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New England's Changing Resource Mix and Challenges for Power System Operations in Extreme Weather Conditions

Northeast Public Power Association
2021 Annual Conference

Gordon van Welie

PRESIDENT & CEO

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*

Key Regional Themes

- **Opportunities and Challenges**: The Clean Energy Transition is creating opportunities and challenges for the region's bulk power system
- **Extensive Analysis Underway**: ISO New England is studying the reliability of a future grid under a range of scenarios
  - This will help the ISO and stakeholders understand the implications for operations, transmission planning, and market design

Key Regional Themes, cont.

- **Managing Risk**: Existing reliability risks during extreme weather will be amplified by increasing restrictions on carbon emissions and a prevalence of limited-energy resources (gas/renewables)
  - There are limits to how much risk can be mitigated through the market
  - New England can learn from extreme weather events in other regions
- **Transmission Expansion**: More transmission will be needed to interconnect and deliver large-scale renewable energy to meet state policy goals (separate from reliability needs)
- **Adapting the Market Design**: Wholesale electricity markets are adapting to changing circumstances and policy objectives

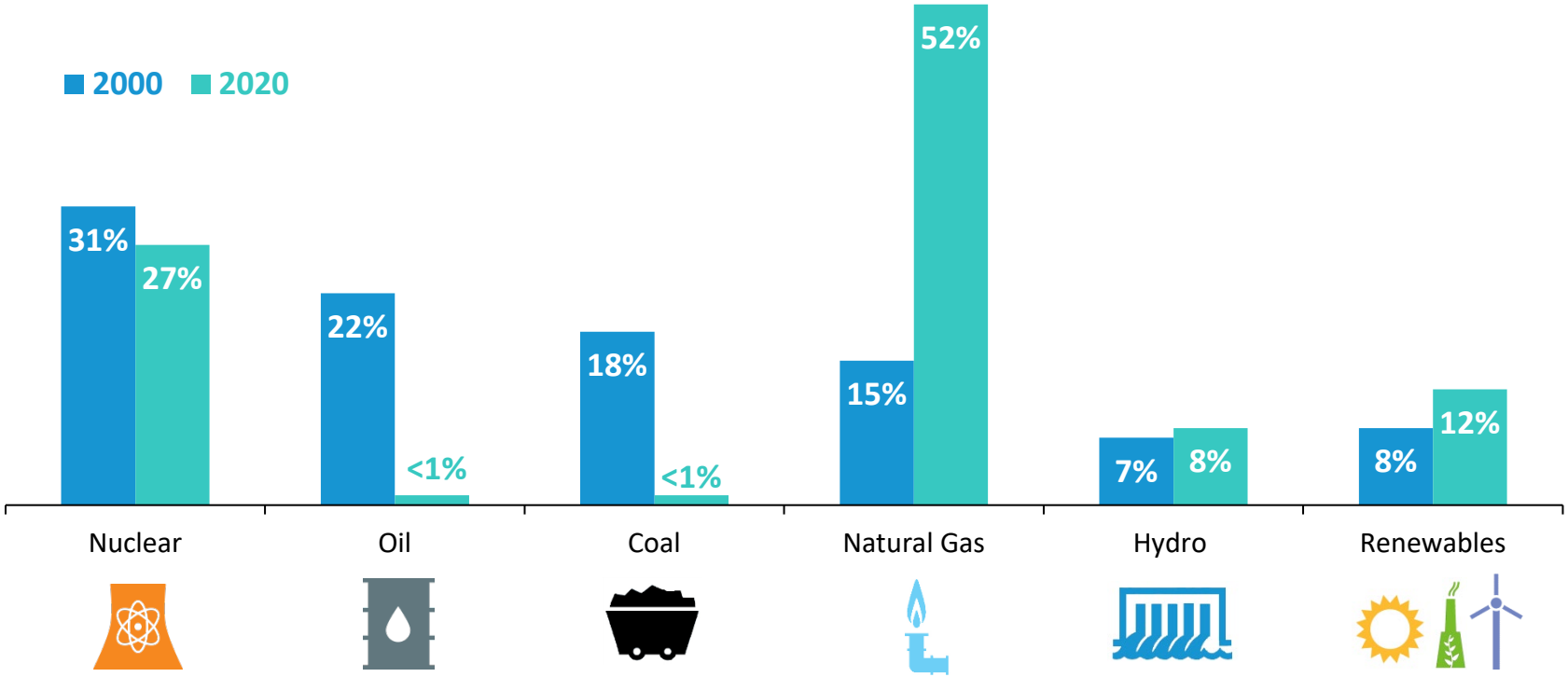
ACHIEVING STATE POLICY GOALS WILL FUNDAMENTALLY CHANGE THE RESOURCE MIX

This will ultimately affect the entire economy as states seek to use clean energy from the grid to electrify the heating and transportation sectors

New England's Power System Has Already Experienced Dramatic Changes in the Energy Mix

Economic and environmental factors have shifted the region's electricity production

Percent of Total **Electric Energy** Production by Fuel Type
(2000 vs. 2020)

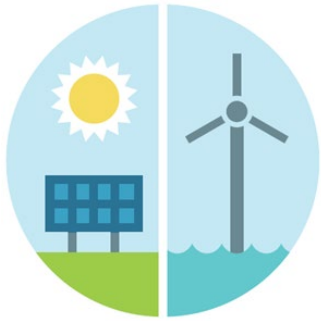


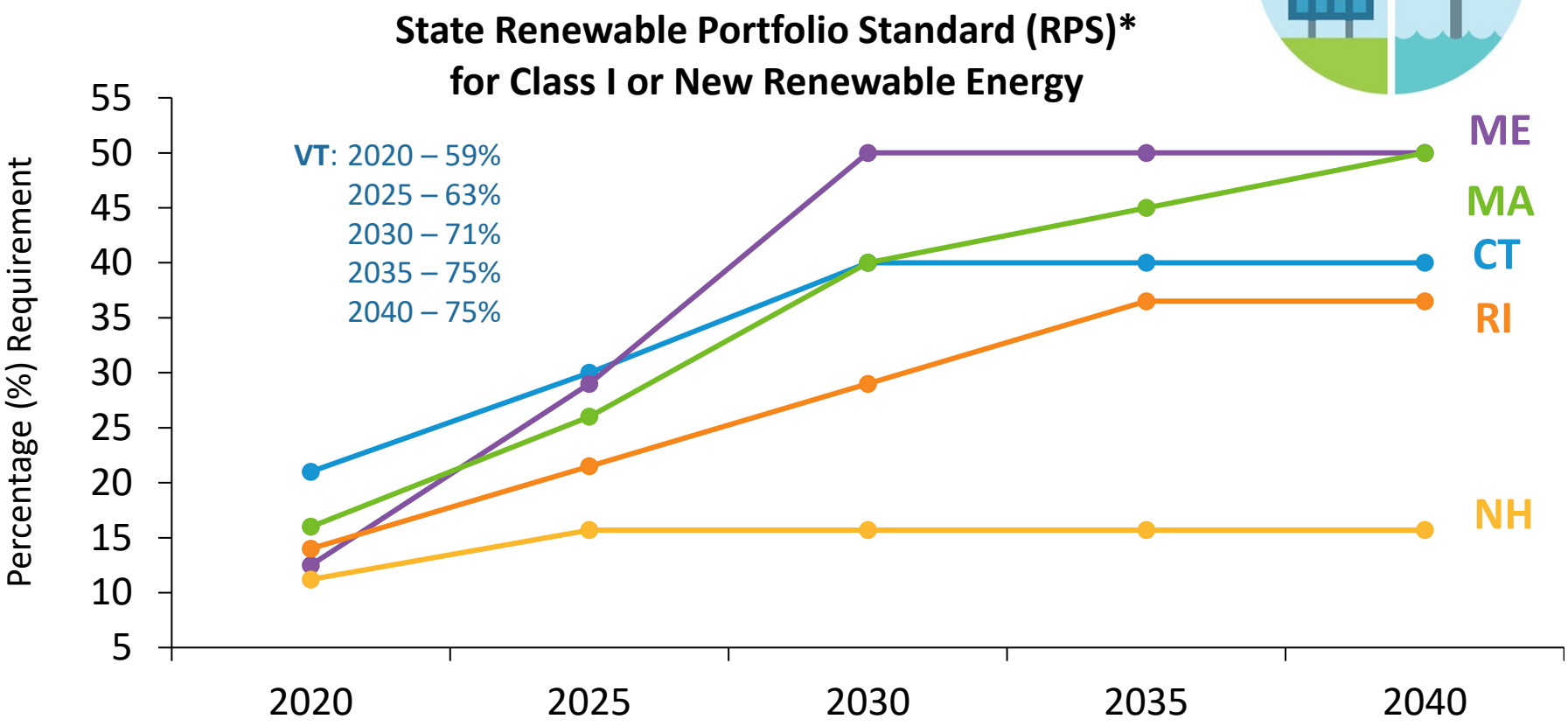
Source: ISO New England Net Energy and Peak Load by Source; data for 2020 is preliminary and subject to resettlement
Renewables include landfill gas, biomass, other biomass gas, wind, grid-scale solar, municipal solid waste, and miscellaneous fuels.
This data represents electric generation within New England; it does not include imports or behind-the-meter (BTM) resources, such as BTM solar.

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

State Polices are Requiring Increasing Amounts of Renewable Energy

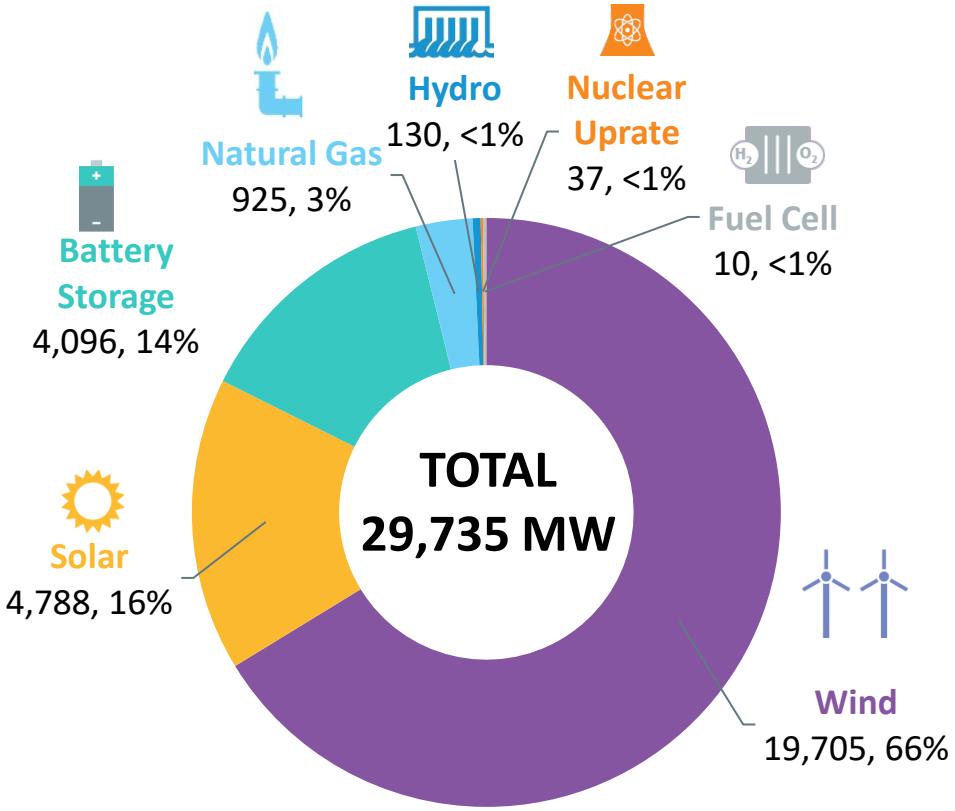




Notes: State RPS requirements promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Connecticut's Class I RPS requirement plateaus 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; it recognizes all forms of new and existing renewable energy and is unique in classifying large-scale hydropower as renewable.

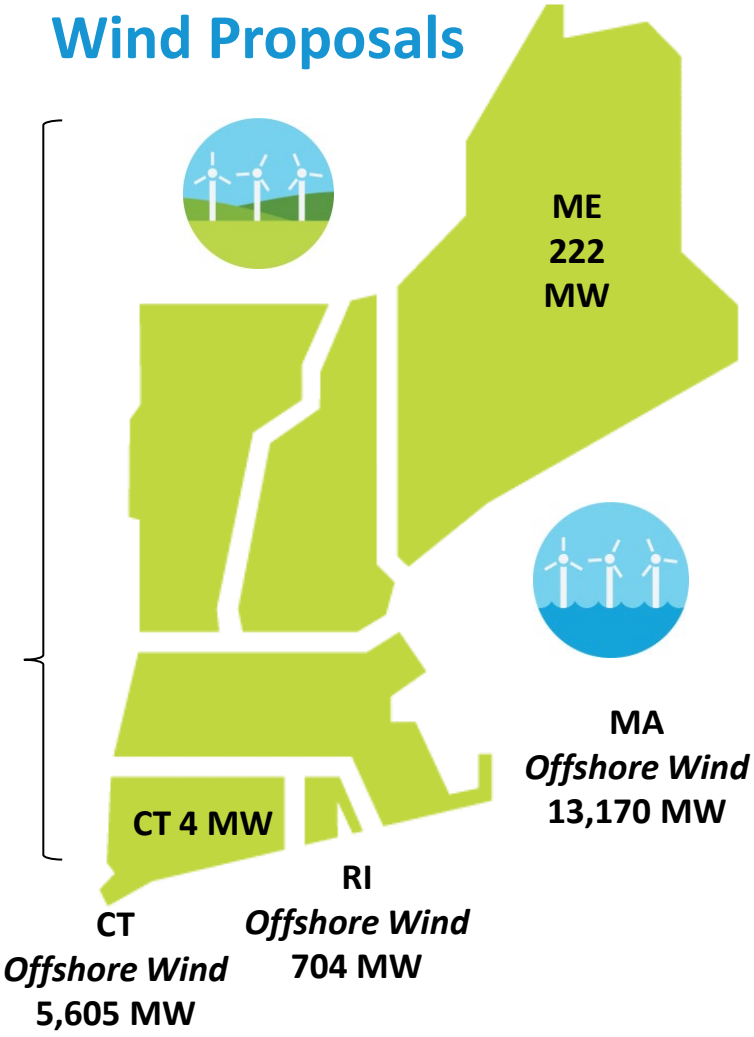
Wind Power Comprises Two Thirds of New Resource Proposals in the ISO Interconnection Queue

All Proposed Resources



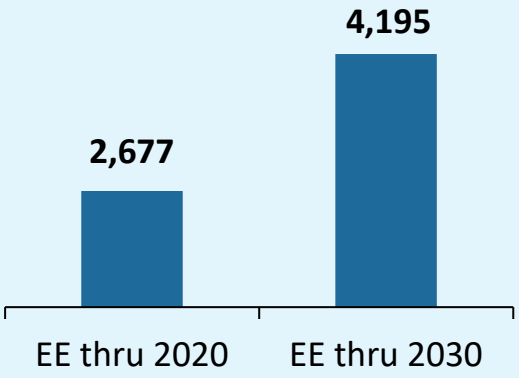
Source: ISO Generator Interconnection Queue (June 2021)
FERC and Non-FERC Jurisdictional Proposals; Nameplate Capacity Ratings
Note: Some natural gas proposals include dual-fuel units (with oil backup).
Some natural gas, wind, and solar proposals include battery storage.

Wind Proposals



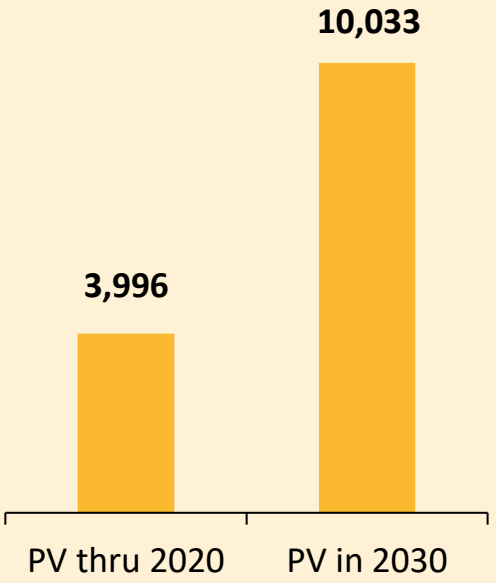
Energy-Efficiency and Renewable Resources Are Trending Up in New England

Energy Efficiency
(MW)



Final 2021 CELT Report, EE through 2020 includes EE resources participating in the FCM. EE in 2030 includes an ISO-NE forecast of incremental EE beyond the FCM

Solar
(MW)



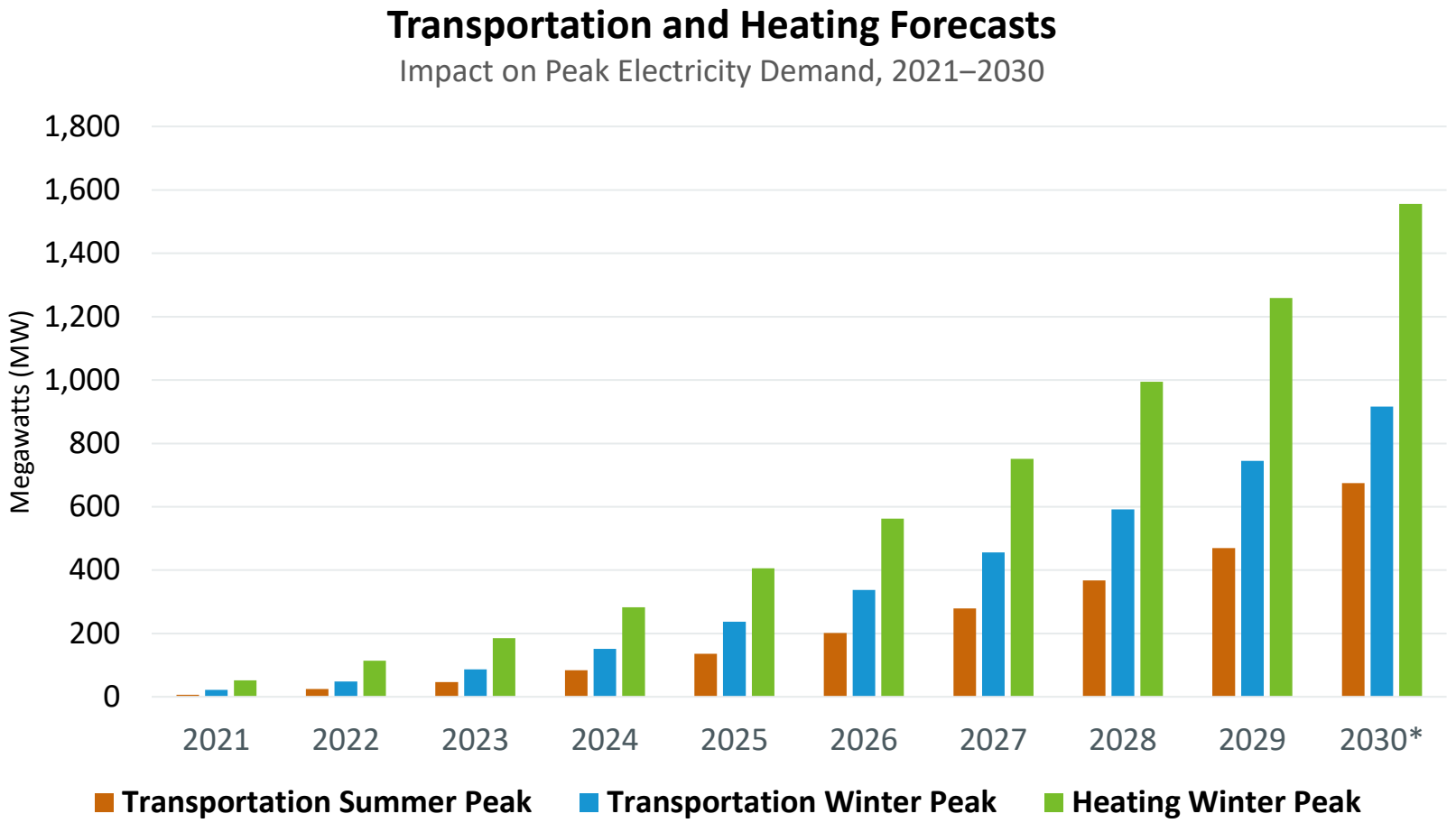
Final 2021 ISO-NE PV Forecast, AC nameplate capacity from PV resources participating in the region's wholesale electricity markets, as well as those connected "behind the meter"

Wind
(MW)

Nameplate capacity of existing wind resources and proposals in the ISO-NE Generator Interconnection Queue (June 2021)

ISO's Electrification Forecast Projects Demand Growth

Electricity demand from electric vehicles and heating sectors over the next decade

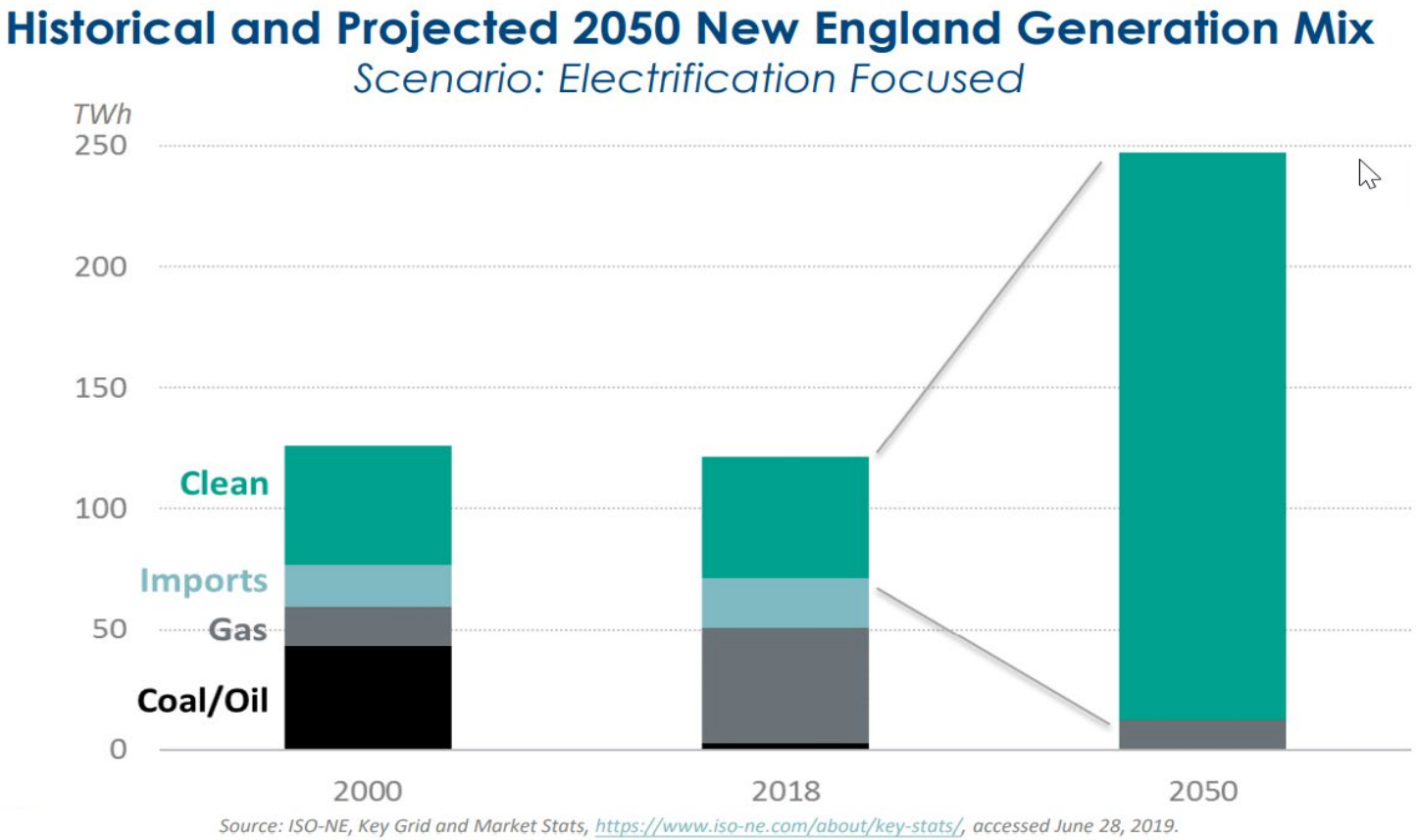


* Percentage of Net System Peak in 2030**:** Transportation – summer: 3%; Transportation – winter: 4%; Heating – winter: 7%

Source: ISO New England, *2021 Forecast Report of Capacity, Energy, Loads, and Transmission (The CELT Report)*

Electrification Could Double Regional Electricity Demand by 2050: Brattle Group

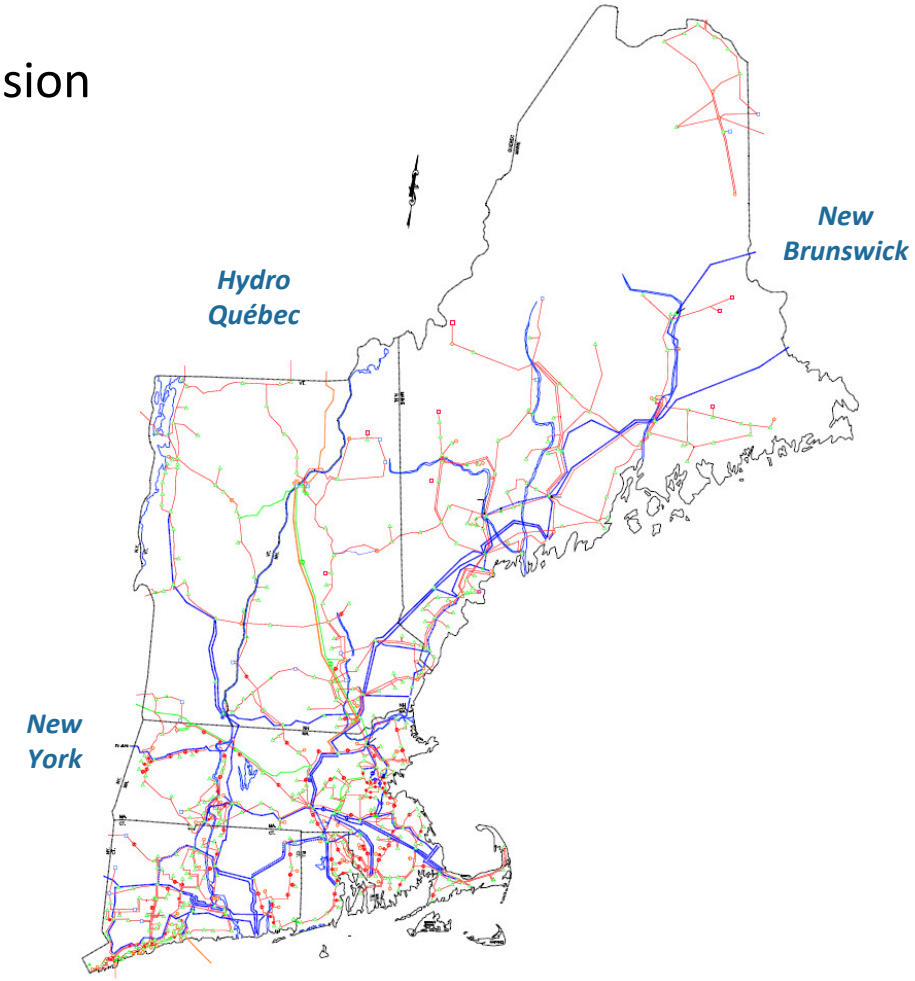
This will need to be supplied by clean energy resources to meet state objectives



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

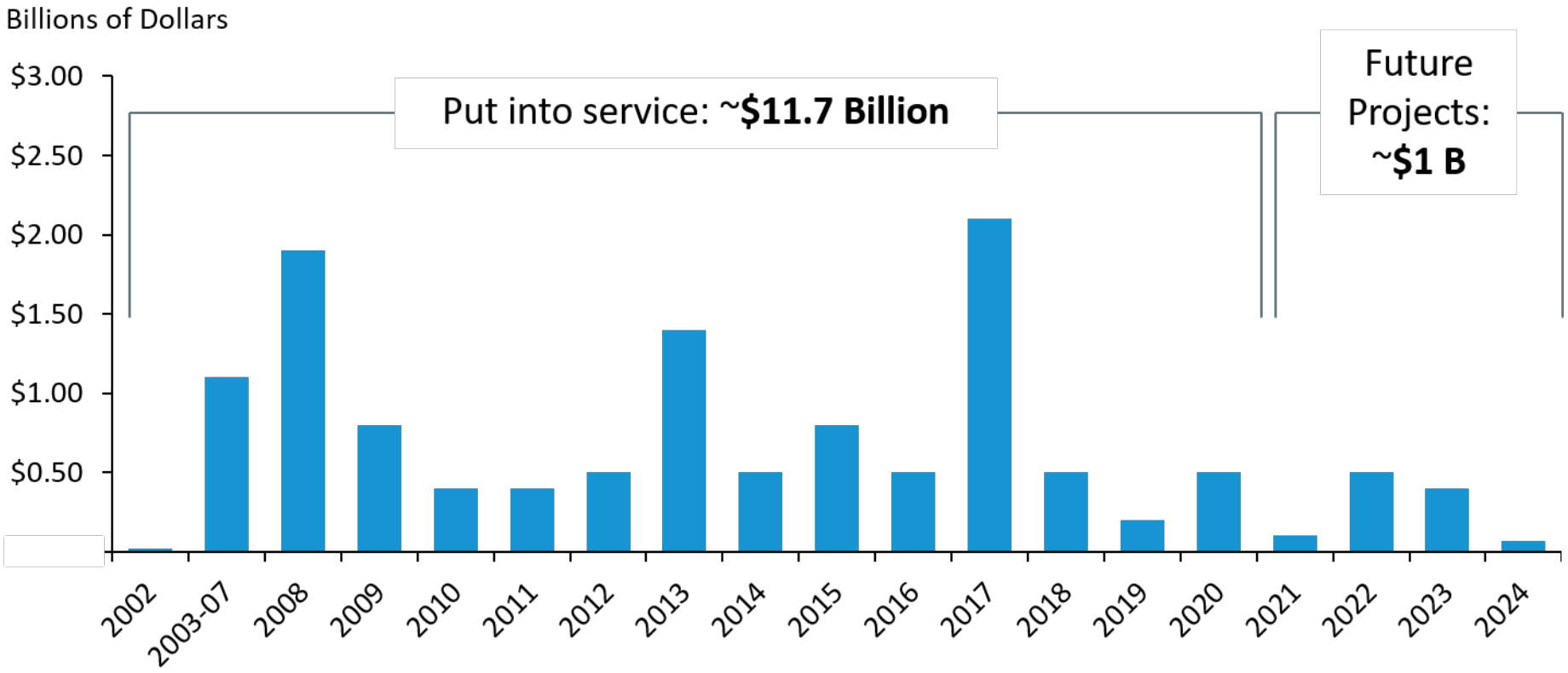
New England's Transmission Grid Is the Interstate Highway System for Electricity

- **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
- **21%** of region's energy needs met by imports in 2020
- **$11.7 billion** invested to strengthen transmission system reliability since 2002; **$1.1 billion** planned
- Developers have proposed multiple transmission projects to access **non-carbon-emitting resources** inside and outside the region



New England Has Made Major Investments in Transmission to Ensure a *Reliable* Electric Grid

Transmission investment by year that projects are put into service (capital costs)



Source: ISO New England RSP Transmission Project Listing, June 2021
Estimated future investment includes projects under construction, planned and proposed.

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

Source: ISO Interconnection Queue (June 2021)

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

- Developers are proposing 13 elective transmission upgrades (ETUs) to help deliver about **3,400 MW** of clean energy to New England load centers
- Wind projects make up roughly **66%** 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
- We are working with NESCOE to study the investment/cost implications of the states' 2050 Vision for the transmission system
- In July, FERC announced it is revisiting transmission planning and cost allocation nationwide to further enable clean energy
- Changes will be required to our transmission planning tariff, including a cost allocation methodology for this transmission

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

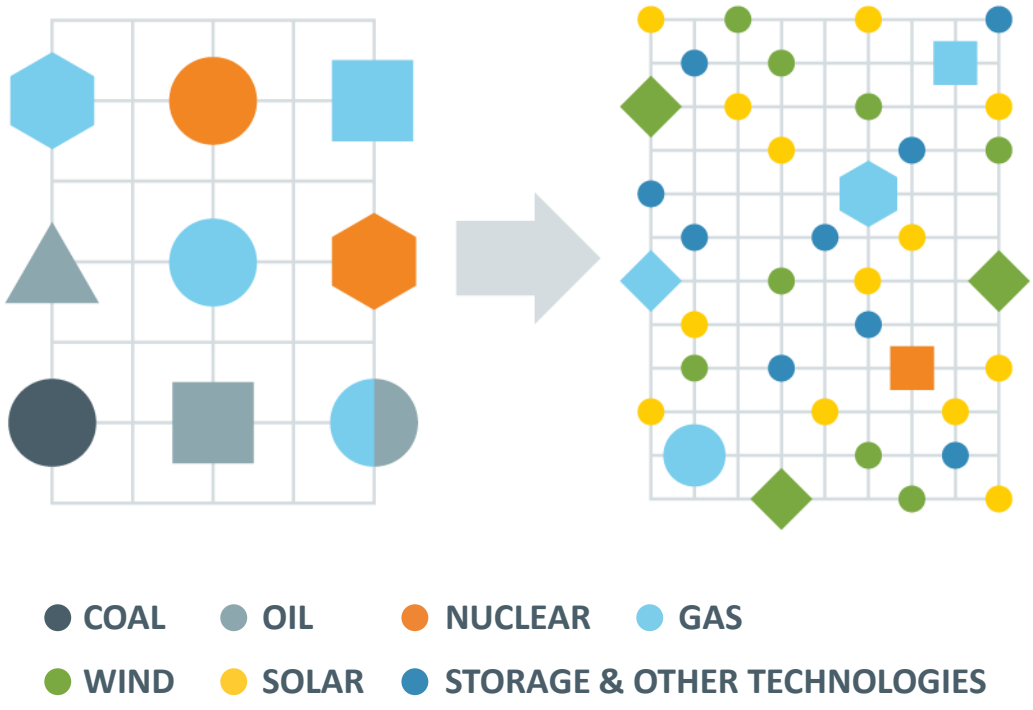
- Currently, about **20 MW** of batteries are dispatchable by the ISO, with many more proposed

What Does the Future Grid Look Like?

There are two dimensions to the transition, happening simultaneously…

1. **A shift from conventional generation to renewable energy**

2. **A shift from centrally dispatched generation to distributed energy resources**



*Maintaining reliable power system operations becomes **more complex** with the shift to greater resources that face constraints on energy production*

Source: ISO New England Status of Non-Price Retirement Requests and Retirement De-list Bids (January 2021)

Since 2013, Roughly 7,000 MW of Generation Have Retired or Announced Plans for Retirement in the Coming Years

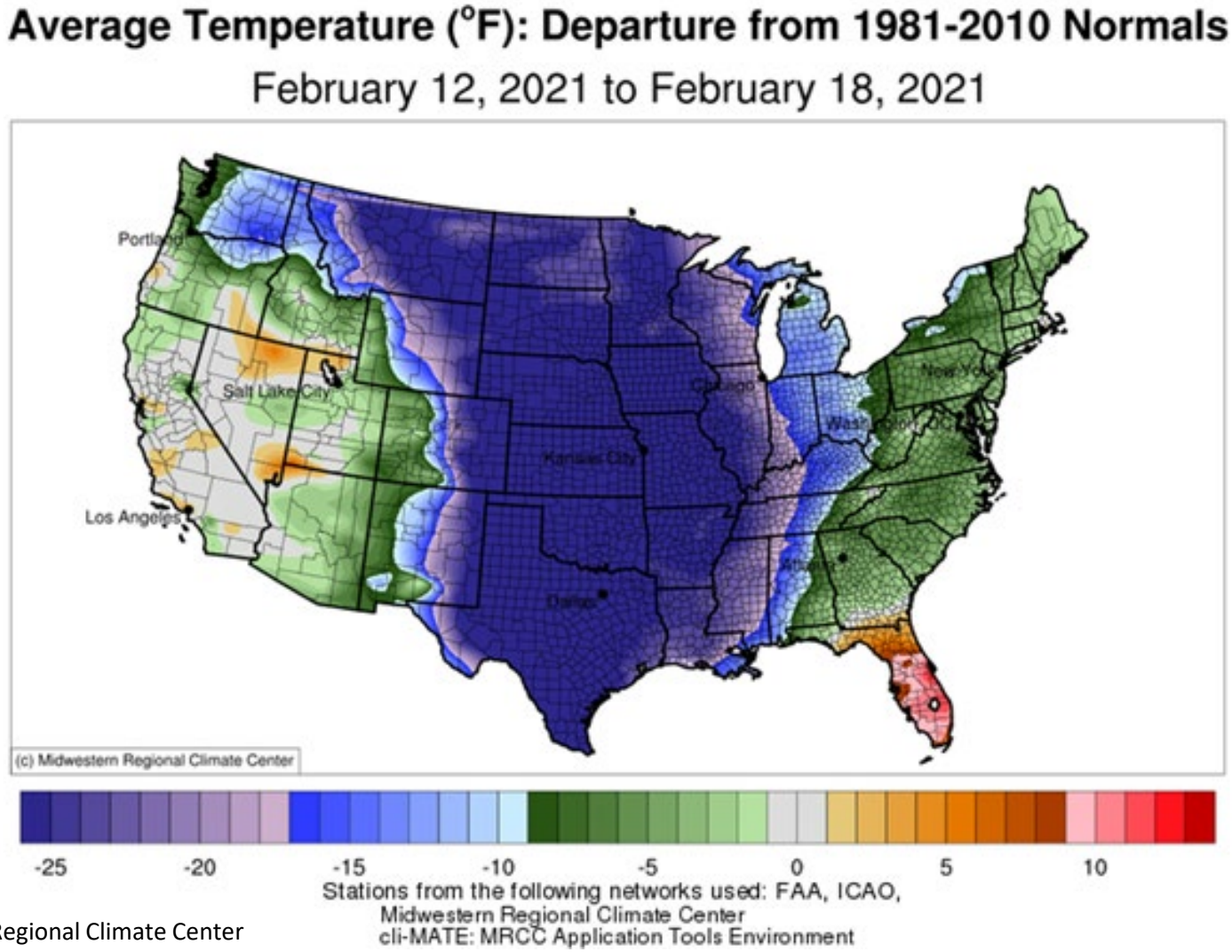
- Include predominantly coal, oil, and nuclear resources
- Another **5,000 MW** of remaining coal and oil are at risk of retirement
- These resources have played an **important** role in recent winters when natural gas supplies are constrained in New England

New England's Generation Fleet Relies Increasingly on "Just-in-Time" Energy Sources: Gas, Renewables

Historically, most resources had large, ready stockpiles of fuel

- **Retirements** of legacy resources, **growth** of renewable resources, and **continued gas pipeline constraints** could leave the region untenably reliant on **"just-in-time" resources**
- The ISO plans further discussions with the states and stakeholders for addressing market-based reliability solutions after FERC's rejection of the ISO's **Energy Security Improvements (ESI) proposal**
- The ISO is looking to develop a design to help ensure that enough flexible supply is available each day **to manage uncertainties** in an increasingly energy-limited power system
- **Energy Adequacy** is critical now and in the future

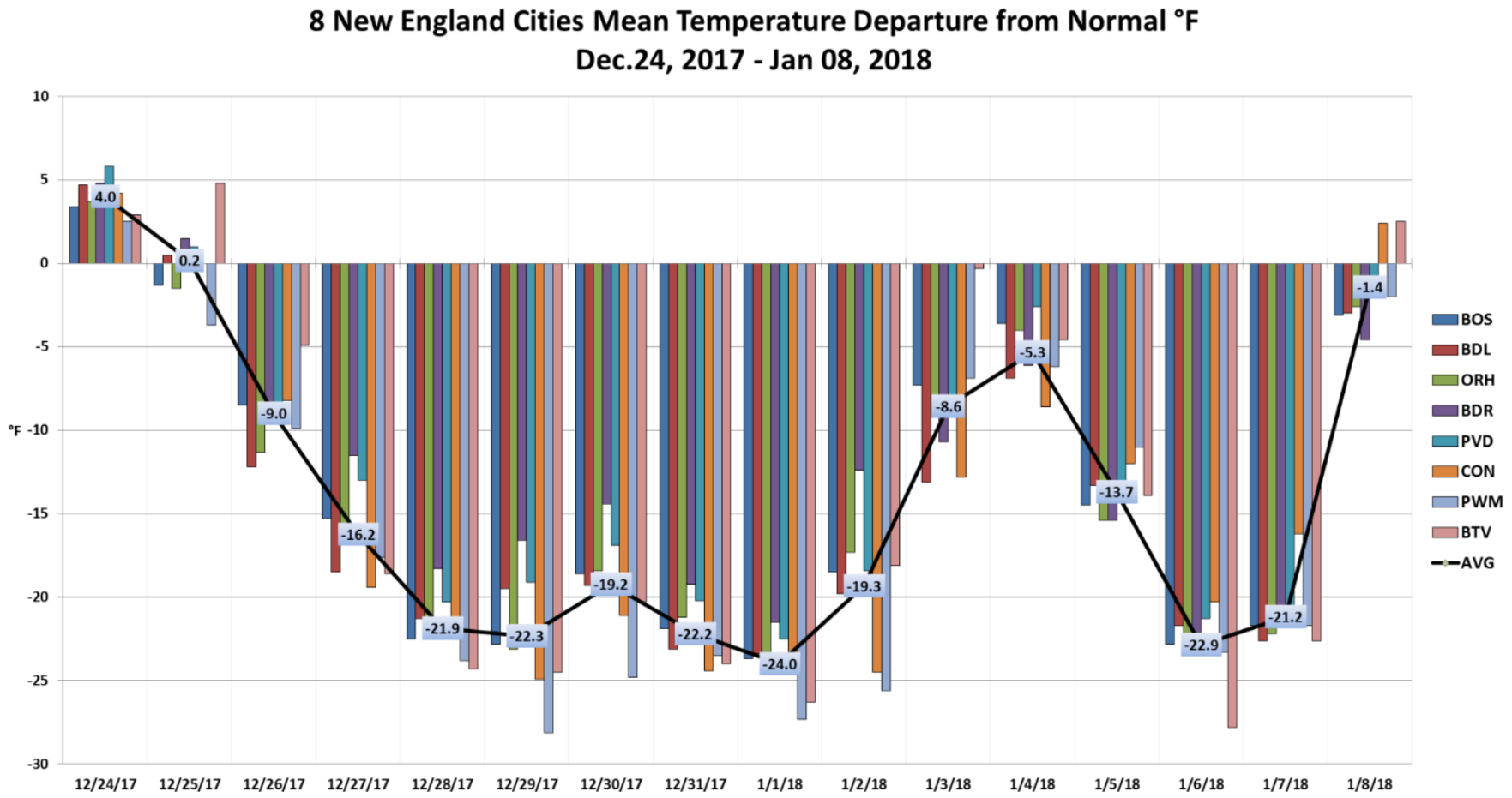
Extreme Cold Was Widespread During Crisis in Texas



Source: Midwest Regional Climate Center

New England Temperatures Fell Well Below the Winter Average in Late Dec., and Early Jan. 2018

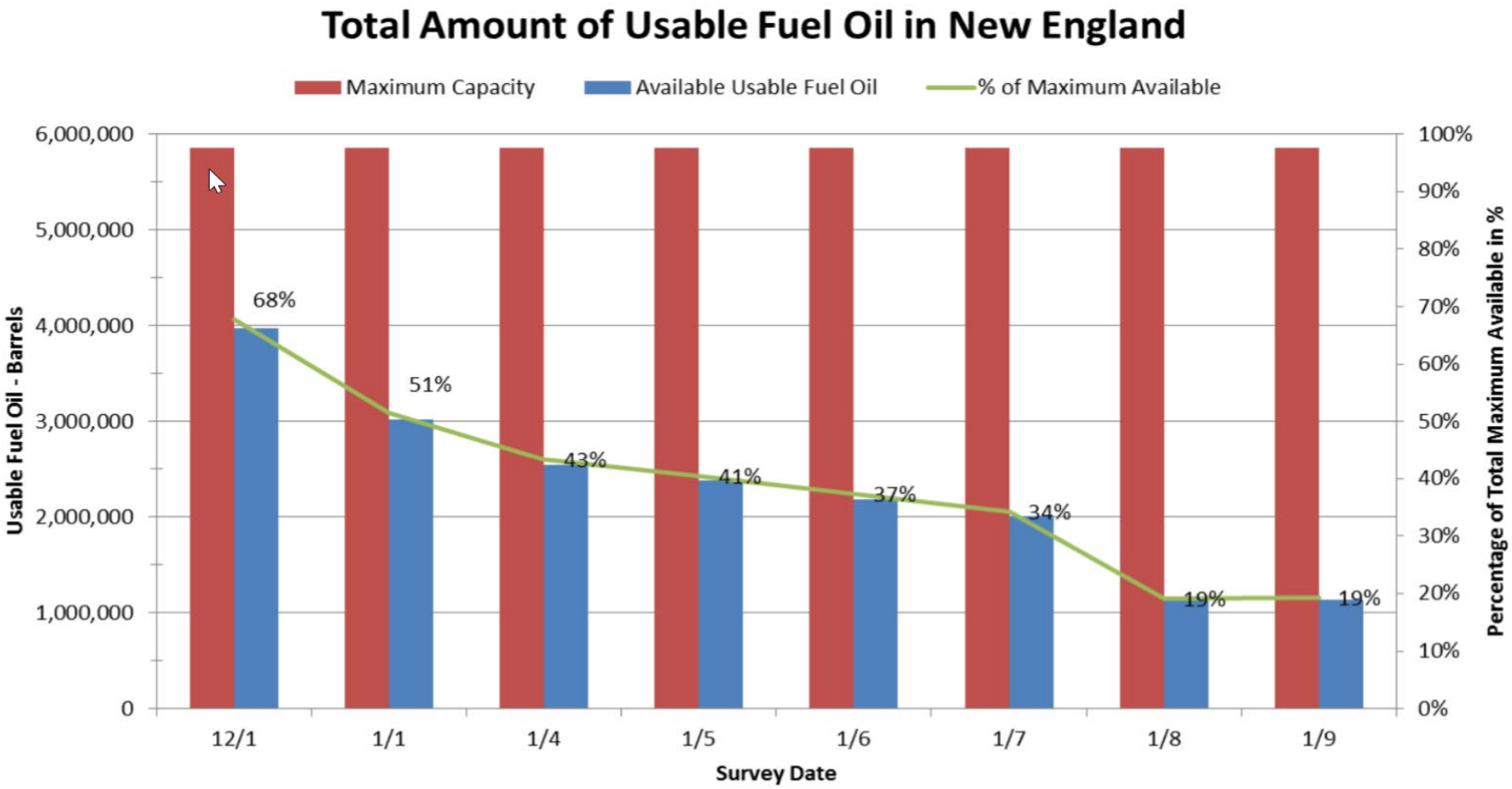
And temperatures stayed well below average for a two-week period



Source: ISO New England, *Post Winter 2017/2018 Review,* Electric/Gas Operations Committee

Cold Weather Exposes Reliability Risks in New England

In-region oil supplies dwindled during early January 2018 cold-weather event



This chart is the ISO's best approximation of usable oil discounted for unit outages, reductions, or emissions

Source: ISO New England, *Post Winter 2017/2018 Review,* Electric/Gas Operations Committee

Texas Events Hold "Lessons Learned" for New England

- Truly extreme weather may be beyond current ISO planning for winter conditions
  - Should we plan for colder extremes?
  - How should we account for low-probability events (a.k.a. "tail risks")?
- Lack of winterization in Texas is **not comparable** to New England
  - However, regional infrastructure may not be prepared for more regular instances beyond current ("90/10") planning assumptions
- In the future, New England could face **increased energy adequacy risks** from the simultaneous loss of energy inputs to both gas-fired and renewable generation
  - New England has long had some form of an energy adequacy problem

Texas Events Hold "Lessons Learned," cont.

- The **underestimated demand from electric heating** exacerbated the imbalance between supply and demand
  - New England is planning to electrify much of its heating and transportation, which will increase demand, particularly in the winter
  - What is the appropriate reliability standard for a grid that is supplying energy to all sectors of the economy? Is it 1 day in 10 years, 1 day in 40 years, or something else?
- FERC/NERC will likely create **new reliability standards** to address winterization, as well as an assessment of energy adequacy
  - Regions will all need to assess how much risk they want to mitigate versus accepting the risk of controlled outages
- If controlled outages are needed, can the electric distribution companies **rotate outages when required**?
  - ISO-NE, the distribution companies, and state regulators need to work together to ensure the ability of distribution companies to implement controlled outages
- The ISO has well-developed **cold weather protocols**, but we continue to assess the unique risks for New England

Regional Discussion to Begin Regarding Extreme Weather and Contingency Events

New initiative will consider New England's reliability risks from severe weather events

- The events in Texas have caused the ISO to further evaluate whether the region is adequately assessing and preparing for low-probability, high-impact reliability risks
- The ISO plans to initiate a process later this year to discuss approaches to modeling tail risks related to extreme weather events and contingencies
- This process will:
  - Initially focus on understanding the modeling approaches to quantify such risks, and
  - Subsequently focus on understanding if and how the region should protect against the risks

Studying the Evolution of New England's Future Grid

ISO is engaged in a myriad of market, planning studies and discussions

- **Future Grid Reliability Study**: Stakeholder-led assessment of the future state (2040) of New England's power system under current energy and environmental policies
- **Pathways to the Future Grid**: Regional identification, exploration, and evaluation of potential wholesale market frameworks that reflect states' policies
  - The ISO is studying the efficacy of a regional net carbon price, a Forward Clean Energy Market, and a hybrid of the two concepts
    - The ISO continues to support net carbon pricing as a solution that integrates seamlessly with the wholesale markets
      - This would allow the New England states to achieve their environmental policy goals while allowing the most efficient fossil-fired resources to remain economically viable and gradually transition to clean fuels (e.g., clean hydrogen)
    - The FCEM concept would allow states to determine the level of demand for clean energy in a separate market framework to pay for these attributes
  - We expect study results in Q2 2022

Studying the Evolution of the Future Grid, cont.

ISO is engaged in a myriad of market, planning studies and discussions

- **2050 Transmission Study** to help states determine how to expand the system to incorporate wind, hydro, and distributed energy resources, in support of their Vision
  - In addition, the ISO is evaluating FERC's Advanced Notice of Proposed Rulemaking (ANOPR) focused on transmission planning and cost allocation for future investments in the electric grid
- **Other key studies/initiatives**:
  - Eliminate the Minimum Offer Price Rule (MOPR)
    - ISO filing to FERC expected in Q1 2022
  - Improve Resource Capacity Accreditation for resource adequacy (e.g., ELCC)
  - Reassess day-ahead ancillary service improvements
  - Evaluate operational impacts of extreme weather and contingency events
  - Develop approach for Distributed Energy Resource Aggregations (Order 2222)
    - ISO filing to FERC due in Feb. 2022

Key Takeaways

- New England is **transitioning** to a power system with heavy penetration of renewable energy resources in order to meet state environmental objectives
  - Transitioning away from generating resources with on-site fuel storage
- **Flexible resources** will be needed to **balance** the variability of renewable energy
- The market design needs to ensure we can **attract and retain** the resources needed *throughout the clean energy transition*
- New England, as a region, needs to **evaluate** the amount of **risk** we can live with for extreme weather events, whether to *mitigate* those risks, by how much, and by whom

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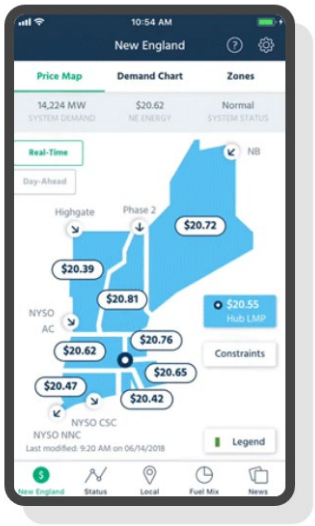
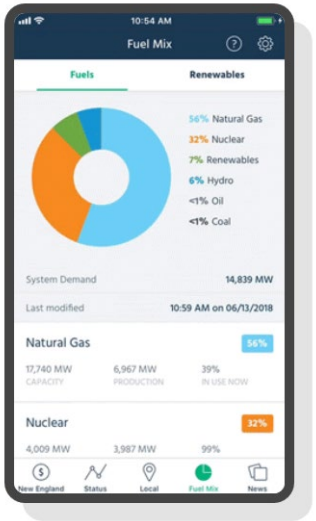
ISO to Go is a free mobile application that puts real-time wholesale electricity pricing and power grid information in the palm of your hand





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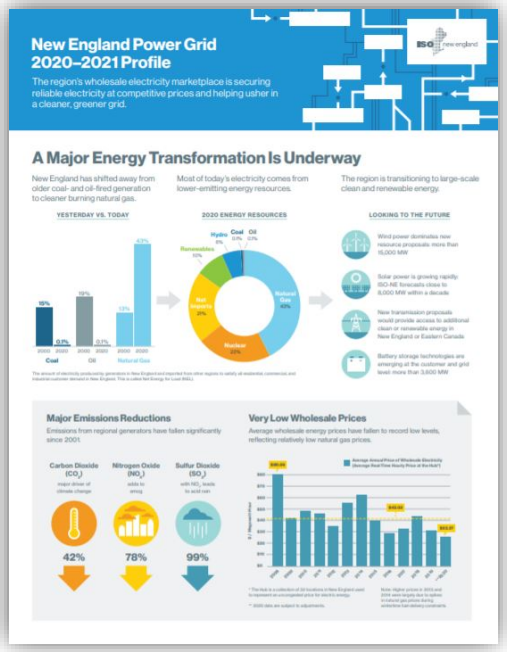
ISO Releases Regional Electricity Outlook and Profiles

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



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

Questions