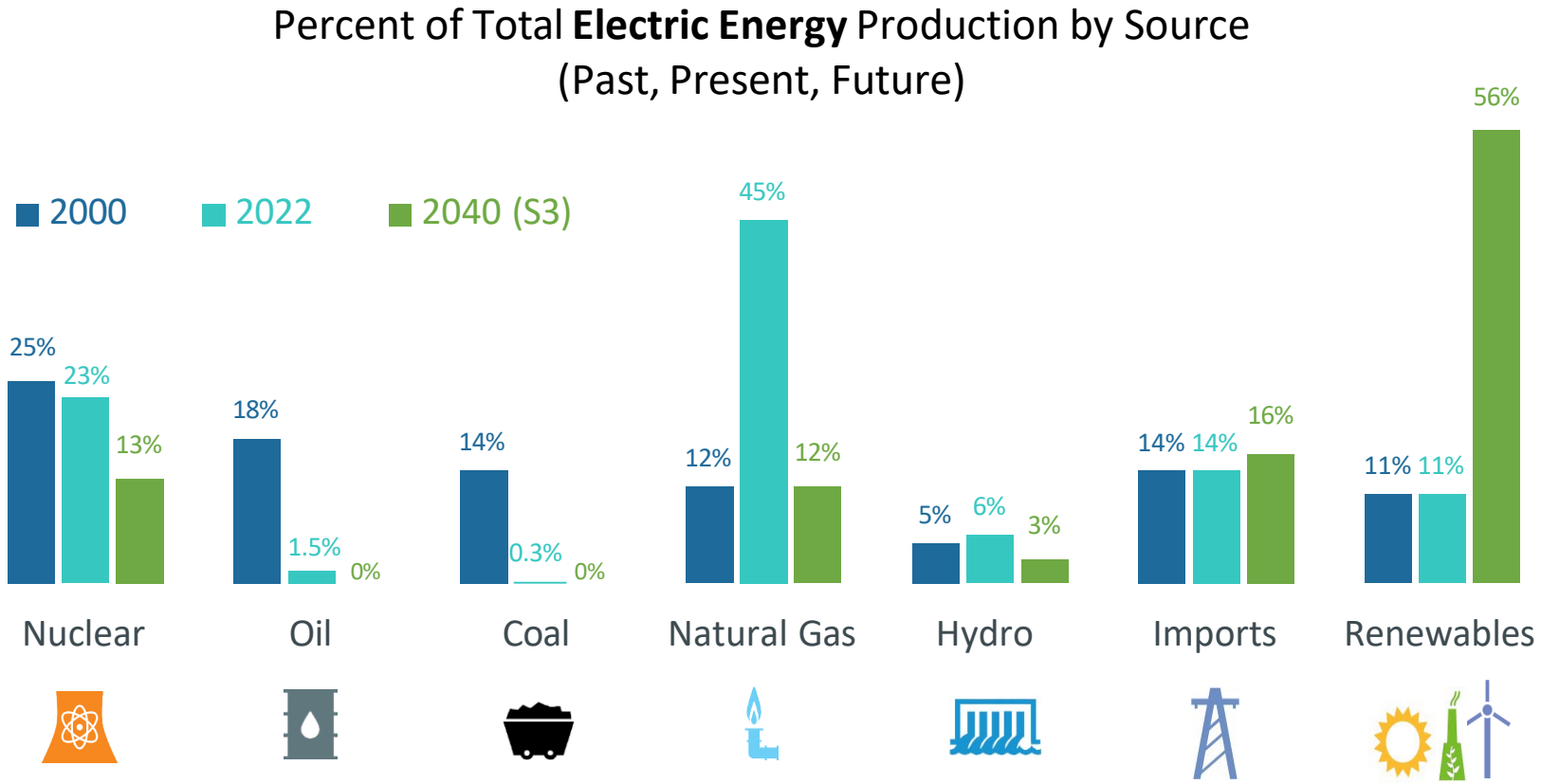




Notes: State RPS requirements promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Connecticut's Class I RPS requirement plateaus at 40% in 2030. Maine's Class I/IA RPS requirement increases to 50% in 2030 and remains at that level each year thereafter. Massachusetts' Class I RPS requirement increases by 2% each year between 2020 and 2024, 3% each year between 2025 and 2029, reverting back to 1% each year thereafter, with no stated expiration date. New Hampshire's percentages include the requirements for both Class I and Class II resources (Class II resources are new solar technologies beginning operation after January 1, 2006). New Hampshire's Class I and Class II RPS requirements plateau at 15.7% in 2025. Rhode Island's requirement for 'new' renewable energy reaches 100% in 2033. Vermont's 'total renewable energy' requirement plateaus at 75% in 2032; it recognizes all forms of new and existing renewable energy and is unique in classifying large-scale hydropower as renewable.

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

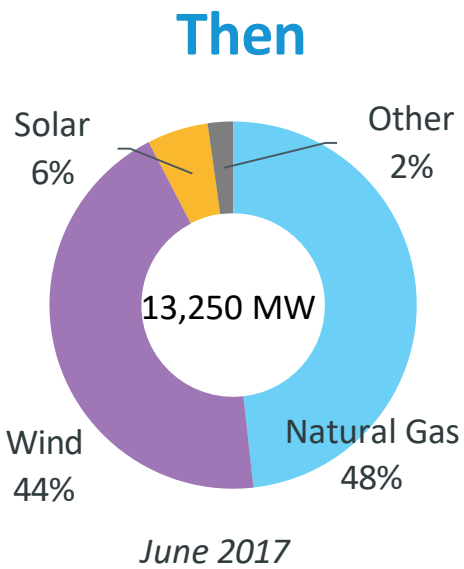


Source: ISO New England Net Energy and Peak Load by Source; data for 2022 is preliminary and subject to resettlement; data for 2040 is based on Scenario 3 of the ISO New England 2021 Economic Study: Future Grid Reliability Study Phase 1.

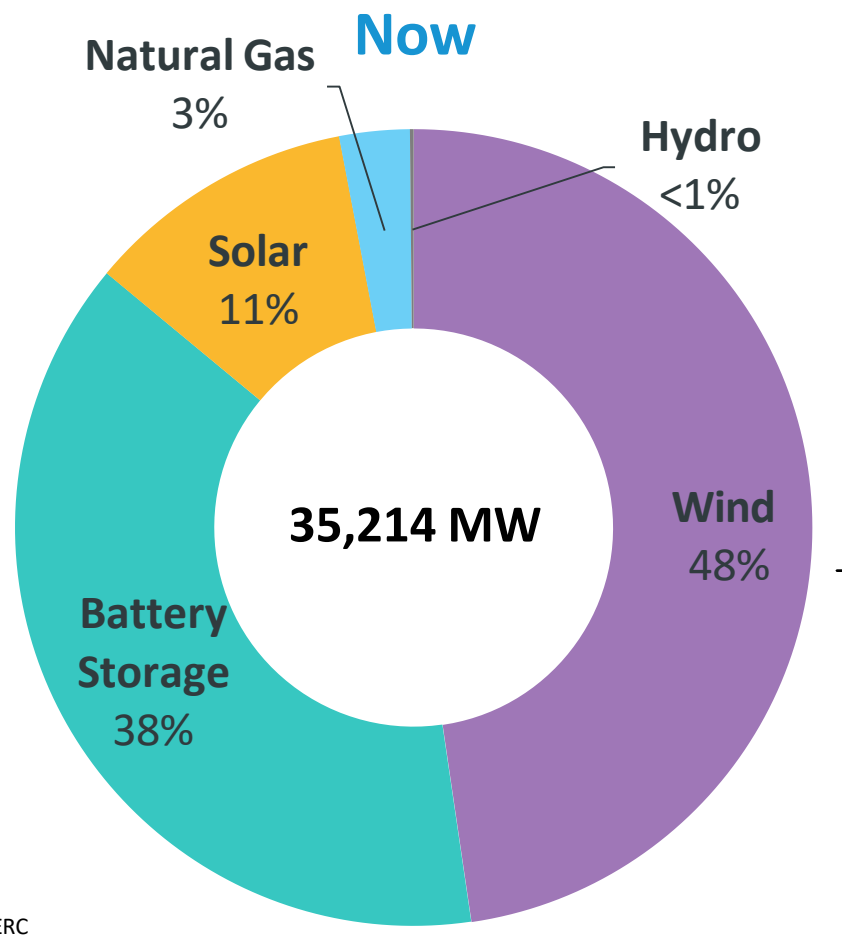
Renewables include landfill gas, biomass, other biomass gas, wind, grid-scale solar, behind-the-meter solar, municipal solid waste, and miscellaneous fuels.

The ISO Generator Interconnection Queue Provides a Snapshot of Resource Proposals

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



June 2017



June 2023

Offshore Wind

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

Onshore Wind

ME	2,325 MW

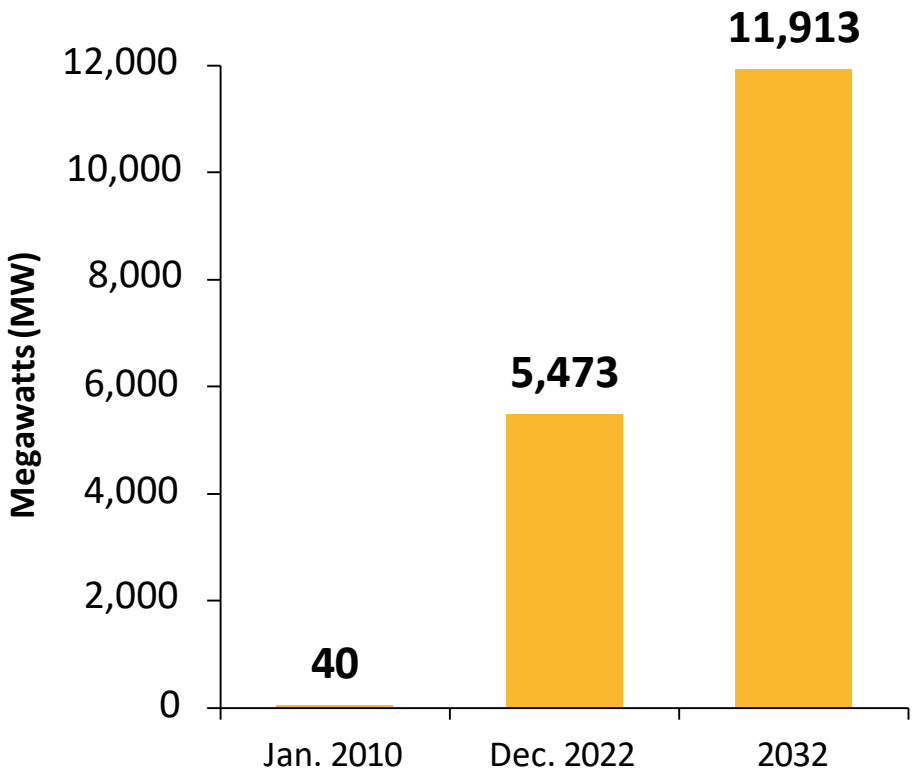
Source: ISO Generator Interconnection Queue, FERC Jurisdictional Proposals; Nameplate Capacity Ratings.

ISO New England Forecasts Strong Growth in Solar Photovoltaic (PV) Resources

December 2022 Solar PV Installed Capacity (MW_{ac})

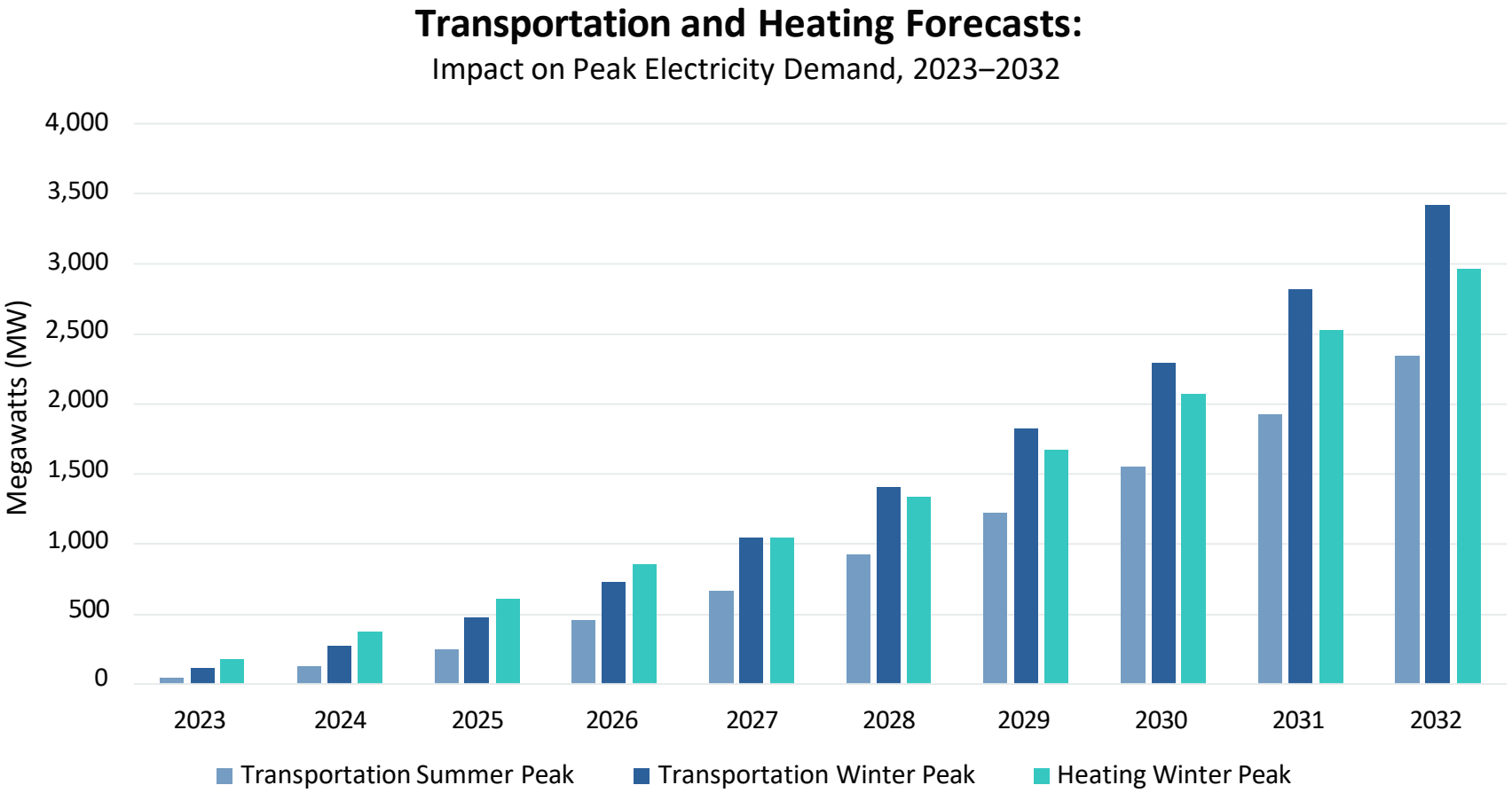
State	Installed Capacity (MW_{ac})	No. of Installations
Connecticut	912	73,553
Massachusetts	3,289	150,020
Maine	295	8,583
New Hampshire	183	14,427
Rhode Island	326	17,034
Vermont	468	19,348
New England	**5,473**	**282,965**

Cumulative Growth in Solar PV through 2032 (MW_{ac})



Note: The bar chart reflects the ISO's projections for nameplate capacity from PV resources participating in the region's wholesale electricity markets, as well as those connected "behind the meter." The forecast does not include forward-looking PV projects > 5 MW in nameplate capacity. Source: ISO New England 2023-2032 Forecast Report of Capacity, Energy, Loads, and Transmission (2023 CELT Report) (May 2023), and 2023 Photovoltaic (PV) Forecast; MW values are AC nameplate.

Electricity Demand from Electric Vehicles and Heating Sectors to Grow Over the Next Decade

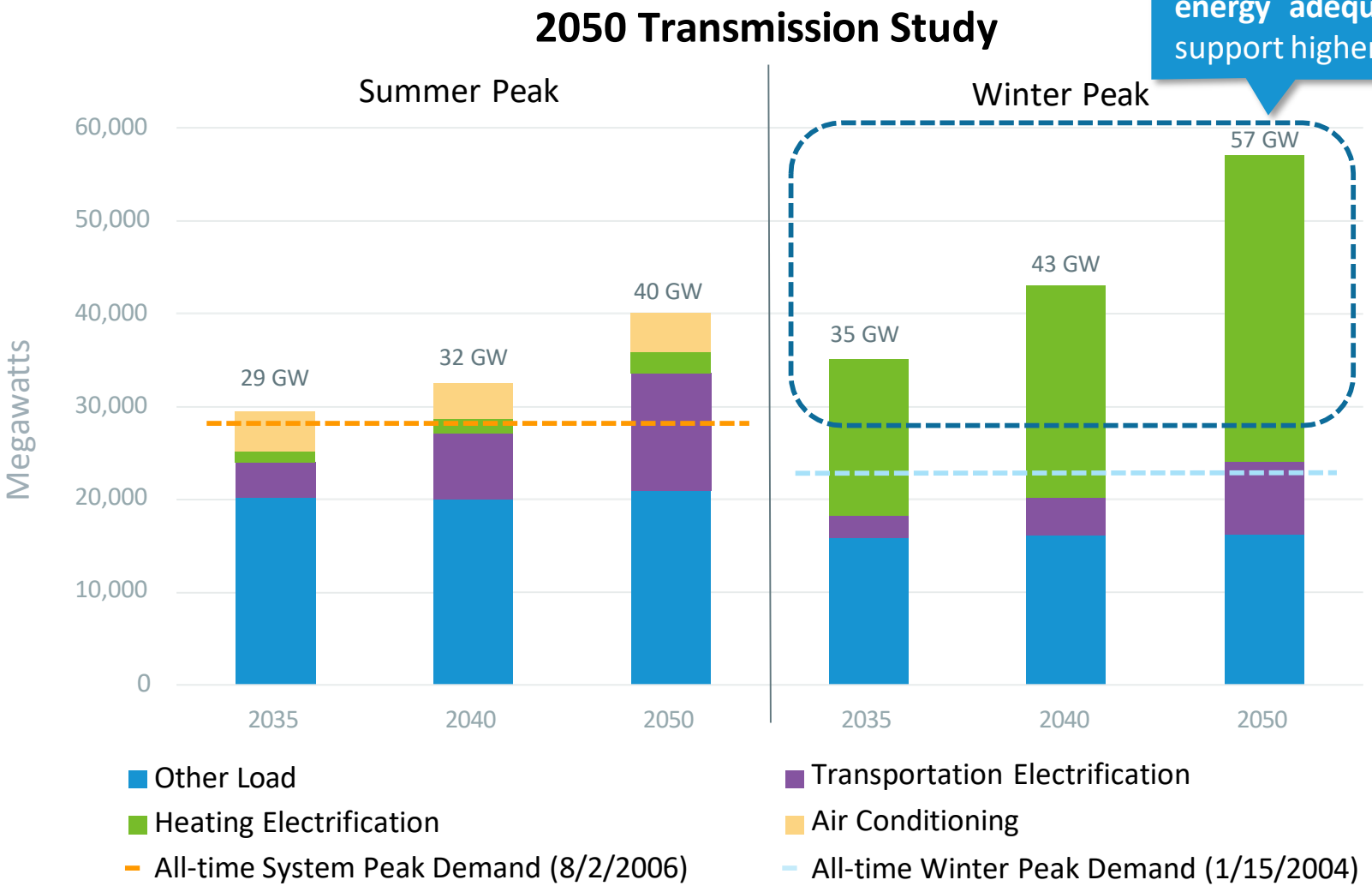


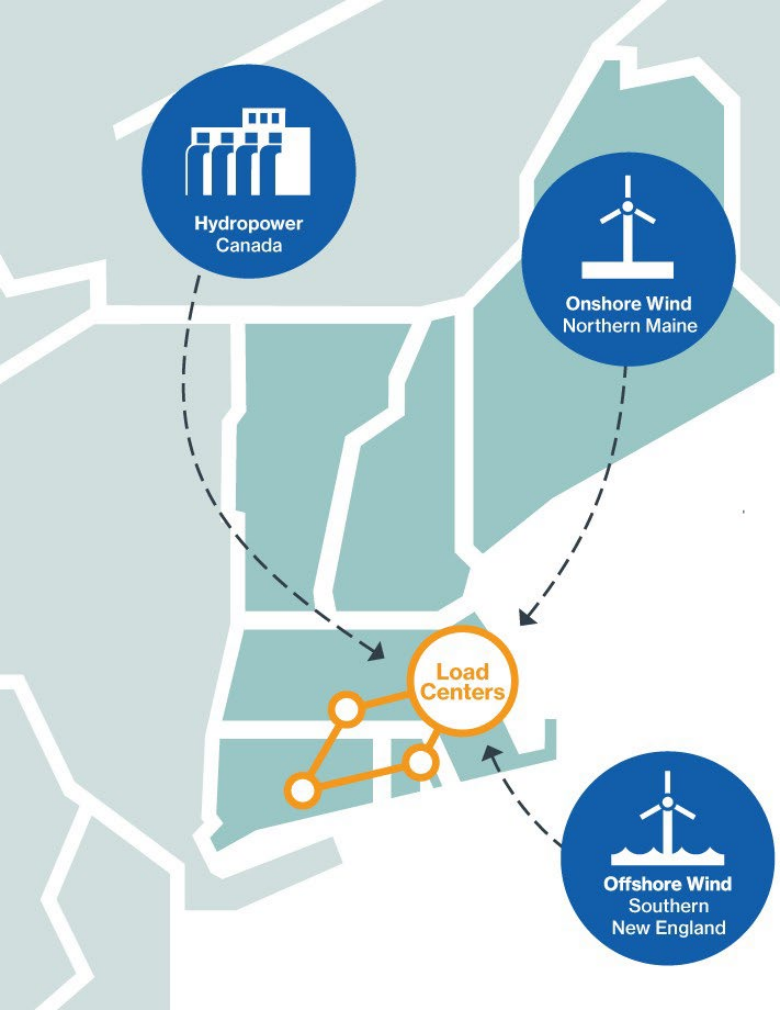
Percentage of Net System Peak in 2032: Transportation – summer: 9%; Transportation – winter: 13%; Heating – winter: 11%

Sources: ISO New England 2023-2032 Forecast Report of Capacity, Energy, Loads, and Transmission (2023 CELT Report) (May 2023), 2023 Forecast Data.

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

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





Lines represent types of ETUs private developers have proposed in recent years

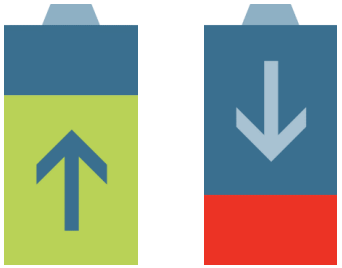
Source: ISO Interconnection Queue (June 2023)

Major Transmission Investment Will Be Required to Support the Region's Clean Energy Transition

- Developers are proposing nine elective transmission upgrades (ETUs) to help deliver over **15,000 MW** of clean energy to New England load centers
  - New England Clean Energy Connect (NECEC) is a 145-mile HVDC transmission line proposed by Central Maine Power to bring 1,200 MW of large-scale hydropower from Hydro-Québec in eastern Canada to Maine and the ISO-NE system
- Wind projects make up nearly **50%** of new resource proposals in the ISO Queue
  - Most are offshore wind proposals in southern New England, but some are onshore wind proposals in northern New England and **would require transmission** to deliver the energy to load centers

Energy Storage Is a Key Part of the New England Power Grid's *Past, Present, and Future*

- Two pumped-storage hydro facilities have operated in New England since the 1970s
  - These resources can supply up to **1,800 MW** of power within **10 minutes for up to 7 hours**



- **In 2016**, together with our stakeholders, the ISO began efforts to enable other energy-storage technologies to participate in the wholesale markets
  - The ISO filed the **Energy Storage Device Project** in Oct. 2018 and FERC approved it, effective April 2019
  - The project largely addressed the major requirements of FERC Order 841, issued in Feb. 2018
- Currently, about **50 MW** of batteries are dispatchable by the ISO, with many more proposed

Source: Seasonal Claimed Capability Monthly Report February 2023

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

1

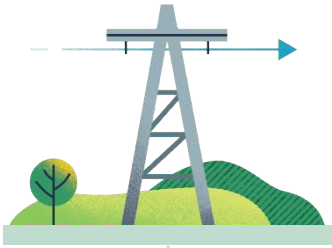
Significant amounts of clean energy to power the economy with a greener grid

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



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

Overview of Studies Supporting the Future Grid

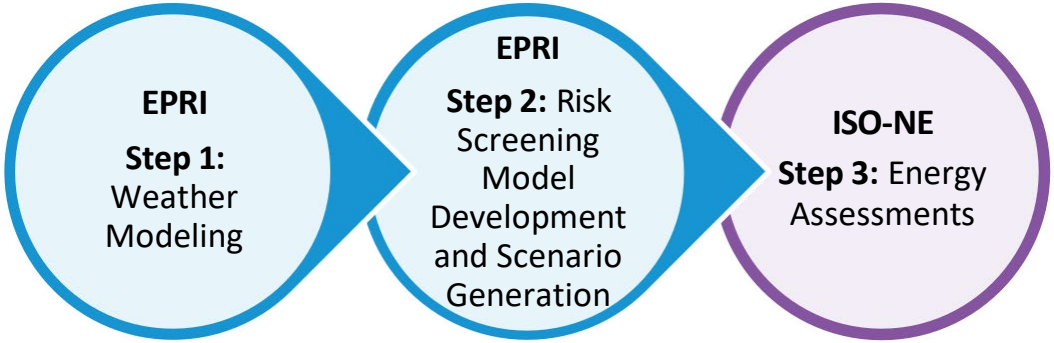
- **Weather**: Operational Impacts of Extreme Weather Events
  - Rigorously model likelihood and impact of extreme weather events
- **Transmission**: 2050 Transmission Study
  - Determine transmission needs to support renewable/high load future
- **Operations**: Future Grid Reliability Study
  - Phase 1- Examine operational effects of renewable-heavy grid
- **Markets**: Pathways to the Future Grid
  - Evaluate different market options to support a renewable-heavy grid
- **Reliability**: Transmission Planning for the Clean Energy Transition
  - Explore how near-term needs assessments should evolve with renewables

Responsive Market Designs

- FERC Order No. 2222
  - Further integrate Distributed Energy Resources (DERs) and DER Aggregations into the regional markets
- Alternative FCM Commitment Horizons (Prompt/ Seasonal)
  - Evaluate possible market design changes to the Forward Capacity Market (FCM) commitment horizon that would replace the Forward Capacity Auction (FCA) with a "prompt" capacity auction, and would structure capacity as a seasonal product
- Resource Capacity Accreditation (RCA) in the FCM
  - Implement new methodologies to accredit resources' capacity contributions to regional resource adequacy
- Day-Ahead Ancillary Services Initiative (DASI)
  - Develop market constructs for procuring and transparently pricing ancillary service capabilities needed for a reliable, next-day operating plan with an evolving resource mix

Operational Impact of Extreme Weather Events – Energy Adequacy Study

- ISO is working with the Electric Power Research Institute to conduct a probabilistic energy adequacy study for New England under extreme weather events
- Study results are intended to inform the region on energy adequacy risks
  - These results may help in 'quantifying' a problem statement on energy adequacy, against which possible solutions can be assessed
- Study establishes a framework for risk analysis that can be updated as climate projections are refined and the resource mix evolves
- Framework contains three major steps:

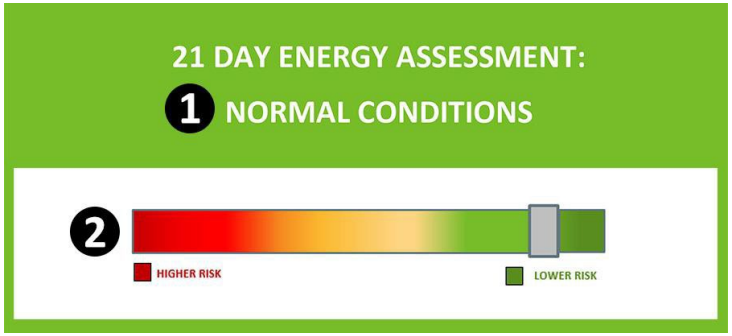


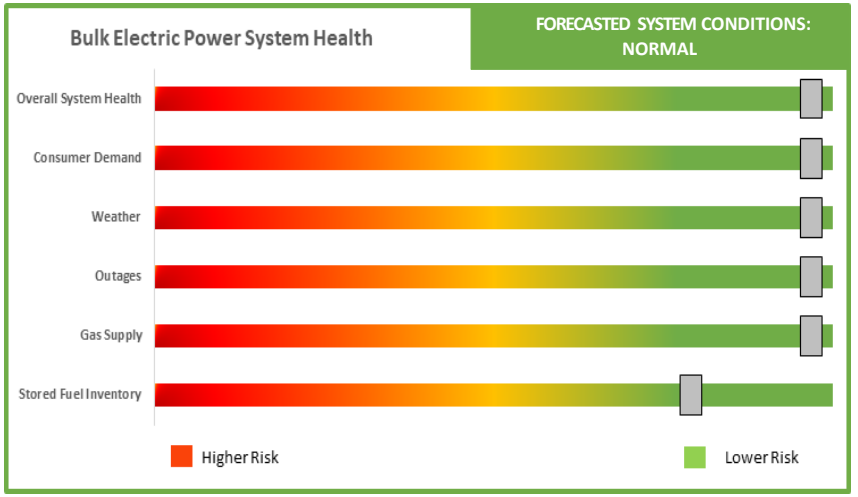
- The energy adequacy risk profile is dynamic and will be a function of the evolution of both supply and demand profiles

ISO's Energy Security Assessment Practices

21-Day Energy Assessment

- Since 2018, ISO has published a 21-Day Energy Assessment Forecast to provide early warning of potential energy shortfalls
- The rolling three-week forecast:
  - Considers anticipated power system conditions, forecasted weather and consumer demand, and expected fuel inventories, and
  - Compares hourly energy forecasts against thresholds established in OP-21
- Results of the assessment give ISO New England, public officials, and stakeholders time to take action to prevent shortfalls from materializing





Energy Adequacy Study Key Takeaways

- Preliminary results of energy assessments for 2027 winter events, 2027 summer events, and 2032 winter events have been presented to the Reliability Committee
- Results reveal a range of energy shortfall risks and associated probabilities
- Results of preliminary studies reveal similar energy adequacy risk with and without the Everett Marine Terminal in-service
  - Assumes that the market will respond with new resources to meet increased electrification load and replace retiring resources, a reliable gas system and responsive oil supply chain, that transmission will be built to interconnect wind and import Canadian hydropower, and no electricity production limitations due to emissions restrictions
  - If key assumptions don't hold, the region may see an increasingly risky profile that the ISO will capture with this assessment tool as we move forward

Energy Adequacy Study Key Takeaways, *cont.*

- In terms of magnitude and probability, baseline studies (using the 2022 CELT forecast) of 2032 winter events indicate an energy shortfall risk similar to that of the 2027 winter event studies
- Sensitivity analysis of 2032 worst-case scenarios indicate an increasing energy shortfall risk profile between 2027 and 2032
- Timely additions of BTM and Utility Scale PV, offshore wind, and incremental imports from NECEC are critical to mitigate energy shortfall risks that result from significant peak winter load growth and retirements
- This energy adequacy study tool developed in partnership with EPRI provides a much needed foundation for the ISO to monitor risks and study the system as it continues to evolve

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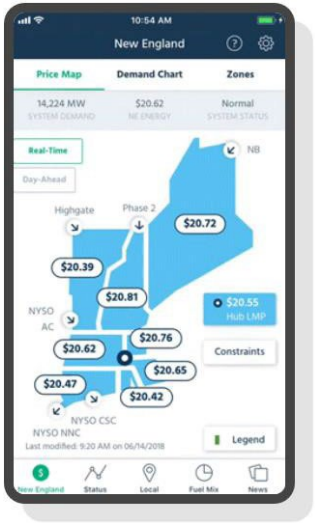
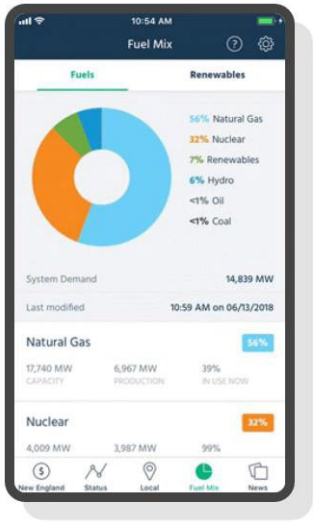
ISO to Go is a free mobile application that puts real-time wholesale electricity pricing and power grid information in the palm of your hand





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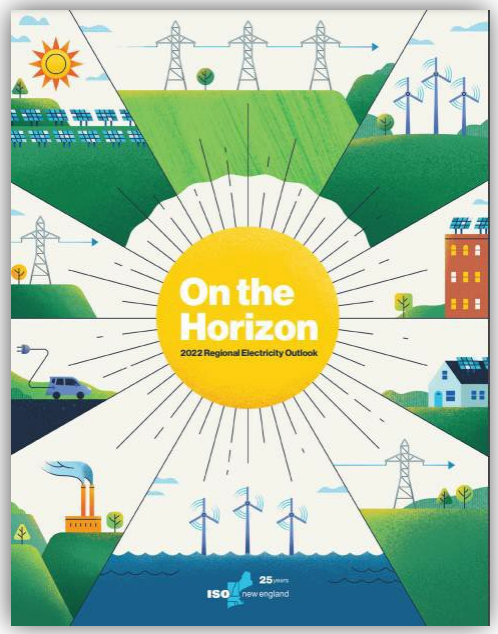
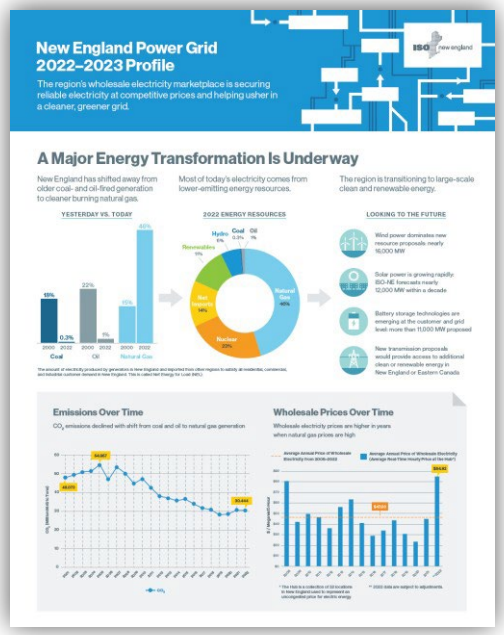
ISO New England Releases Several Publications



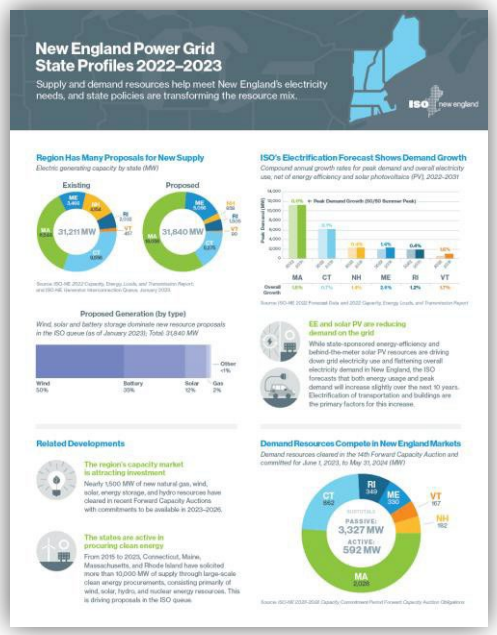
2022 Regional Electricity Outlook

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

Consumer Liaison Group Provides a Forum for Consumers to Learn about Regional Electricity Issues

- A forum for sharing information between the ISO and electricity consumers in New England
- The CLG Coordinating Committee consists of 12 members who represent various stakeholder groups
- Quarterly meetings are free and open to the public, with in-person and virtual options to participate
- Remaining 2023 Meetings
  - Thursday, September 21
  - Wednesday, December 6

2022 CLG Annual Report

More information on the CLG is available at: https://www.iso-ne.com/committees/industry-collaborations/consumer-liaison/

Questions