MARCH 2, 2022

ISO New England Regional Overview and Outlook

RI Senate Environment and Agriculture Committee

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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*

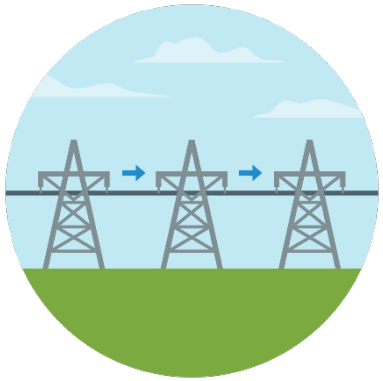
ISO New England (ISO) Has More Than Two Decades of Experience Overseeing the Region's Restructured Electric Power System

- **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

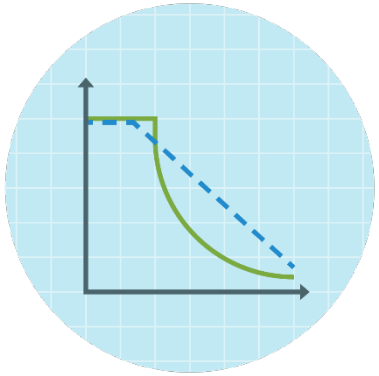
Grid Operation

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



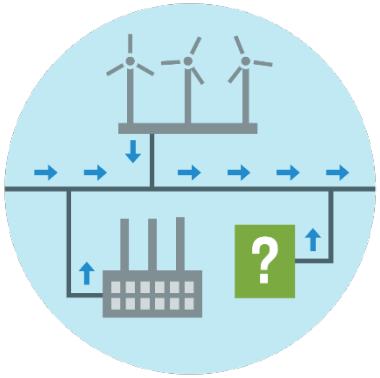
Market Administration

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

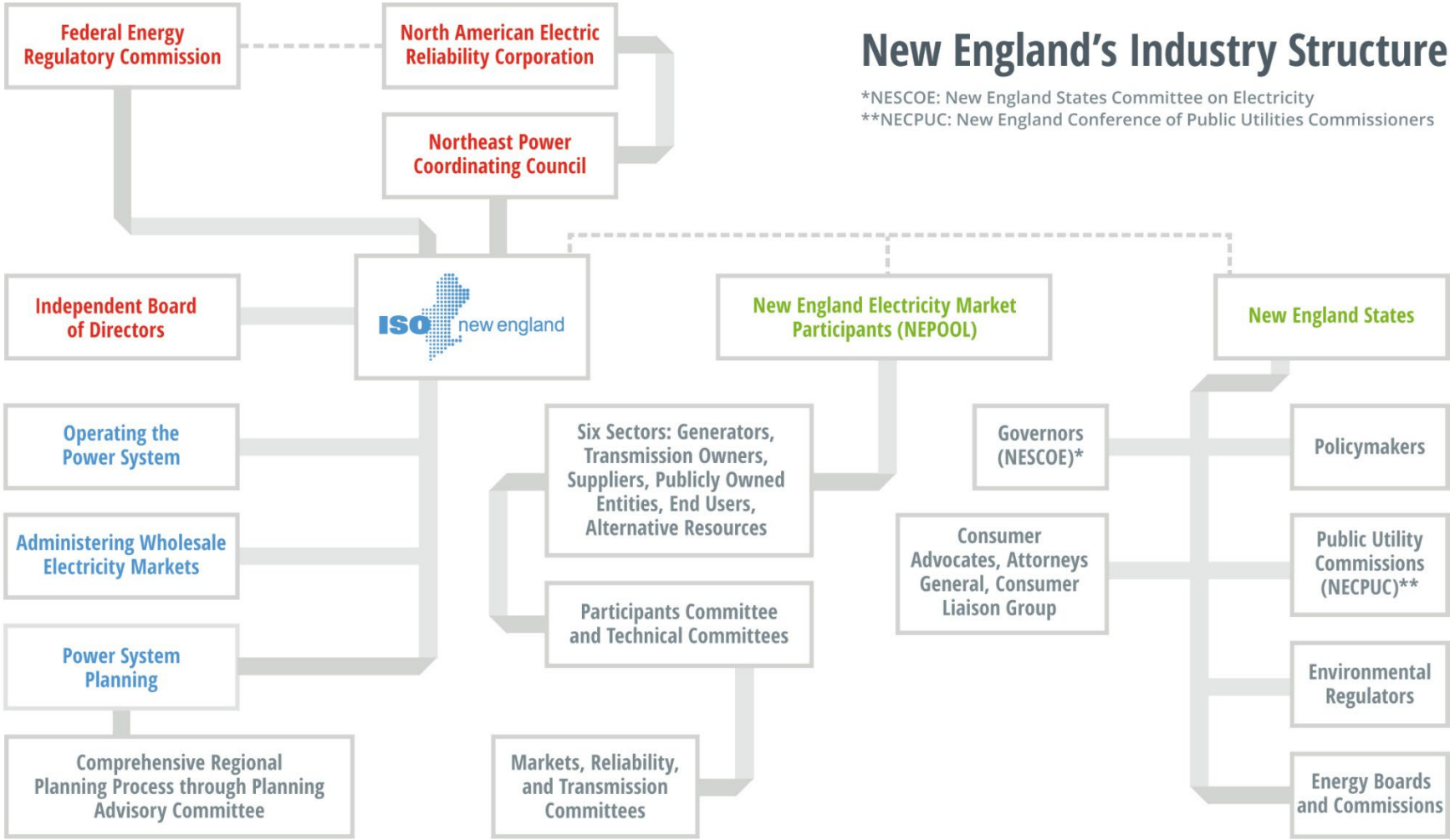


Power System Planning

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



Numerous Entities Including an Independent Board Provide Oversight of and Input on ISO's Responsibilities



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**

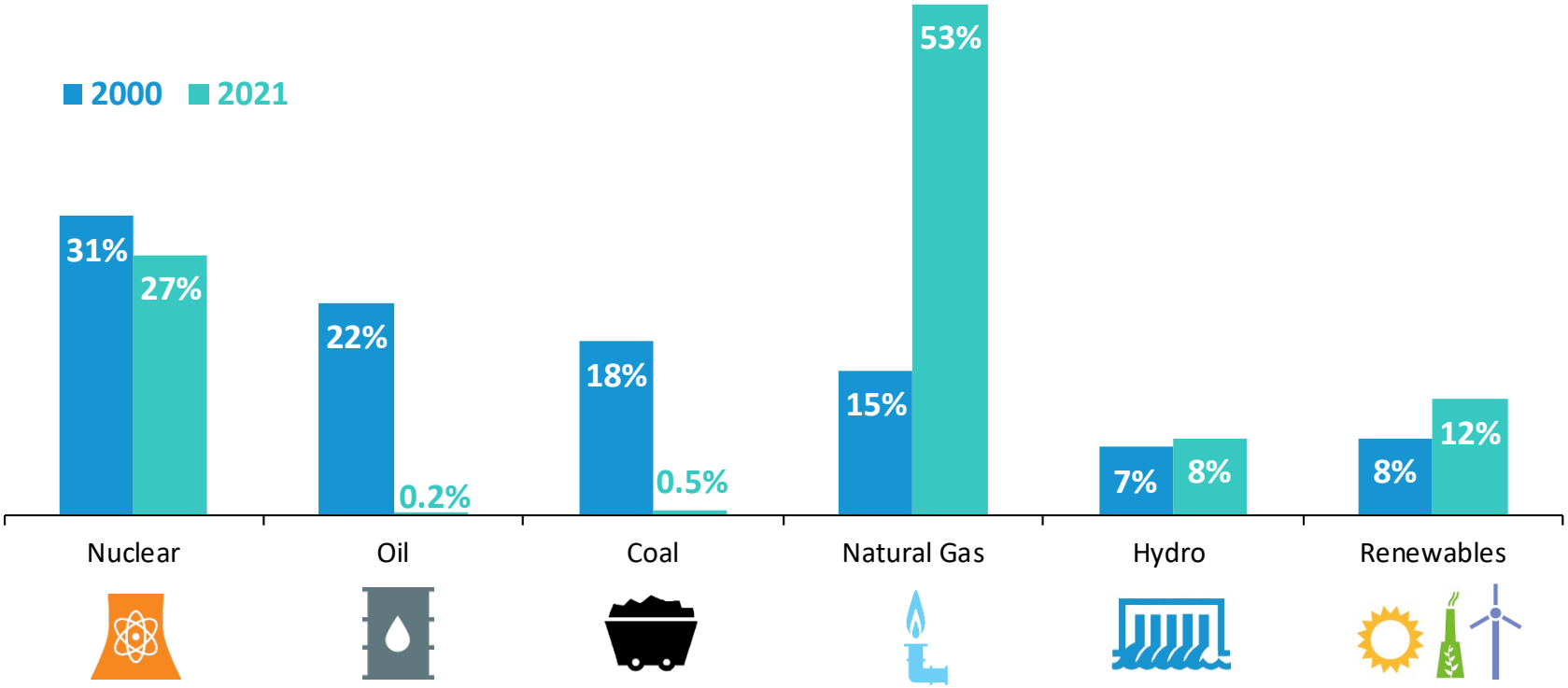
The region could shift back to a **winter-peaking system** with the electrification of heating demand

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

Dramatic Changes in the Energy Mix

The fuels used to produce the region's electric energy have shifted as a result of economic and environmental factors

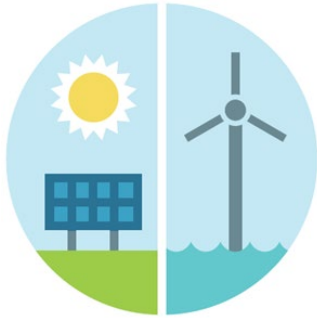
Percent of Total **Electric Energy** Production by Fuel Type
(2000 vs. 2021)

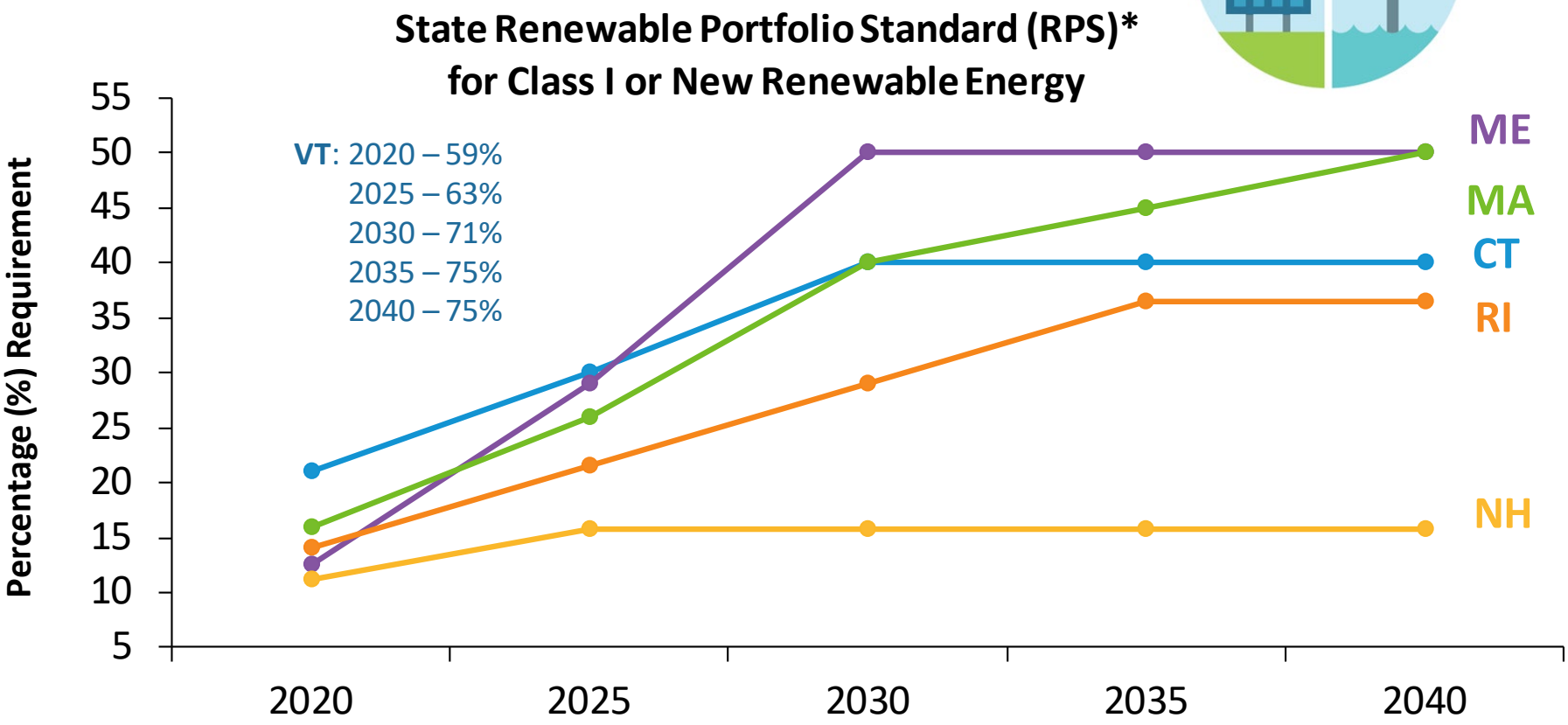


Source: ISO New England Net Energy and Peak Load by Source; data for 2021 is preliminary and subject to resettlement
Renewables include landfill gas, biomass, other biomass gas, wind, grid-scale solar, municipal solid waste, and miscellaneous fuels.
This data represents electric generation within New England; it does not include imports or behind-the-meter (BTM) resources, such as BTM solar.

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 plateaus at 36.5% in 2035. Vermont's 'total renewable energy' requirement plateaus at 75% in 2032 and recognizes all forms of new and existing renewable energy.

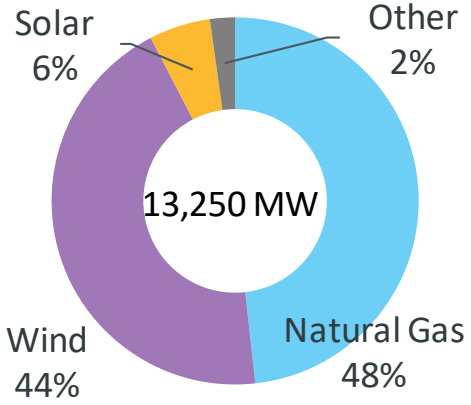
States Are Targeting Increases in Renewable and Clean Energy and Deep Reductions in CO_2 Emissions

≥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 statewide GHG emissions limit MA clean energy standard
90% by 2050	VT renewable energy requirement
100% by 2050 Carbon-Neutral by 2045	ME renewable energy requirement ME emissions goal
100% by 2040	CT zero-carbon electricity goal
100% by 2030	RI renewable energy goal

The ISO Generator Interconnection Queue Provides Snapshots of the Future Resource Mix

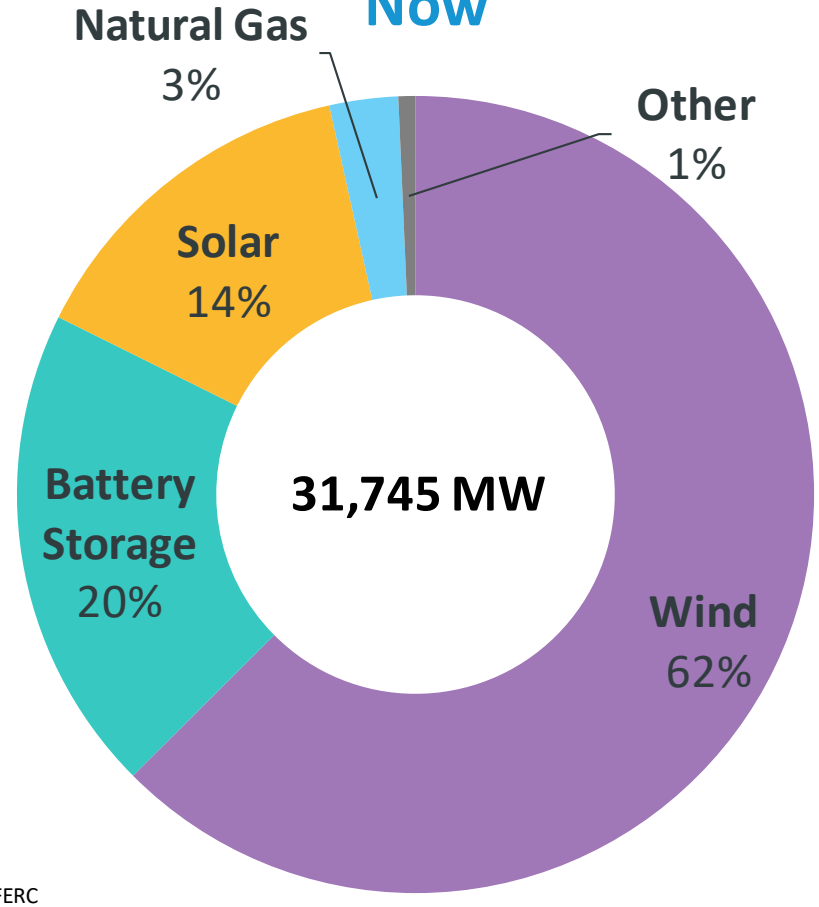
Dramatic shift in types of proposed resources from natural gas to wind

Then



June 2017

Now



February 2022

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

Offshore Wind

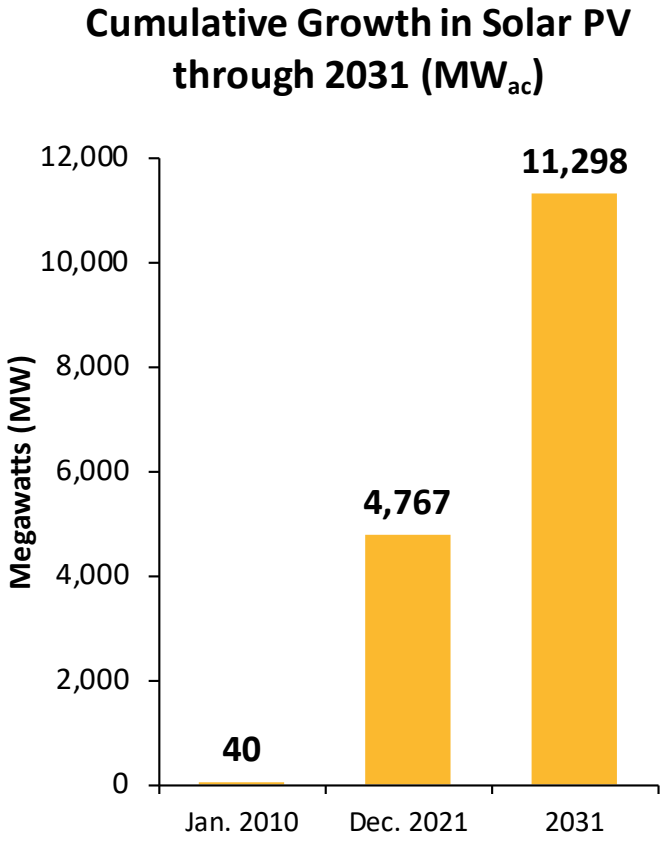
CT	3,600 MW
MA	14,109 MW
ME	12 MW
RI	704 MW

Onshore Wind

CT	4 MW
ME	1,425 MW

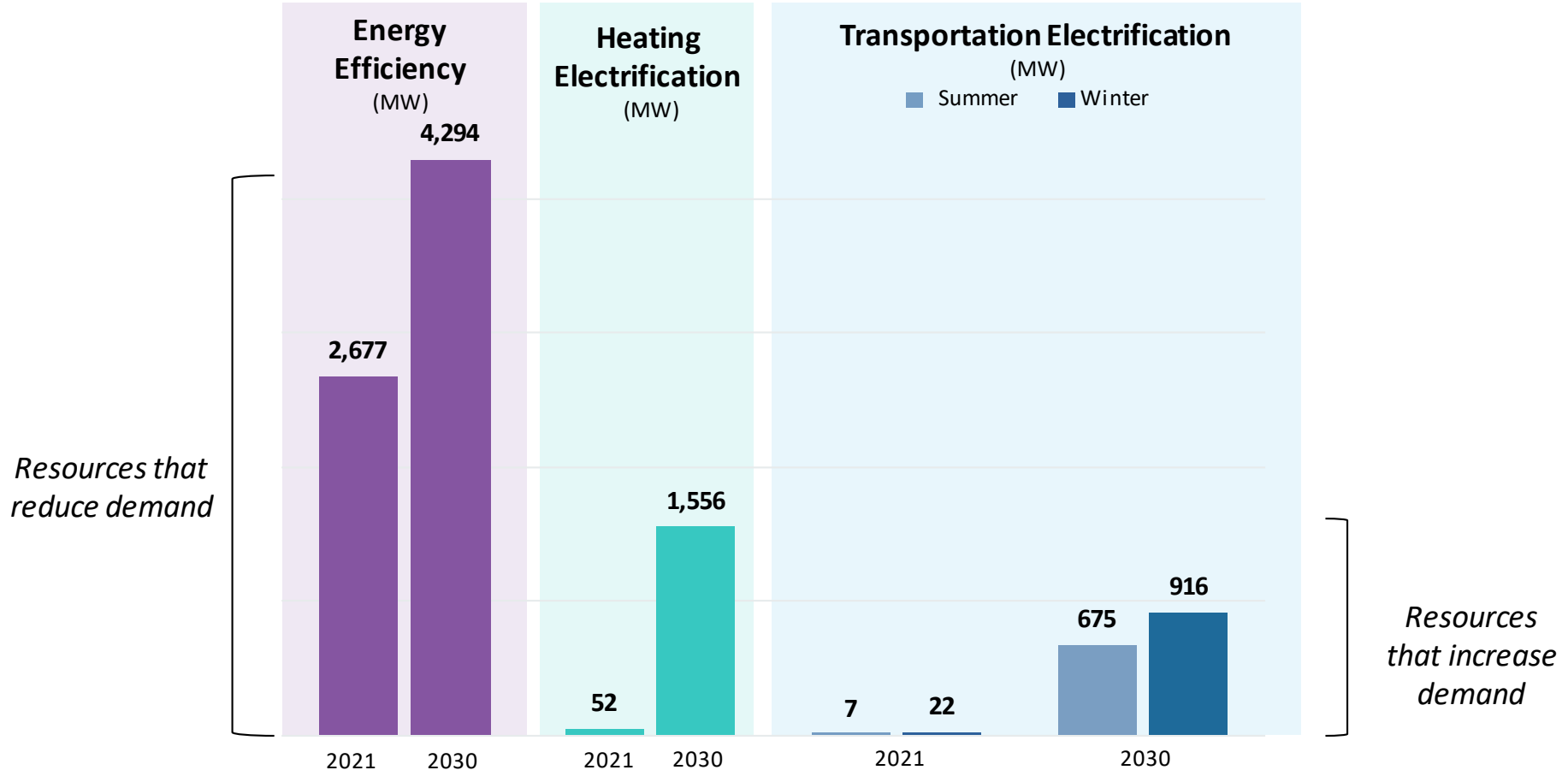
ISO New England Forecasts Growth in Distributed Generation Resources

- Since 2013, the ISO has led a regional **Distributed Generation Forecast Working Group** (DGFWG) to collect data on distributed generation (DG) policies and implementation, and to forecast DG growth
- The DGFWG focuses on the following types of DG resources:
  - Under 5 MW
  - Connected to the distribution system
  - Not visible to the ISO directly
  - Specifically solar photovoltaic (PV) resources, the largest DG component
- ISO efforts to account for solar resources connected to the distribution system include:
  - Forecasting long-term solar growth
  - Forecasting short-term solar performance
  - Improving interconnection processes



ISO's Ten-Year Forecasts Provide an Outlook for Electricity Use and Peak Demand

Deployment of these technologies create new challenges for grid operations and forecasting

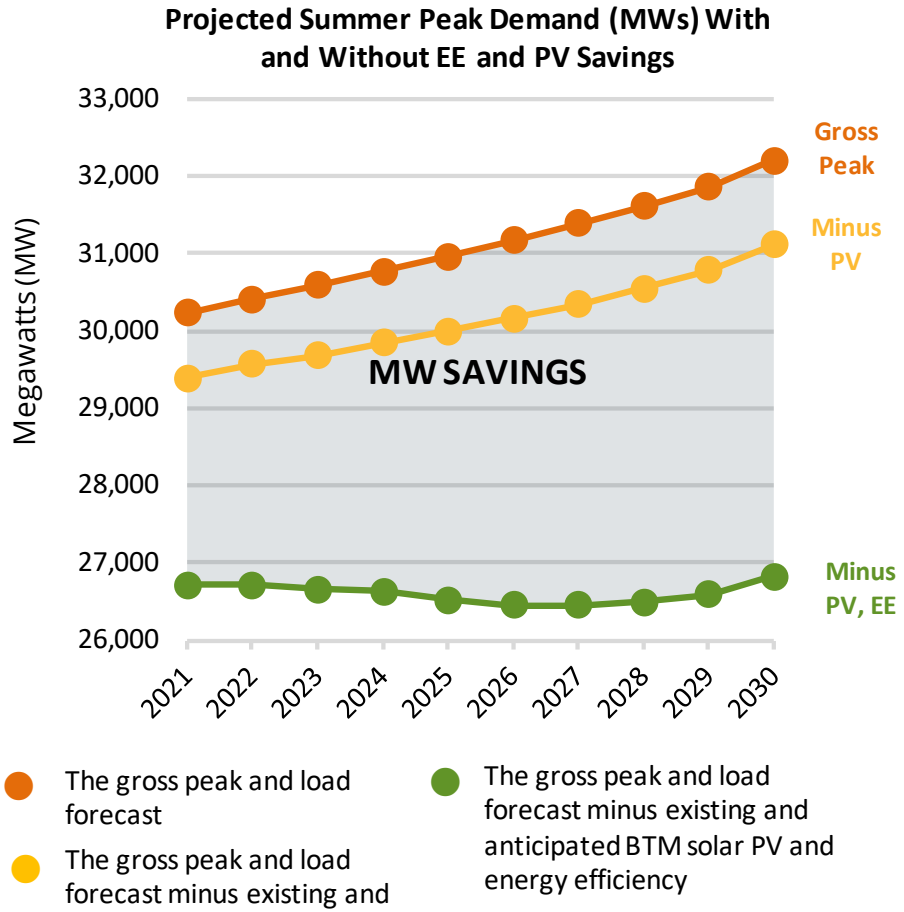


Source: ISO New England 2021-2030 Forecast Report of Capacity, Energy, Loads, and Transmission (2021 CELT Report) (May 2021) 2021 Forecast Itemization. EE through 2020 includes EE resources participating in the Forward Capacity Market (FCM). EE in 2030 includes an ISO-NE forecast of incremental EE beyond the FCM.

ISO-NE Continually Evaluates Opportunities to Enhance the Market Design to Enable New Storage Technologies

- **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
- Batteries can participate in all of ISO New England's markets **today**
- Currently, about **20 MW** of batteries are dispatchable by the ISO, with many more proposed
- The ISO is looking **at further enhancements** to better incorporate technologies into the markets and value reliability services

Energy Efficiency and Behind-the-Meter Solar Resources Are Reducing Peak Demand

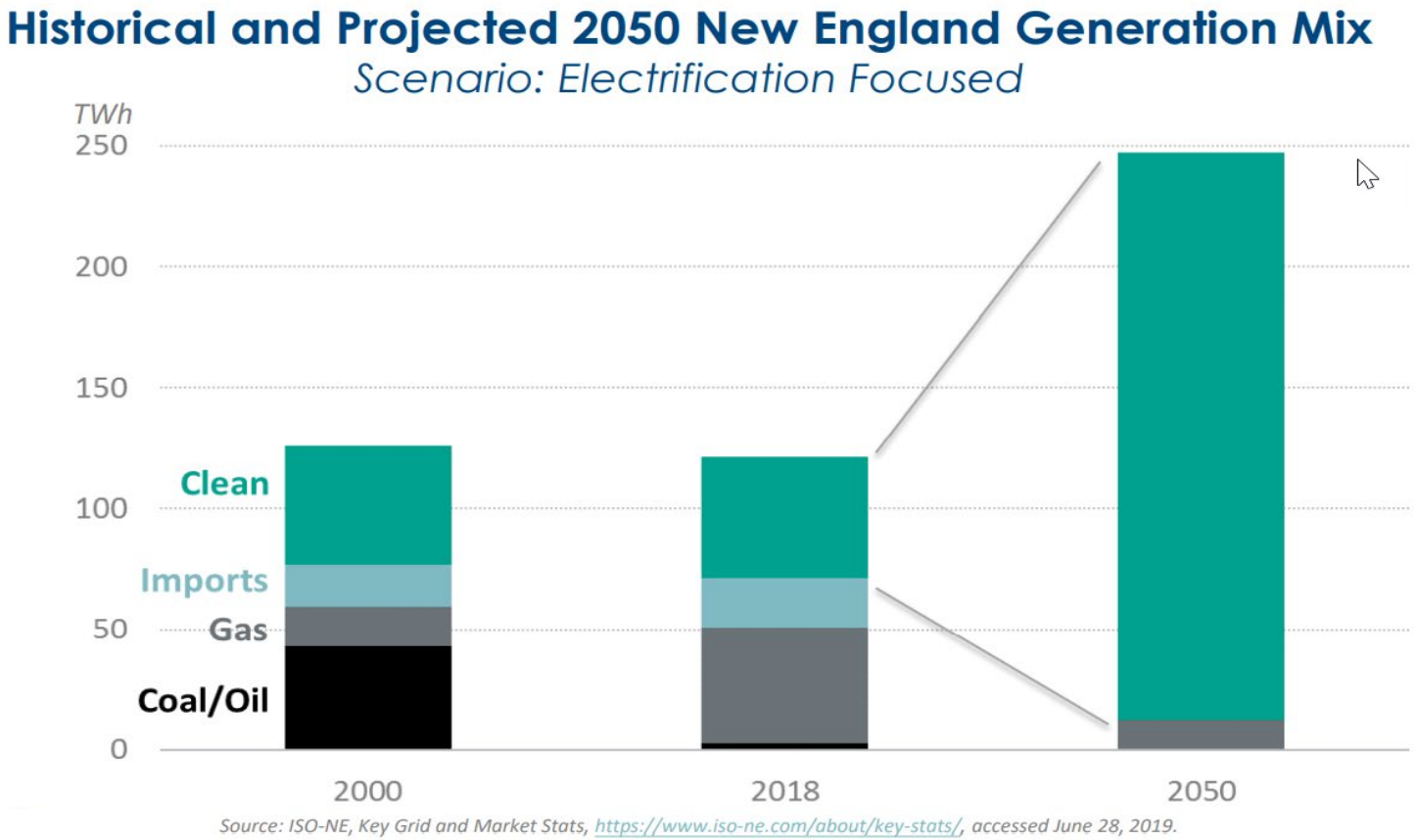


- **28,130 MW:** all-time summer peak demand, set on August 2, 2006
- Energy efficiency (EE) and behind-the-meter (BTM) solar are **reducing** annual growth in peak demand
- Annual growth rates for 2021–2030:
  - **+0.7% without EE and BTM solar**
  - **-0.01% with EE and BTM solar**
- Electrification of heating and transportation will increase load

Source: ISO New England 2021-2030 Forecast Data File (April 2021). 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).

Electrification Could Double Regional Electricity Demand by 2050: Brattle Group

This will need to be supplied by clean energy resources to meet state objectives



Source: *Achieving 80% GHG Reduction in New England by 2050*, September 2019, The Brattle Group

Critical Inputs to a Reliable Power System with High Penetration of Renewables

Robust Transmission System

- $12B invested over two decades regionally to strengthen system reliability
- More transmission will be needed to interconnect and deliver large-scale renewable energy to meet state policy goals (separate from reliability)
- ISO is actively planning for the *Clean Energy Transition*, including a look-ahead to 2050 at the request of the New England States

Robust Fleet of Clean Energy Resources

- States continue procuring resources to meet their clean energy goals
- ISO system planning ensures reliable interconnections
- Wholesale electricity markets are being adapted to integrate and accommodate these resources
- ISO, together with the states and stakeholders, is actively studying methods to incent renewable energy development through the wholesale electricity markets (*Pathways to the Future Grid*)

Critical Inputs to a Reliable Power System with High Penetration of Renewables, *cont.*

Robust Fleet of Balancing Resources

- Market design improvements are needed to ensure *retention* and *entry* of resources that can balance renewable energy on a routine basis

Robust Energy Supply Chain and/or Energy Reserve

- Region needs access to "on call" **stored energy**, or **conservation measures**, to address ***gaps*** when there is no sun or wind, or significant contingencies
  - This can be accomplished through a combination of long-duration stored energy that can be accessed by the region, and by retail electricity and gas demand that is responsive to wholesale prices
- **Electrification** of heating and transportation will *increase* the gap, and the importance of stored energy or conservation measures

Looking Ahead: Designing Markets for a Clean *and* Competitive Resource Mix

- Moving beyond the goal of ensuring reliability at the lowest cost, state-level policies and legislation have driven the focus and growth in renewable resources
- During the past 10 years, the ISO's goal has been to reduce or eliminate barriers that inhibit participation on both the grid- and wholesale level
- In the coming decades, ISO will continue to work to ensure the power system can transform the resources it currently uses and also adapt the transmission system and wholesale markets as consumer demand grows from the decarbonization of other sectors

2021 Regional Electricity Outlook

Overview of ISO Work to Support the Future Grid

- **Weather**: Operational Impacts of Extreme Weather Events
  - Rigorously model likelihood and impact
- **Transmission**: 2050 Transmission Study
  - What transmission is needed 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
  - Transition and elimination of the MOPR
- **Reliability**: Transmission Planning for the Clean Energy Transition
  - How should near-term needs assessments evolve with renewables?

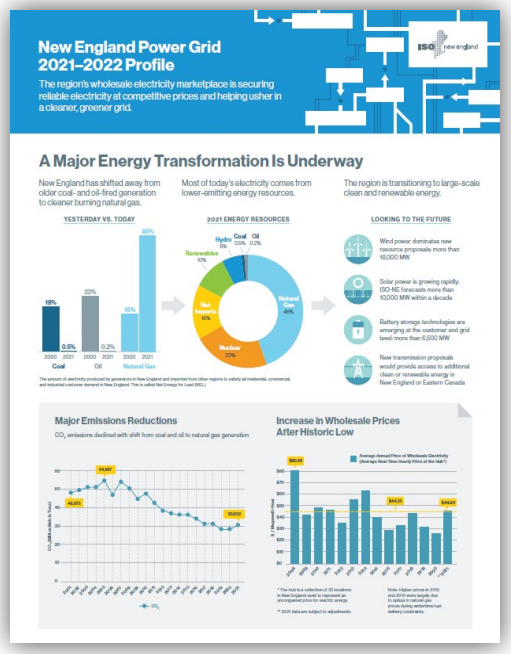
- **Other Studies**
  - Inverter-based resource modeling and integrated market simulator

ISO New England Releases Several Publications

2021 Regional Electricity Outlook

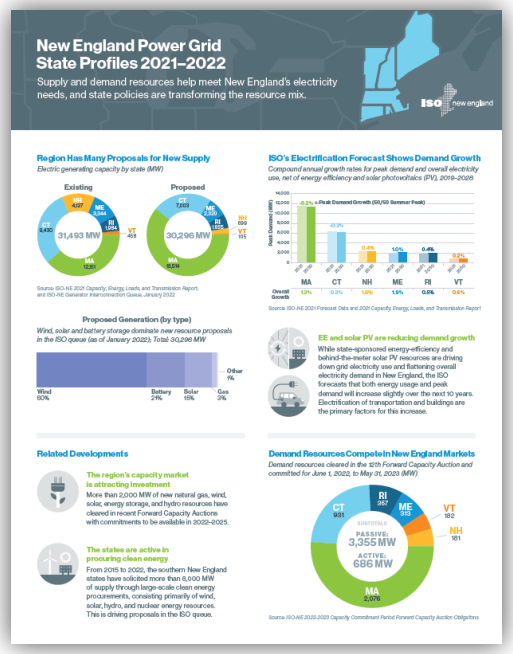
Provides an in-depth look at New England's biggest challenges to power system reliability, the solutions the region is pursuing, and other ISO New England efforts to improve services and performance

2022 Update Coming Soon



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

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Subscribe to the *ISO Newswire*

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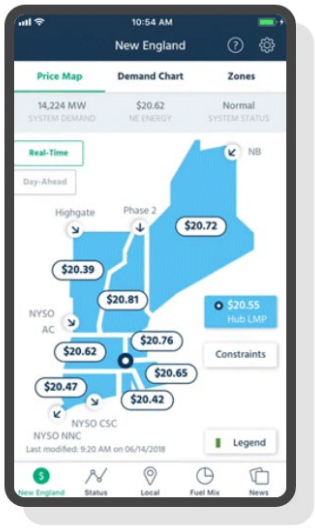
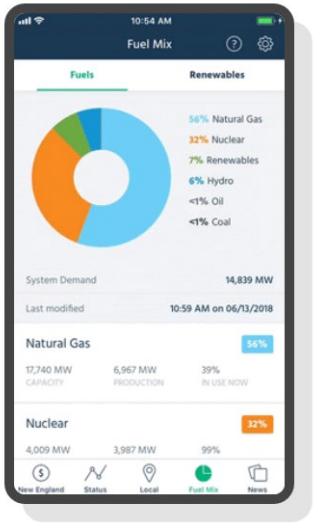
ISO to Go is a free mobile application that puts real-time wholesale electricity pricing and power grid information in the palm of your hand





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Questions

APPENDIX

Additional Information on the ISO's Efforts Supporting the Region's Transition to the Future Grid

Modeling and Assessing Operational Impacts of Extreme Weather Events

Considering how to study New England's reliability risks from severe weather events

- The 2021 events in Texas have caused the ISO to further evaluate whether our region is adequately assessing and preparing for low-probability, high-impact reliability risks (tail risks)
- The ISO initiated the project with NEPOOL and state officials this fall
- Through 2022 and 2023, the ISO and stakeholders will discuss approaches to modeling tail risks related to extreme weather events
- This process will:
  - Initially focus on understanding the modeling approaches to quantify such risks
  - Subsequently focus on understanding if and how the region should protect against the risks
- The ISO will work with Electric Power Research Institute on this project

2050 Transmission Study: A High-Level Study for the Years 2035, 2040, and 2050

- Initial study scope and assumptions developed **in conjunction with the states**
- Aims to **inform the region** of the amount, type, and high-level cost estimates of transmission infrastructure that would be needed to cost-effectively:
  - Incorporate clean-energy and distributed-energy resources and;
  - Meet state energy policy requirements and goals, including economy-wide decarbonization

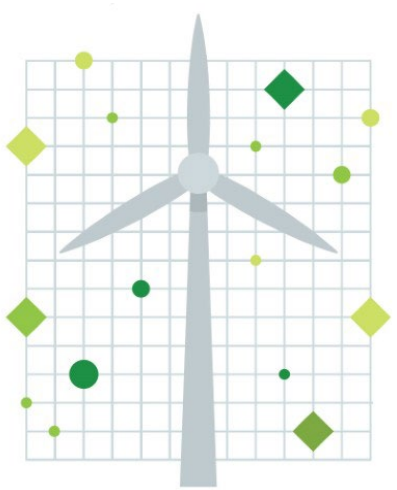
- Looks **well beyond** the ISO's 10-year horizon for transmission planning
- It is ***not*** a plan to build specific projects

The most up-to-date information on the 2050 study is available at the Planning Advisory Committee

Future Grid Reliability Study (Phase 1)

Stakeholder-led Assessment of the Region's Power System in 2040

- Examines the implications of a **substantially-changed** New England grid, where clean, intermittent resources comprise a majority of the generation mix
  - Studies whether the ISO can operate the grid reliably under status-quo market mechanisms
  - Considers what products and attributes are missing
- NEPOOL requested this study; stakeholders, including the New England States Committee on Electricity (NESCOE), **developed the scenarios**
- A full report is expected in 2022



The most up-to-date information on the FGRS study is available at https://www.iso-ne.com/committees/key-projects/new-englands-future-grid-initiative-key-project

Pathways to the Future Grid

Exploring Potential Market Frameworks To Support the Power Grid's Evolution

- The ISO has modeled three potential marke designs that could help the region **decarbonize** the New England electric system
  - Net Carbon Pricing
  - Forward Clean Energy Market (FCEM)
  - Hybrid of the two (FCEM and Net Carbon Pricing)
- Under all cases, region-wide emissions from the electricity sector will **be 80% below 1990 levels in 2040**
  - NEPOOL requested this study, with stakeholders weighing in on the market designs
- Draft report results available now

The most up-to-date information on the Pathways study is available at
https://www.iso-ne.com/committees/key-projects/new-englands-future-grid-initiative-key-project

Transmission Planning for the Clean Energy Transition

- The ISO has **pilot-tested** a variety of transmission planning assumptions for 2030, exploring the question: **What new concerns and phenomena need to be analyzed?**
- Based on results, the ISO will finalize and document new study conditions for **load, solar generation, and wind generation** to use going forward in its planning studies
- The ISO will continue **further analyses into 2022** on renewable energy modeling and inter-area coordination of renewable energy integration, including:
  - Detailed Distributed Energy Resource (DER) modeling
  - DER protection settings
  - Criteria for the acceptable level of DER tripping following transmission system events
- Draft and final reports documenting the analysis performed in the TPCET Pilot Study are expected to be published **by the end of 2021**

The most up-to-date information is available at the Planning Advisory Committee

Also needed: Tools to Support Future Grid Studies

Models, simulators, and other tools that are adaptive to evolving technologies and system conditions are needed to support future-grid studies

- **Inverter-Based Resource Integration and Modeling Assessment**
  - A multi-year project (2021-2023) to assess and adopt advanced, innovative analysis techniques that capture the **unique performance characteristics of inverter-based resources** (e.g., solar and wind)
- **Integrated Market Simulator Development**
  - A multi-year project (2021-2023) to develop a new platform to produce accurate, timely, long-term wholesale electricity market-simulation results
  - Will enable the ISO **to better and more cost-effectively quantify** the potential outcomes of future market design changes or potential changes in system supply and demand conditions
  - Will aid the ISO's **research and development** projects and cost impact studies