APRIL 17, 2020

ISO New England Overview and Regional Update

NH EESE Board

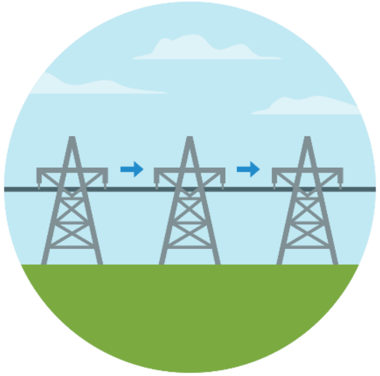
Kate Epsen

EXTERNAL AFFAIRS

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

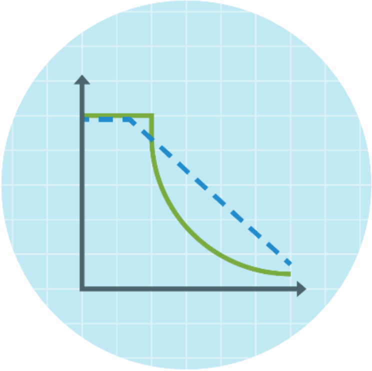
Grid Operation

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



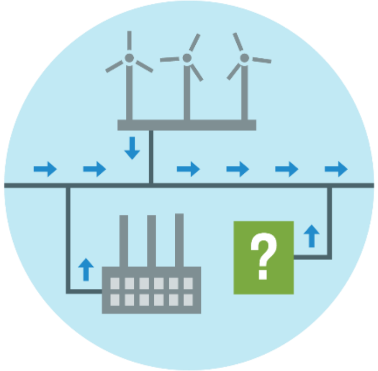
Market Administration

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



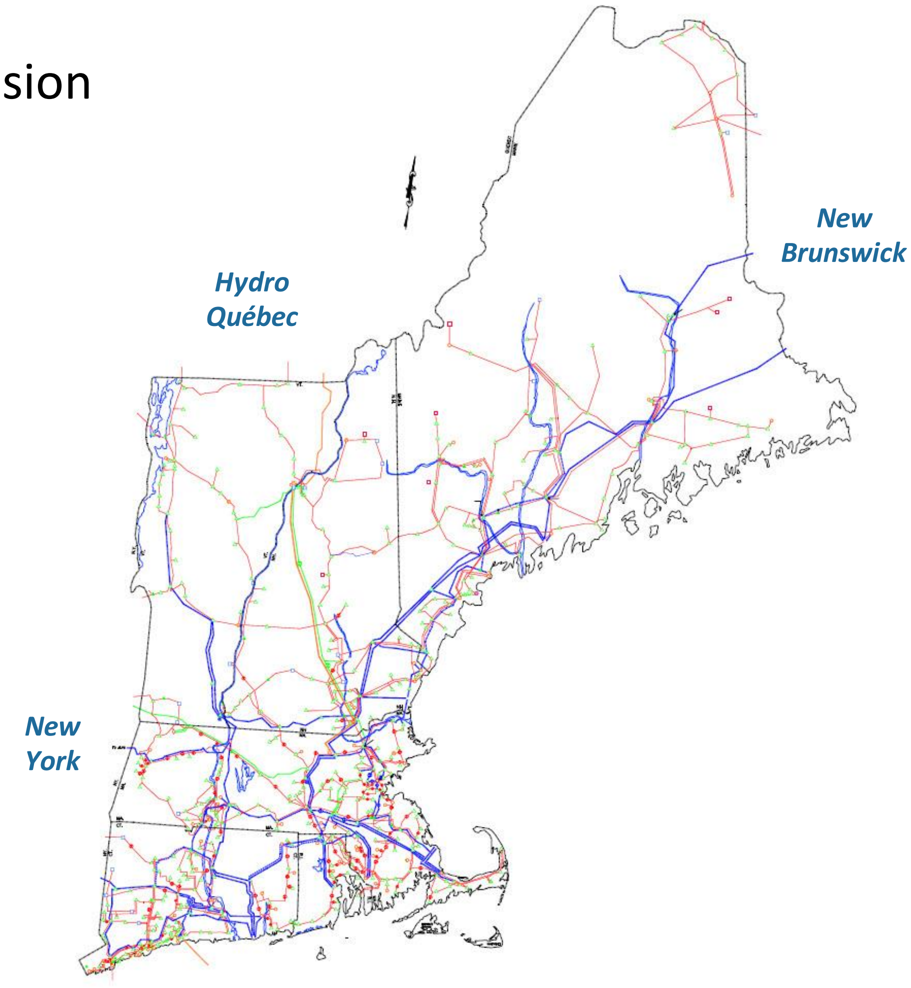
Power System Planning

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



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

- **9,000 miles** of high-voltage transmission lines (115 kV and above)
- **13 transmission interconnections** to power systems in New York and Eastern Canada
- **19%** of region’s energy needs met by imports in 2019
- **$10.9 billion** invested to strengthen transmission system reliability since 2002; **$1.5 billion** planned
- Developers have proposed multiple transmission projects to access **non-carbon-emitting resources** inside and outside the region



New England Demand At-a-Glance

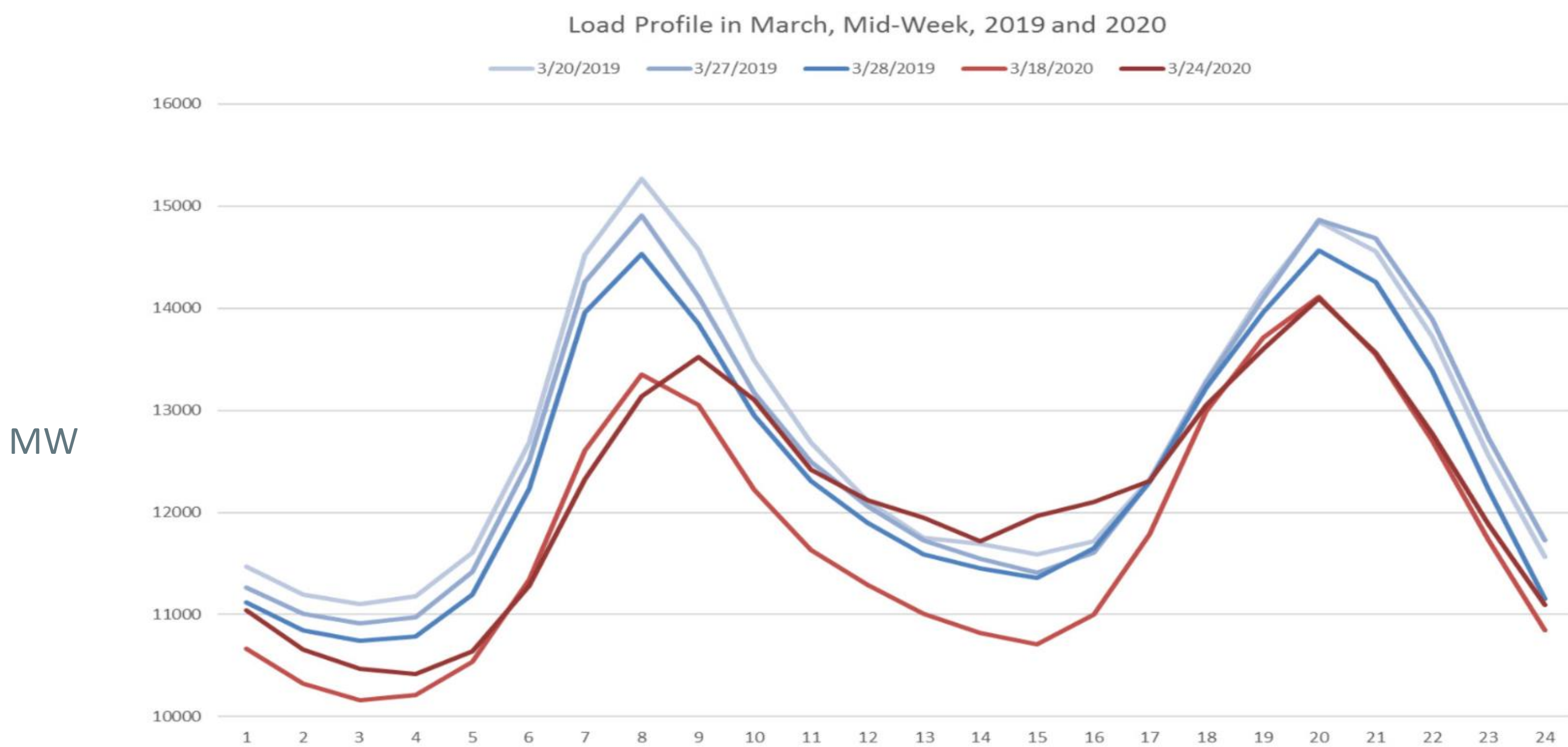
- **7.2 million** retail electricity customers drive the demand for electricity in New England (14.8 million population)
  - Region's all-time summer peak demand: **28,130 MW** on August 2, 2006
  - Region's all-time winter peak demand: **22,818 MW** on January 15, 2004
- Energy efficiency (EE) and behind-the-meter (BTM) solar are **reducing** peak demand growth and overall electricity use over the next ten years
  - **-0.4%** annual growth rate for summer peak demand (with EE and BTM solar)
  - **-0.4%** annual growth rate for overall electricity use (with EE and BTM solar)
- BTM solar is **shifting** peak demand later in the day in the summertime

Note: Without energy efficiency and solar, the region's peak demand is forecasted to grow 0.7% annually and the region's overall electricity demand is forecasted to grow 1.1% annually. Summer peak demand is based on the "50/50" forecast for typical summer weather conditions.

ISO & New England Power System in COVID-19

- **A mild March and the COVID-19 impact drove lower electricity demand, fuel and energy prices**
  - The impact of COVID-19 began to show in the second half of March, reducing demand by approx. 3-5% compared to what would be expected under similar weather conditions
  - Load forecasting model is being modified but minimal historic data available to inform the model
- **Low natural gas prices and reductions in loads compared to March 2019 resulted in significantly lower average LMPs in March 2020**
  - DA and RT LMPs in March 2020 were $17.18/MWh and $16.82/MWh, respectively
  - These LMPs were 21% lower than February 2020 and 55% lower than March 2019
- System is operating normally
- Updates posted frequently on http://isonewswire.com/

Load Profile in March, Mid-Week: 2019 vs. 2020



This chart shows the differences in demand patterns between mid-week March days in 2019 (blue) and 2020 (red).

Hours in Day

New England's Wholesale Electricity Markets

Energy Market

Electric Energy: The Day-Ahead and Real-Time Energy Markets are forward and spot markets for trading **electric energy**. Energy prices **fluctuate** throughout the day and at different locations in New England, reflecting the amount of consumer demand, constraints on the system, and the price of fuel that resources use to generate electricity.

Ancillary Markets

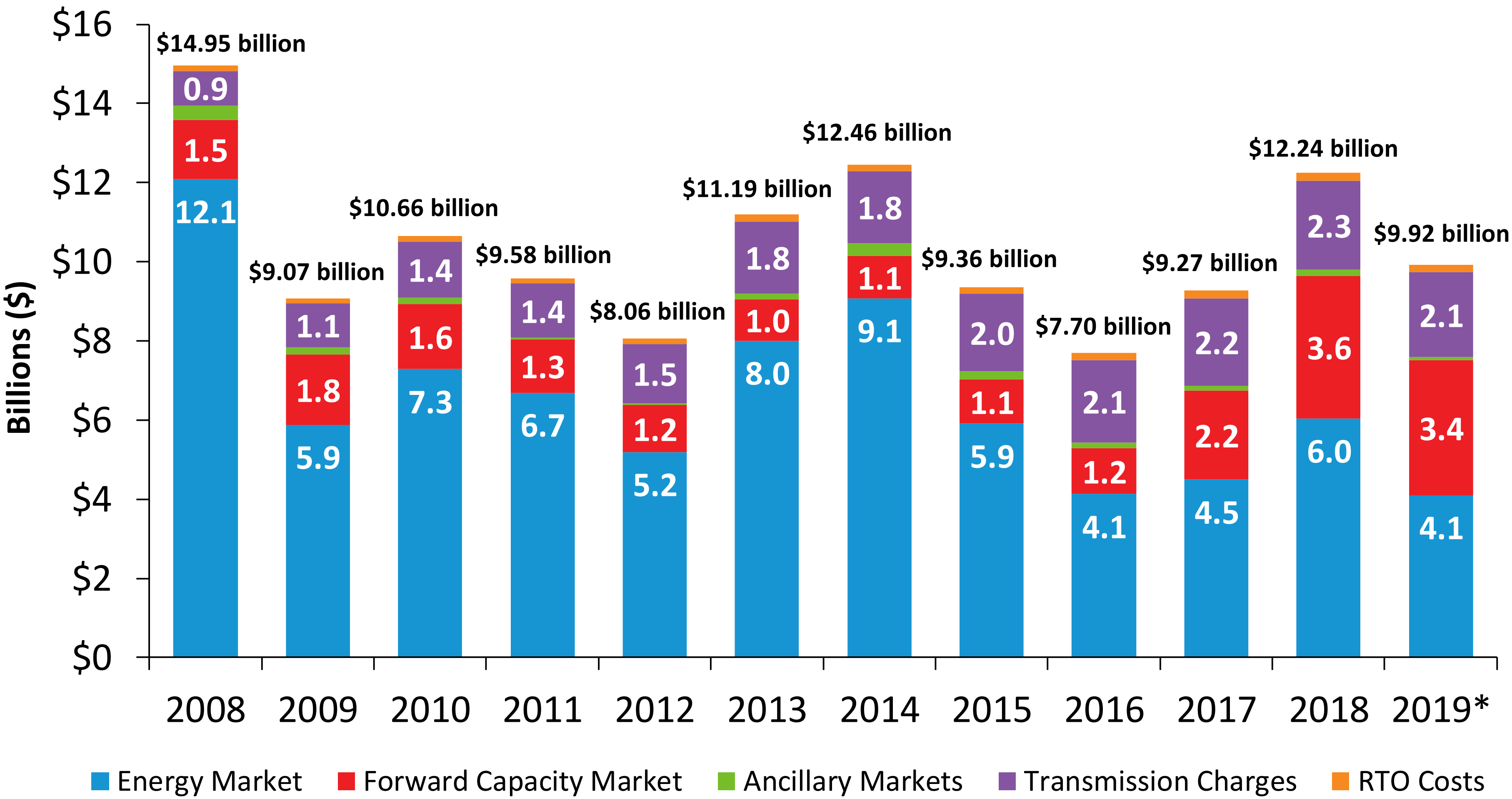
Short-Term Reliability Services: Resources compete in the ancillary markets to provide backup electricity as well as services needed to support the physical operation of the system, such as frequency regulation and voltage support. These services are **critical** during periods of heavy demand or system emergencies.

Forward Capacity Market

Long-Term Reliability Services: Resources compete to sell **capacity** to the system in three years' time through annual Forward Capacity Auctions. The Forward Capacity Market works in tandem with the Energy Markets to **attract** and **sustain** needed power resources today and into the future.

New England Wholesale Electricity Costs

Annual wholesale electricity costs have ranged from $7.7 billion to $15 billion



Source: *2019 Report of the Consumer Liaison Group*; * 2019 data is preliminary and subject to resettlement
Note: Forward Capacity Market values shown are based on auctions held roughly three years prior to each calendar year.

New England Wholesale Electricity Costs[a]

	2015		2016		2017		2018		2019*	
	$ Mil.	¢/kWh	$ Mil.	¢/kWh	$ Mil.	¢/kWh	$ Mil.	¢/kWh	$ Mil.	¢/kWh
Wholesale Market Costs										
Energy (LMPs)[b]	$5,910	4.5	$4,130	3.2	$4,498	3.5	$6,041	4.7	$4,105	3.3
Ancillaries[c]	$210	0.2	$146	0.1	$132	0.1	$147	0.1	$81	0.1
Capacity[d]	$1,110	0.8	$1,160	0.9	$2,245	1.8	$3,606	2.8	$3,401	2.7
Subtotal	*$7,229*	*5.5*	*$5,437*	*4.2*	*$6,875*	*5.4*	*$9,794*	*7.6*	*$7,586*	*6.0*
Transmission charges[e]	$1,964	1.5	$2,081	1.6	$2,199	1.7	$2,250	1.7	$2,146	1.7
RTO costs[f]	$165	0.1	$180	0.1	$193	0.2	$196	0.2	$184	0.1
Total	**$9,358**	**7.1**	**$7,698**	**5.9**	**$9,267**	**7.3**	**$12,240**	**9.4**	**$9,915**	**7.9**

(a) Average annual costs are based on the 12 months beginning January 1 and ending December 31. Costs in millions = the dollar value of the costs to New England wholesale market load servers for ISO-administered services. Cents/kWh = the value derived by dividing the dollar value (indicated above) by the real-time load obligation. These values are presented for illustrative purposes only and do not reflect actual charge methodologies. *** The wholesale values for 2019 are preliminary and subject to resettlement.**

(b) Energy values are derived from wholesale market pricing and represent the results of the Day-Ahead Energy Market plus deviations from the Day-Ahead Energy Market reflected in the Real-Time Energy Market.

(c) Ancillaries include first- and second-contingency Net Commitment-Period Compensation (NCPC), forward reserves, real-time reserves, regulation service, and a reduction for the Marginal Loss Revenue Fund.

(d) Capacity charges are those associated with the Forward Capacity Market (FCM).

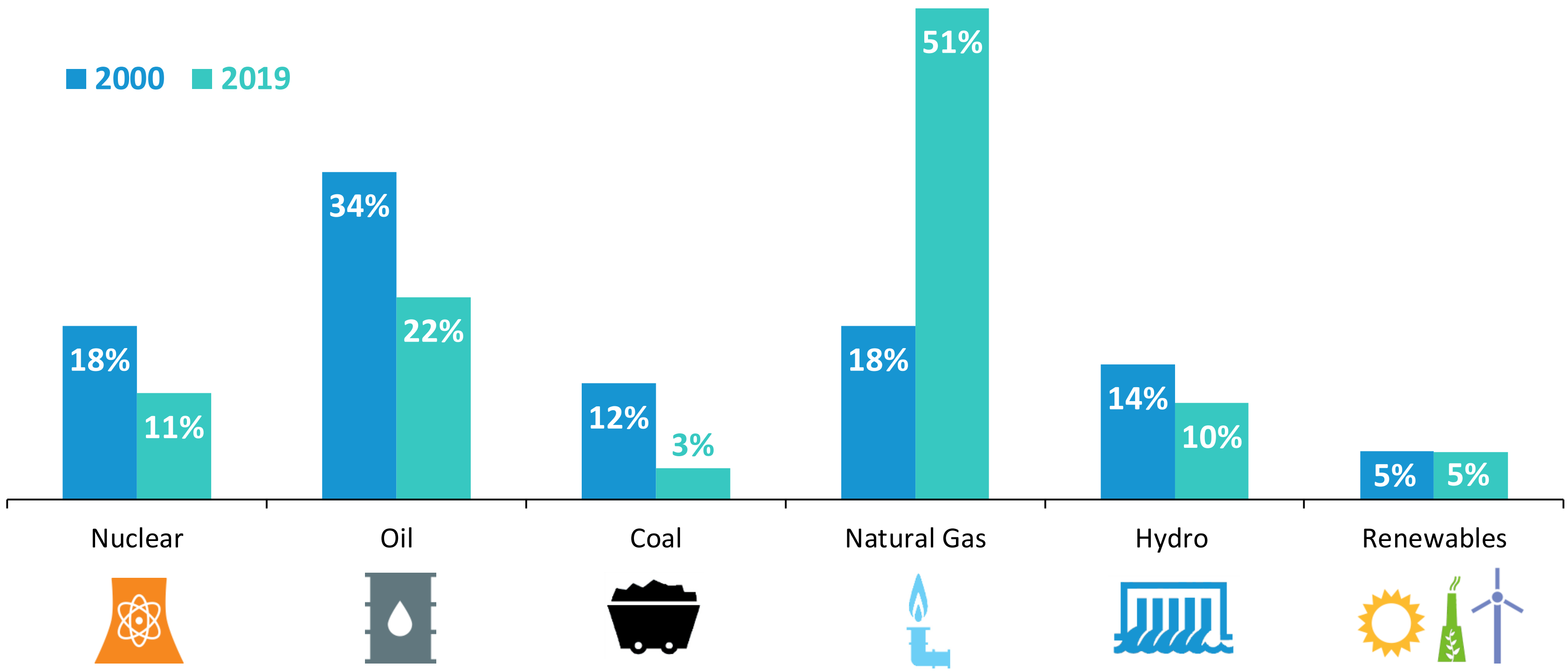
(e) Transmission charges reflect the collection of transmission owners' revenue requirements and tariff-based reliability services, including black-start capability, voltage support, and FCM reliability. In 2019, the cost of payments made to these generators for reliability services under the ISO's tariff was $42.2 million. Transmission charge totals reflect the refund of Schedule 1 TOUT charges to regional network load.

(f) RTO costs are the costs to run and operate ISO New England and are based on actual collections, as determined under Section IV of the *ISO New England Inc. Transmission, Markets, and Services Tariff*.

Dramatic Changes in Power System Resources

The resources making up the region's installed generating capacity have shifted from nuclear, oil, and coal to natural gas

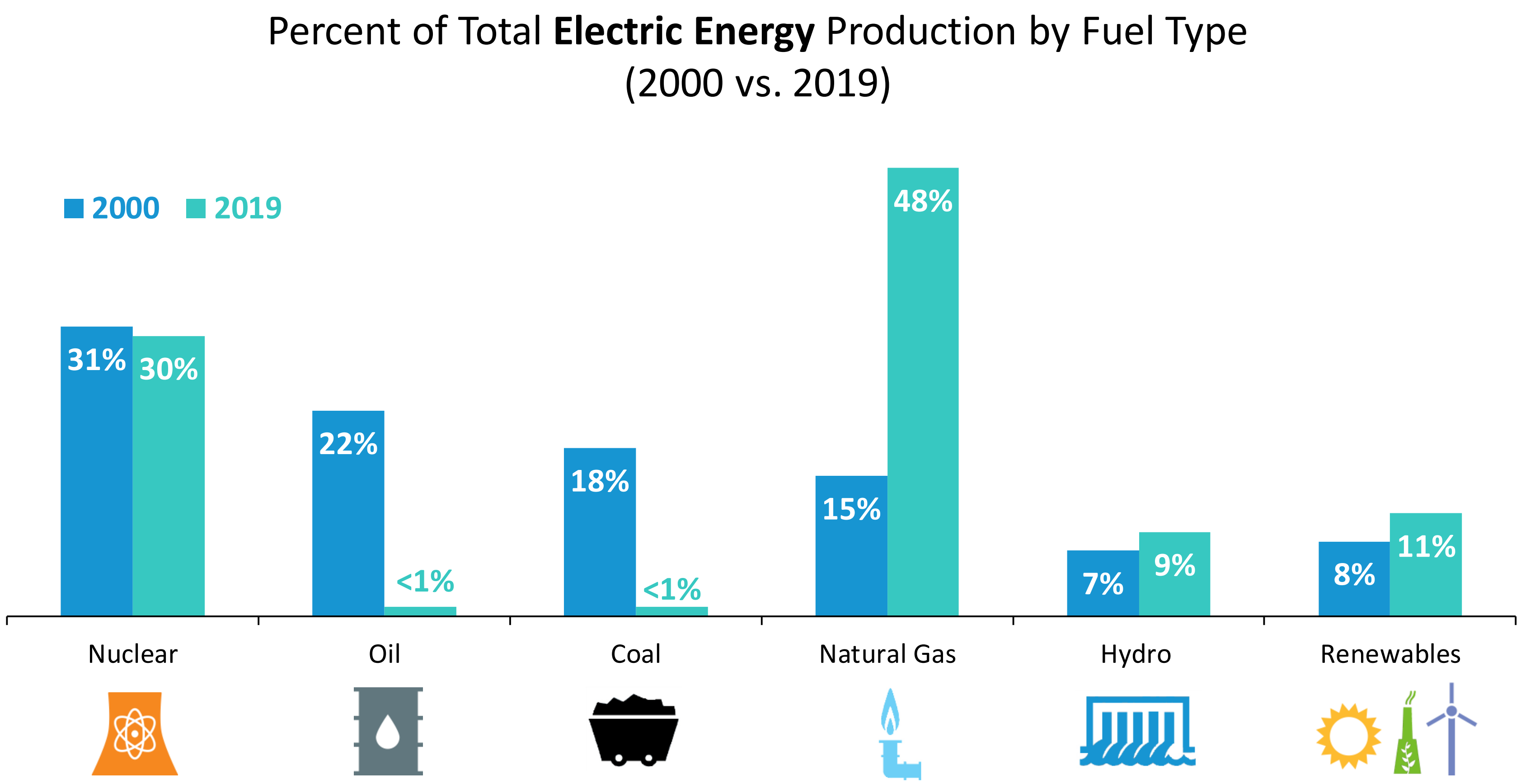
Percent of Total System **Capacity** by Fuel Type
(2000 vs. 2019)



Source: 2019 CELT Report, Summer Seasonal Claimed Capability (SCC) Capacity
Renewables include landfill gas, biomass, other biomass gas, wind, grid-scale solar, municipal solid waste, and miscellaneous fuels.

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



Source: ISO New England Net Energy and Peak Load by Source; data for 2019 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.

Power Plant Emissions Have Declined with Changes in the Fuel Mix

New England Generator Air Emissions 2000 vs. 2017

Carbon Dioxide (CO_2)
major driver of climate change

Nitrogen Oxide (NO_x)
adds to smog

Sulfur Dioxide (SO_2)
with No_x, leads to acid rain

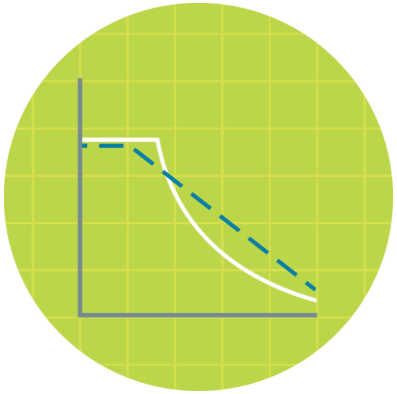
- The **70 million short tons** of carbon dioxide emissions avoided regionally between 2001 and 2017 is like taking more than **13.5 million passenger vehicles** off of the road for a year
- For comparison, in 2016, roughly 5.1 million vehicles were registered in New England

Source: [2017 ISO New England Electric Generator Air Emissions Report] (April 2019); ISO New England [2019 Regional Electricity Outlook] (March 2019)

Forward Capacity Auction #14 Concluded With Sufficient Resources and the Lowest Clearing Price in the Auction's History

- FCA #14 was held on February 3, 2020 to procure the capacity resources needed to meet demand for electricity, plus reserve requirements, during the **June 1, 2023 to May 31, 2024** capacity commitment period

- The **clearing price** in the auction was **$2.00** per kilowatt-month (kW-month) across all of New England, compared to $3.80/kW-month in last year's auction



- The estimated cost of the capacity market in 2023-2024 will be about **$980 million**
  - Down from the estimated cost of last year's auction ($1.6 billion)

For more information, see https://www.iso-ne.com/static-assets/documents/2020/02/fca_14_results_filing.pdf

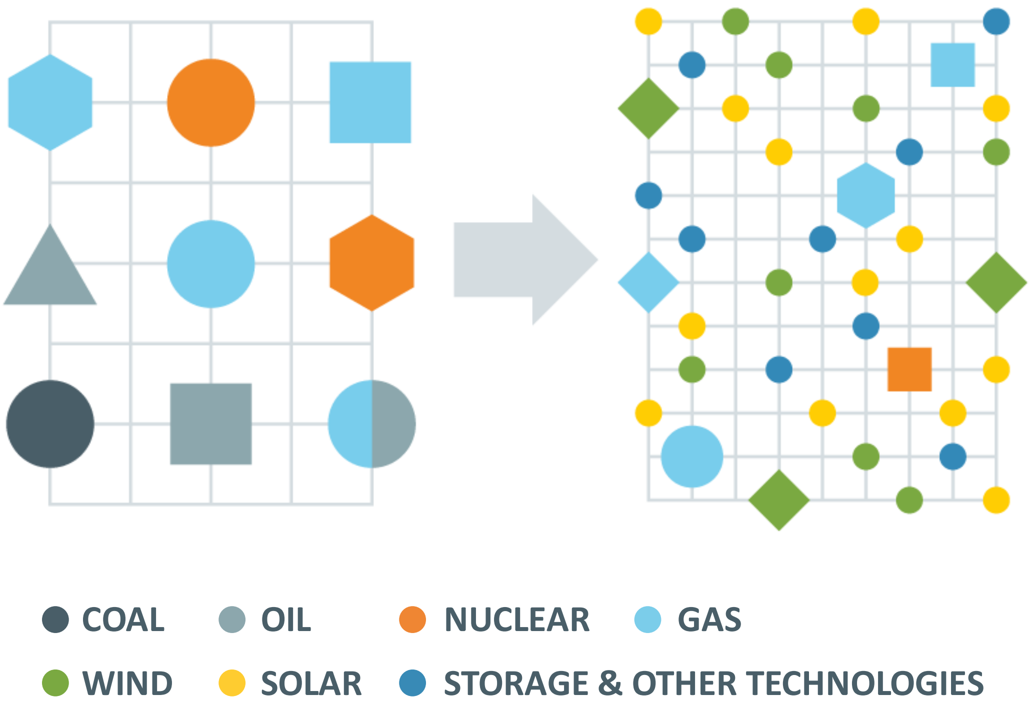
FCA #14 Attracted and Retained a Variety of Resources to Ensure Resource Adequacy in 2023-2024

- The auction concluded with commitments from **33,956 MW** of capacity to be available during the 2023-2024 capacity commitment period
  - **28,978 MW** of generation, including 335 MW of new generating resources
  - **3,919 MW** of energy-efficiency and demand-reduction measures, including 323 MW of new demand resources
  - **1,059 MW** of total imports from New York, Québec and New Brunswick
- Prior to the auction, ISO New England retained two units, Mystic Generating Station Units 8 and 9, needed for fuel security in 2023-2024

What Is a Hybrid Grid?

There are two dimensions to the transition, happening simultaneously…

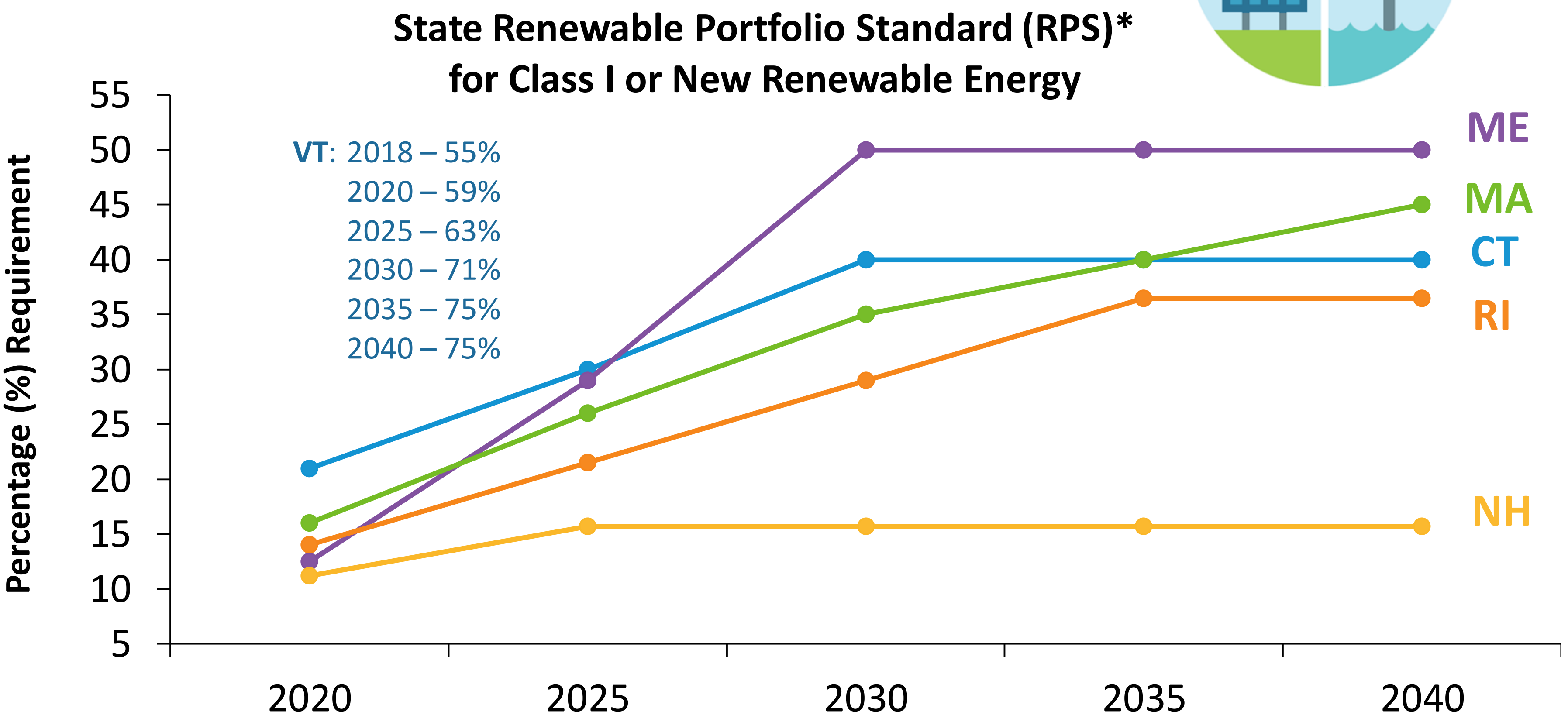
1. A shift from conventional generation to renewable energy
2. A shift from centrally dispatched generation to distributed energy resources



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

Renewable Energy Is on the Rise

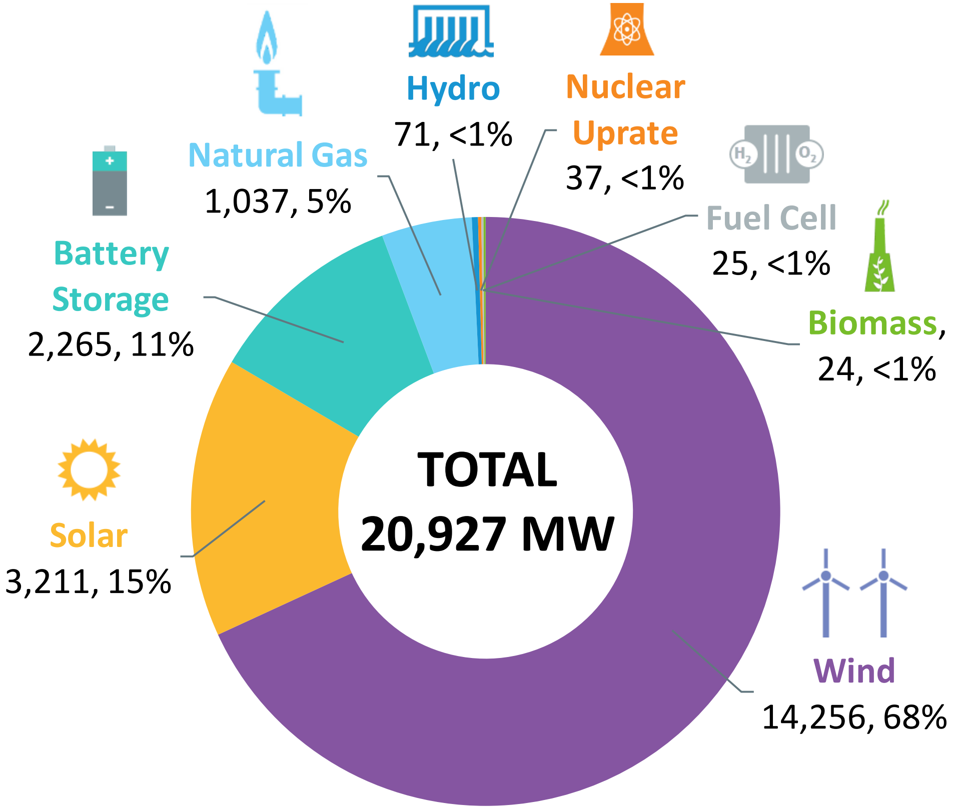
State policy requirements are a major driver



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 2030, 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.

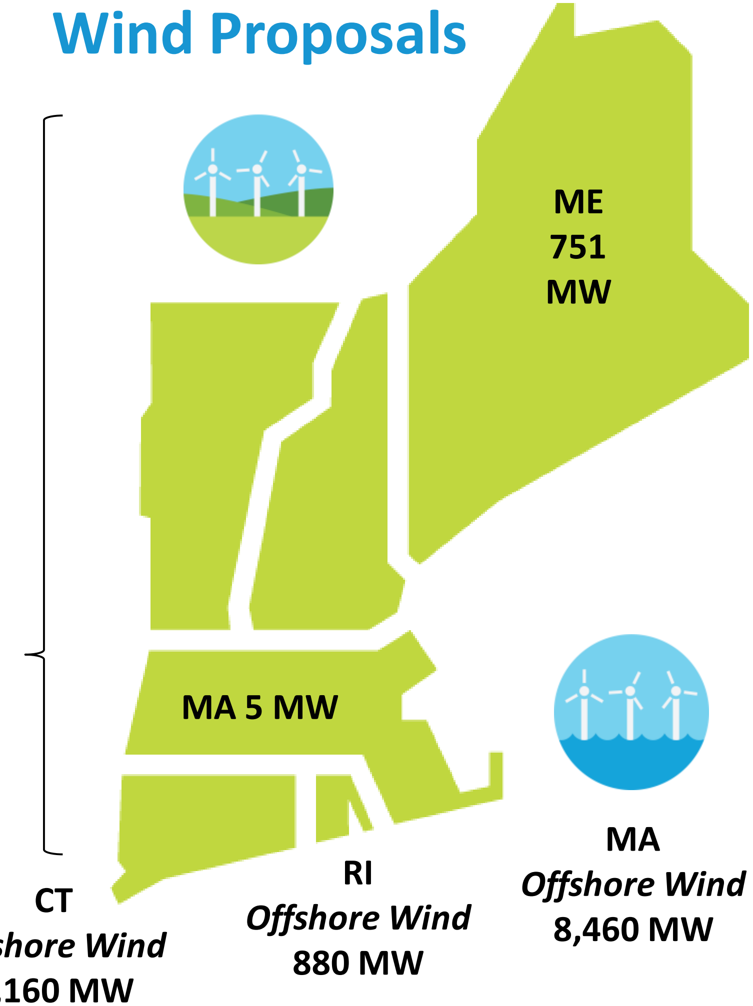
Wind Power Comprises Two Thirds of New Resource Proposals in the ISO Interconnection Queue

All Proposed Resources



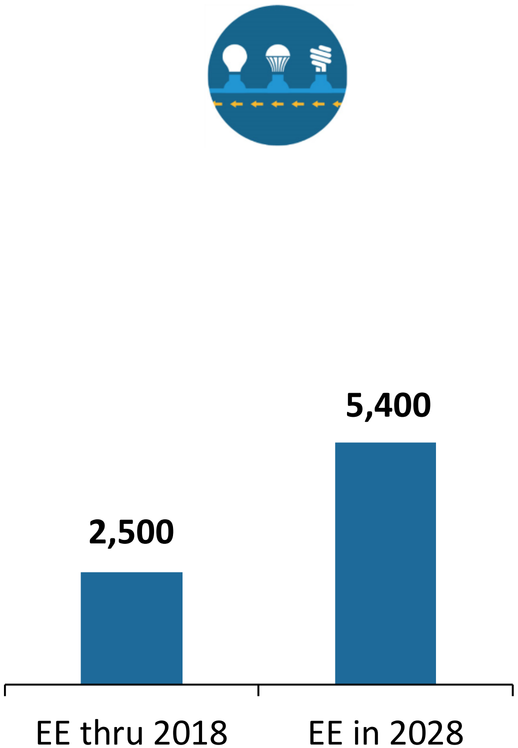
Source: ISO Generator Interconnection Queue (January 2020)
FERC and Non-FERC Jurisdictional Proposals; Nameplate Capacity Ratings
Note: Some natural gas proposals include dual-fuel units (with oil backup).
Some natural gas, wind, and solar proposals include battery storage.

Wind Proposals



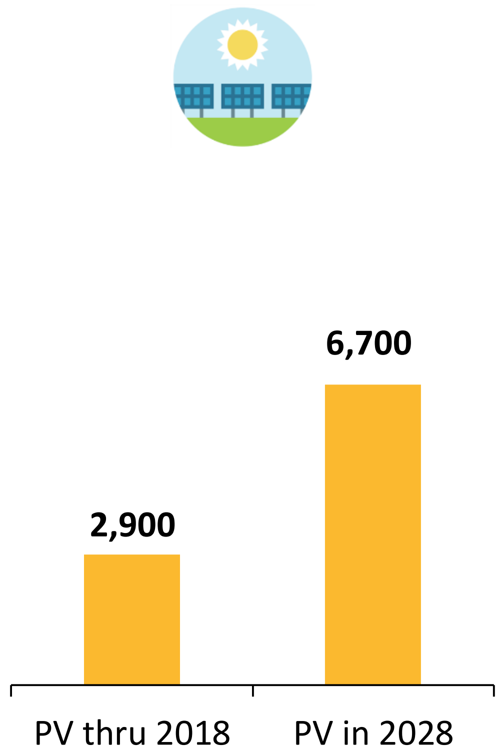
Energy-Efficiency and Renewable Resources Are Trending Up in New England

Energy Efficiency
(MW)



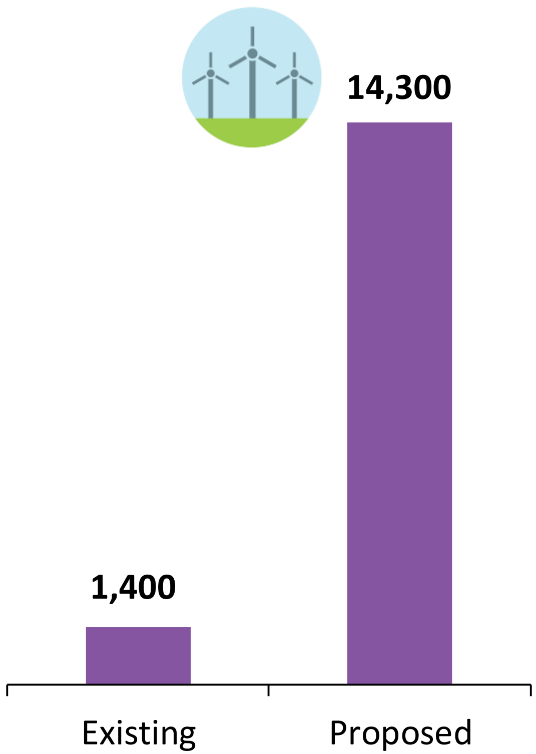
Final 2019 CELT Report, EE through 2018 includes EE resources participating in the Forward Capacity Market (FCM). EE in 2028 includes an ISO-NE forecast of incremental EE beyond the FCM.

Solar
(MW)



Final 2019 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; some wind proposals include battery storage.

Draft 2020 PV Forecast

Nameplate Capacity, MW_{ac}

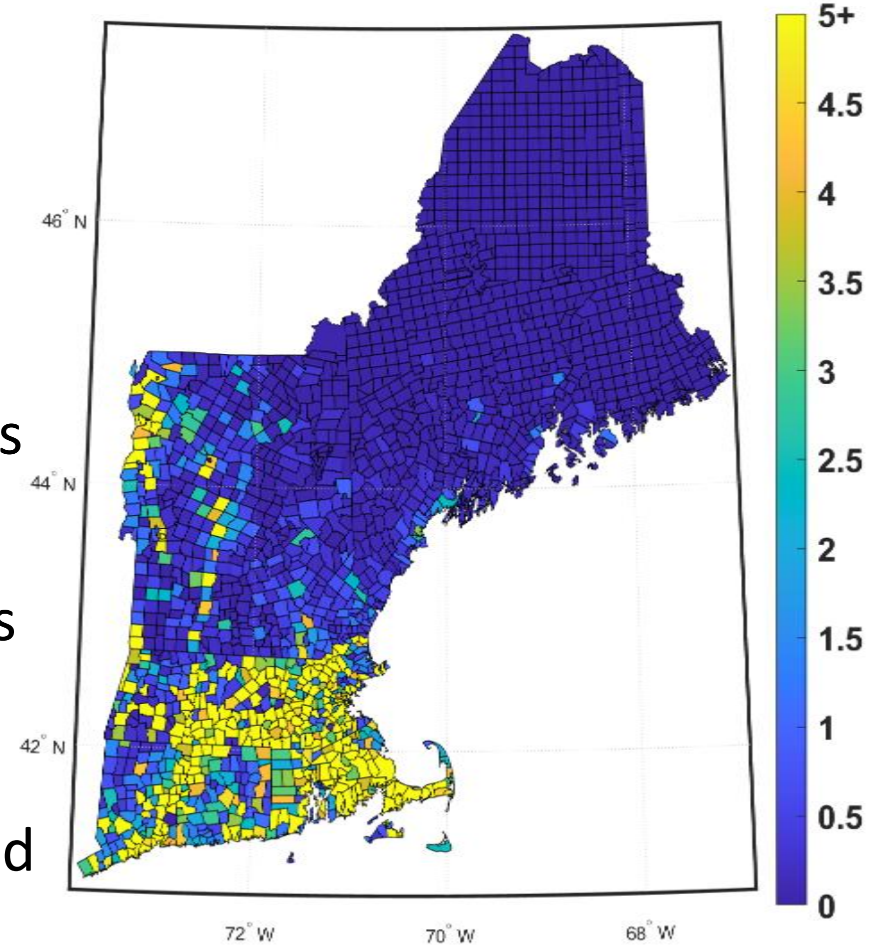
States	Annual Total MW (AC nameplate rating)											Totals
	Thru 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	
CT	566.5	97.0	84.1	119.4	119.4	71.4	71.4	71.4	71.4	43.4	42.0	**1,357.4**
MA	2180.4	319.6	283.5	267.8	267.8	221.1	178.5	173.3	168.0	162.8	157.5	**4,380.2**
ME	56.3	14.2	80.9	97.7	97.7	97.7	12.7	12.7	12.7	12.7	12.7	**507.9**
NH	105.2	20.3	19.3	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	**290.3**
RI	159.7	49.1	46.5	43.9	42.4	42.4	42.4	42.4	42.4	42.4	42.4	**596.1**
VT	364.1	29.5	23.4	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	**593.8**
Regional - Annual (MW)	**3432.4**	**529.6**	**537.7**	**569.0**	**567.5**	**472.9**	**345.3**	**340.0**	**334.8**	**301.5**	**294.9**	**7,725.6**
Regional - Cumulative (MW)	**3432.4**	**3962.1**	**4499.8**	**5068.8**	**5636.3**	**6109.2**	**6454.5**	**6794.5**	**7129.2**	**7430.8**	**7725.6**	**7,725.6**

Notes:

(1) Forecast values include FCM Resources, non-FCM Energy Only Generators, and behind-the-meter PV resources
(2) The forecast values are net of the effects of discount factors applied to reflect a degree of uncertainty in the policy-based forecast
(3) All values represent end-of-year installed capacities
(4) Forecast does not include forward-looking PV projects > 5MW in nameplate capacity

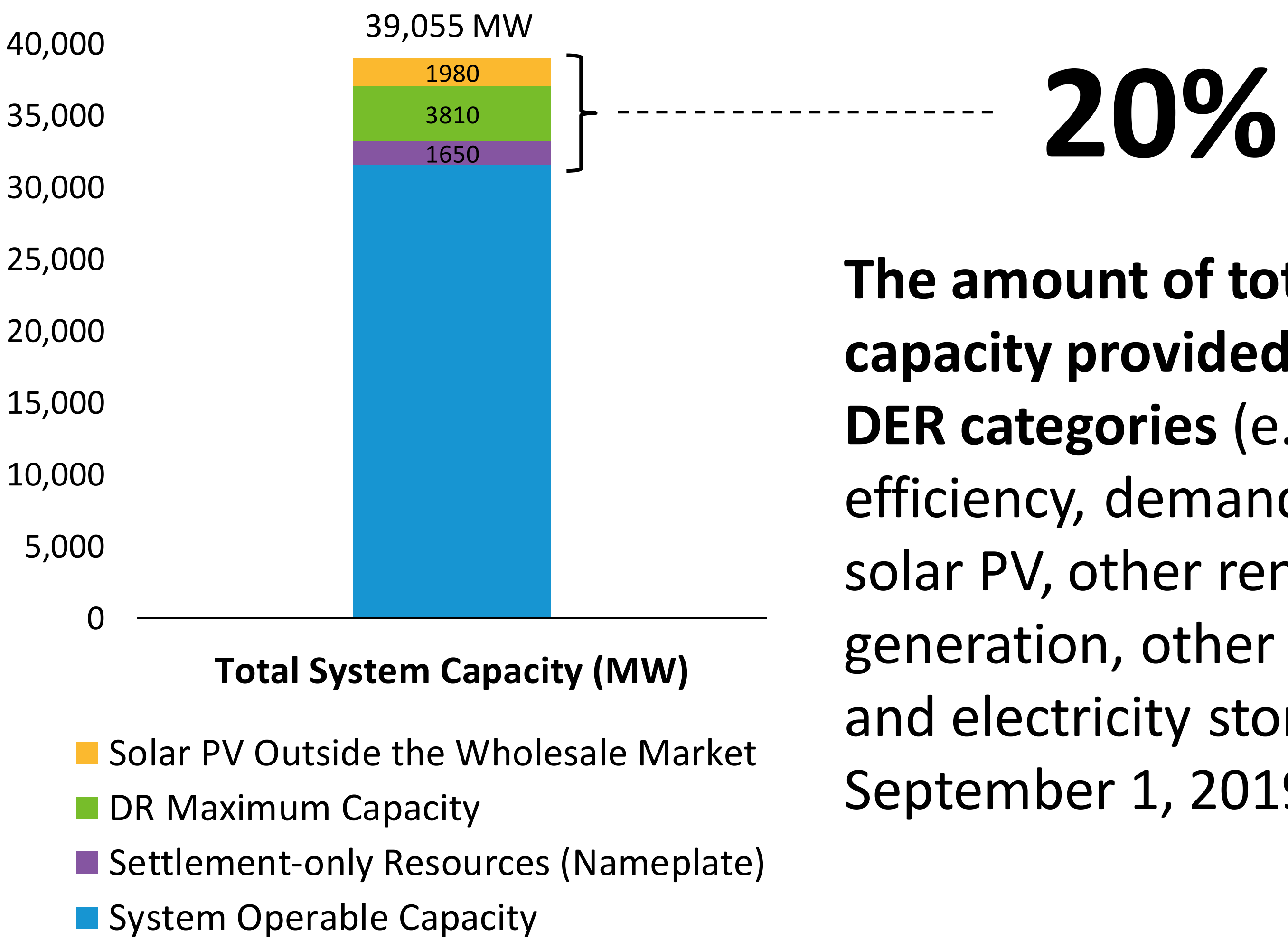
State Installed Solar PV "Heat Maps"

- Understanding the spatial distribution of existing solar PV resources will be critical to the ISO's ongoing integration activities within both System Planning and System Operations
- Based on the data provided by distribution owners, the ISO has aggregated the installed nameplate capacity by town within each state, and generated heat maps showing the results



Note: Heat map reflects MW of solar PV installed through December 2019.

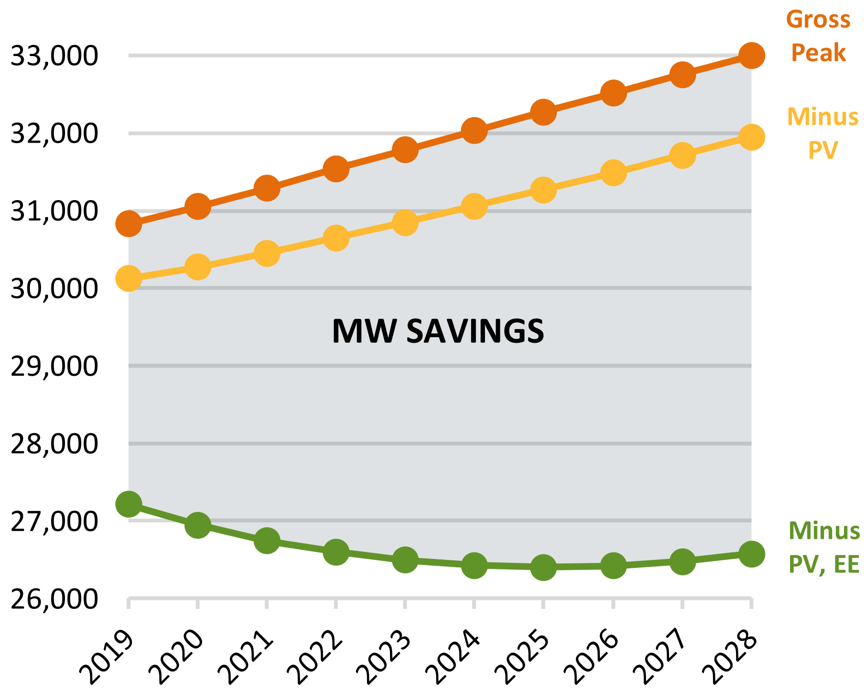
DERs Comprise A Sizable Share of System Capacity



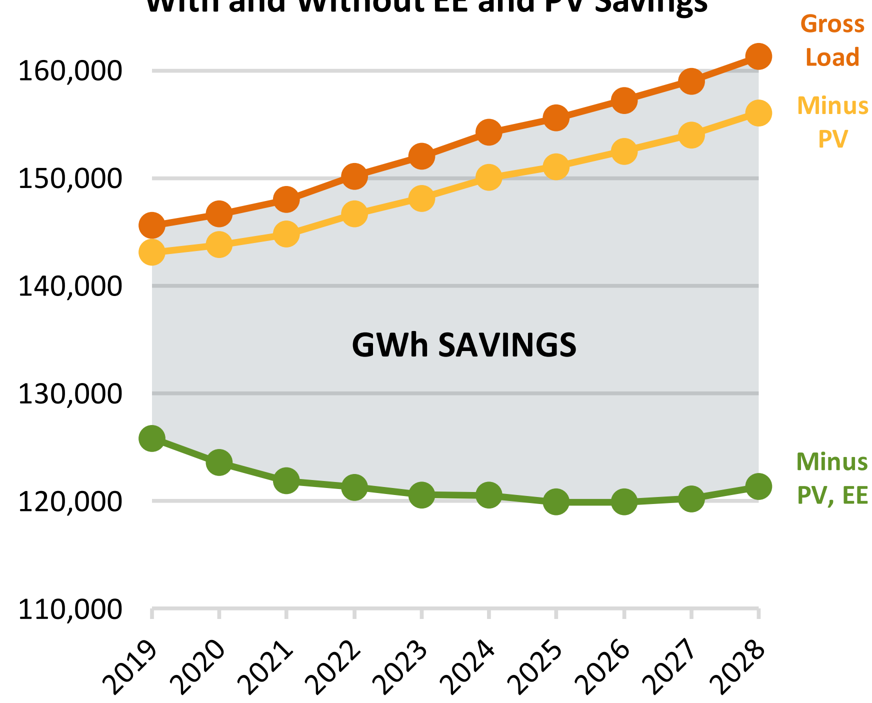
The amount of total system capacity provided by various DER categories (e.g., energy efficiency, demand response, solar PV, other renewable generation, other generation and electricity storage) as of September 1, 2019

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

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



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

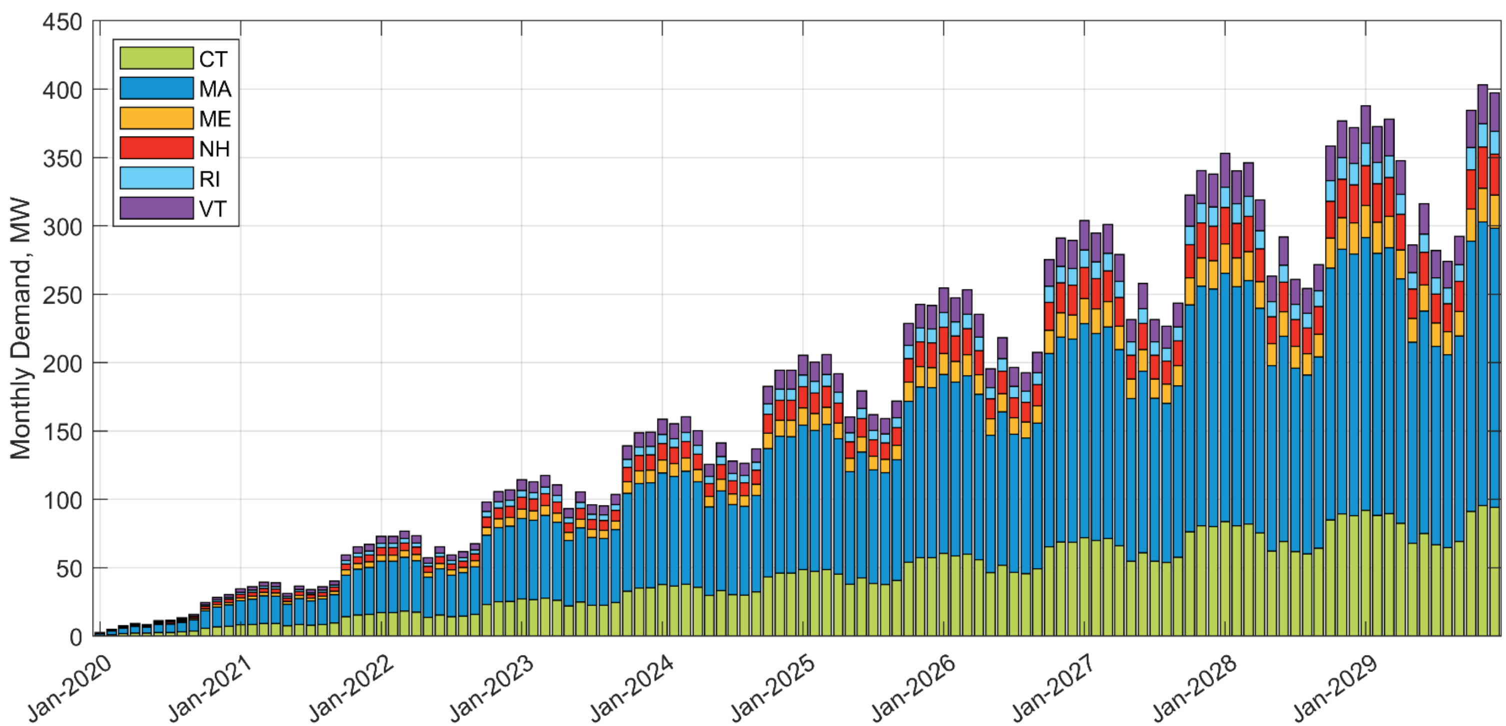


- **The gross peak and load forecast**
- **The gross peak and load forecast minus existing and anticipated "behind-the-meter" (BTM) solar PV resources**
- **The gross peak and load forecast minus existing and anticipated BTM solar PV and energy efficiency**

Note: Summer peak demand is based on the "90/10" forecast, which accounts for the possibility of extreme summer weather (temperatures of about 94^{o} F).
Source: ISO New England 2019-2028 Forecast Report of Capacity, Energy, Loads, and Transmission (2019 CELT Report) (April 2019)

ISO Load Forecasting Now Includes Electrification

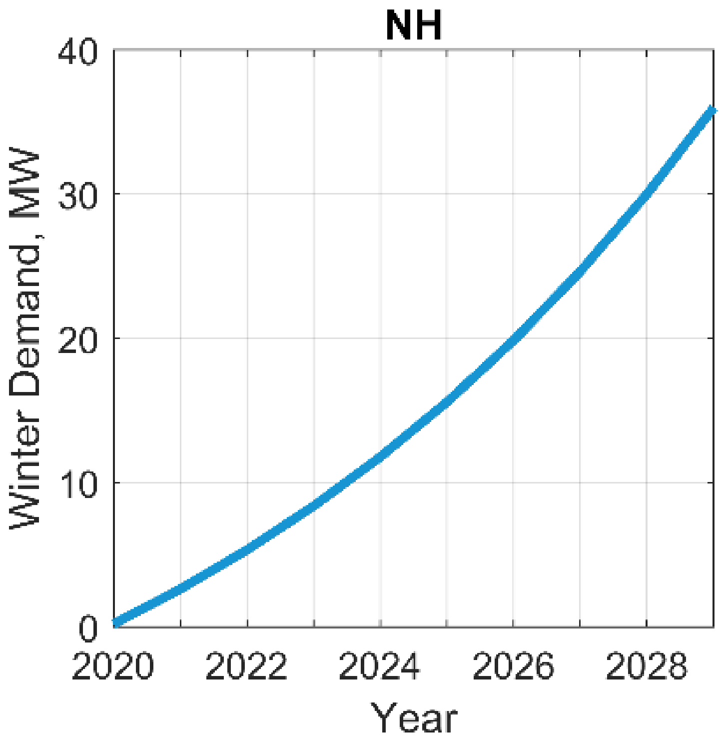
- Ten-year forecasting for air-source heat pumps and for light-duty electric vehicles
  - Forecast uses data-driven assumptions to convert the ASHP/EV adoption forecast into estimated impacts on monthly energy and demand, by state



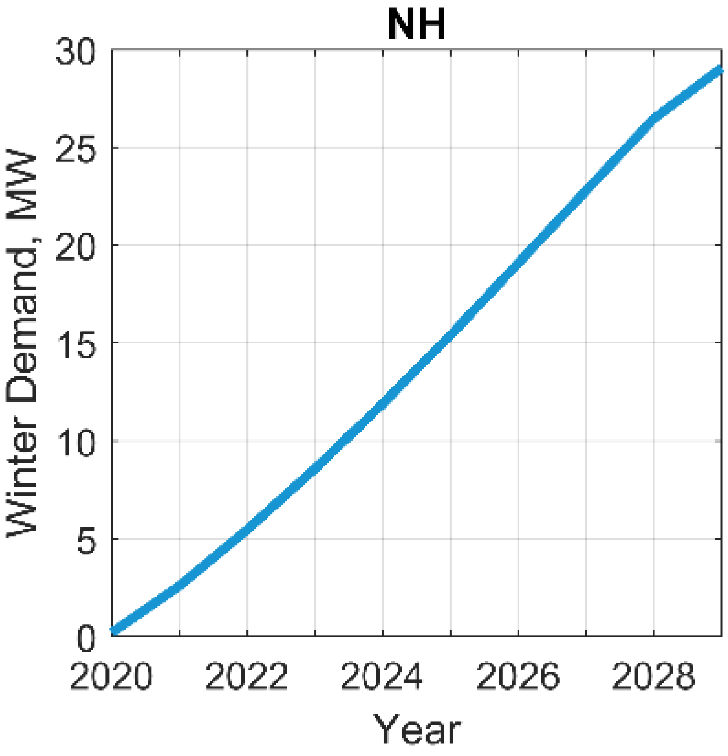
EV Results for New England

NH Electrification Load Forecasting Results

- **NH's ASHP Forecast: Impact on Winter Demand:**



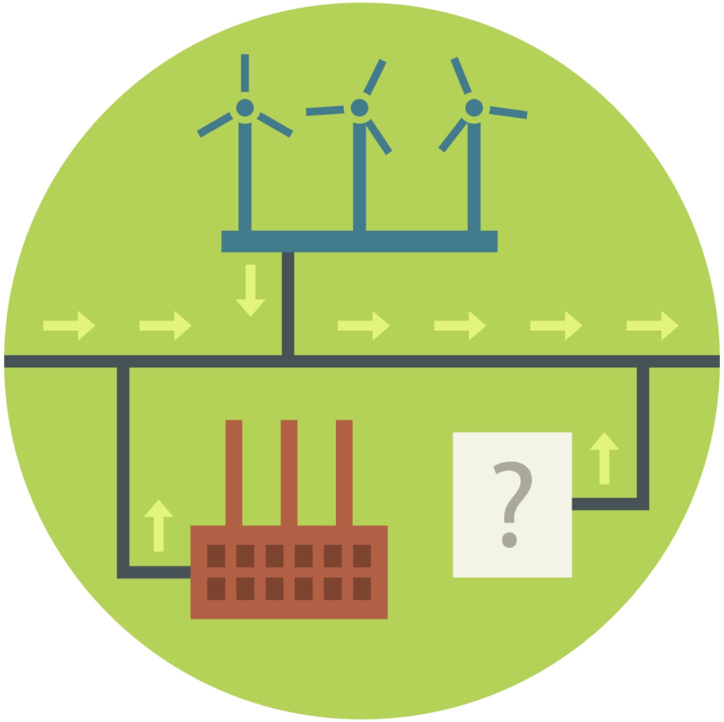
- **NH's EV Forecast: Impact on Winter Demand:**



TRANSMISSION UPDATE

ISO-NE's Planning Functions in New England's Transmission System

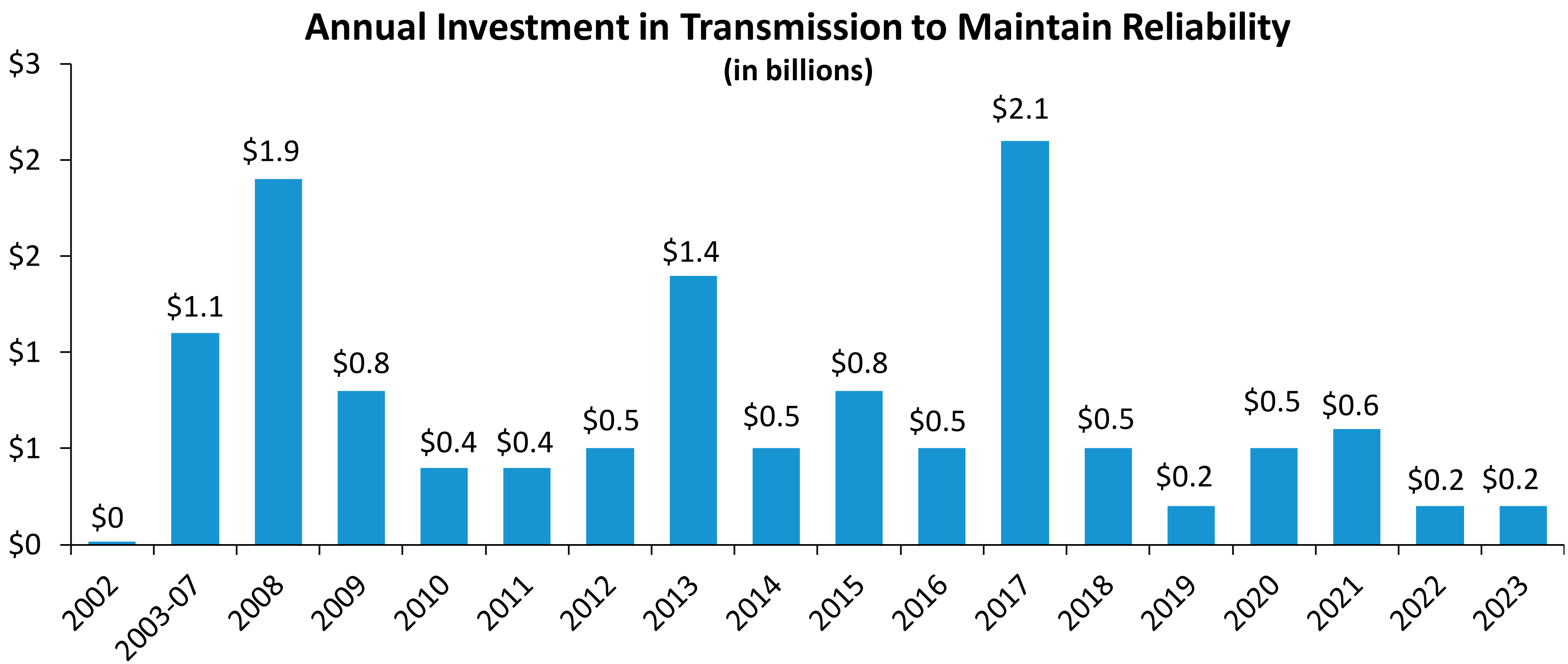
- Administers requests for interconnection of generation and regional transmission system access
- Conduct transmission system needs assessments
- Plan regional transmission system to provide regional network service
- Develop Regional System Plan (RSP) with a ten-year planning horizon



The ISO Issued Its First Competitive RFP for Transmission Solutions in December 2019

- On **December 20**, the ISO issued a request for proposal (RFP) to address transmission needs in the Boston area
  - Triggered by the announced retirement of **Mystic Generating Station**
- The RFP marks a **milestone** for ISO New England
  - **First competitive transmission solicitation** issued under FERC Order 1000
- 8 Qualified Project Sponsors submitted **36 proposals** (March 4)
- The ISO expects to make a final selection in the **summer of 2021**
- For **additional information**, see the [ISO Newswire]

Region Has Made Major Investments in Transmission Infrastructure to Ensure a Reliable Electric Grid

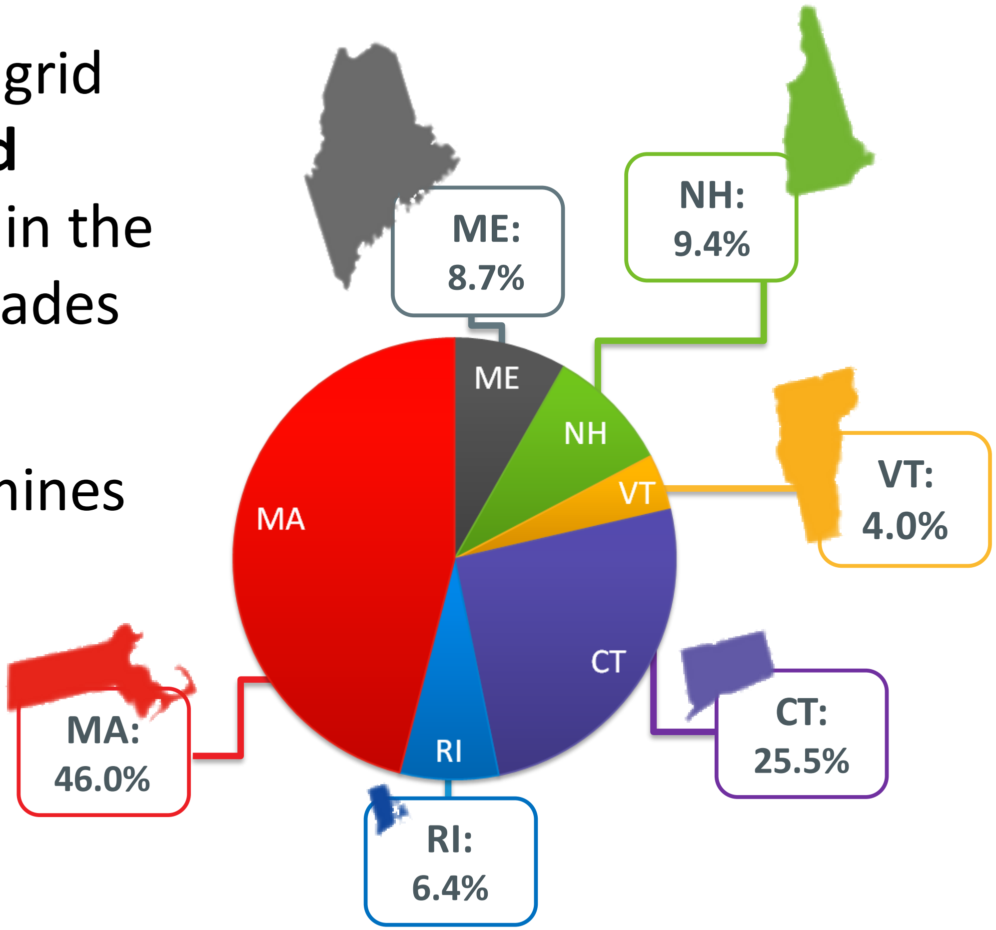


Cumulative Investment through March 2020	**$11 billion**
Estimated Future Investment through 2022	**$1.5 billion**

Source: ISO New England RSP Transmission Project Listing, March 2020
Estimated future investment includes projects under construction, planned and proposed.

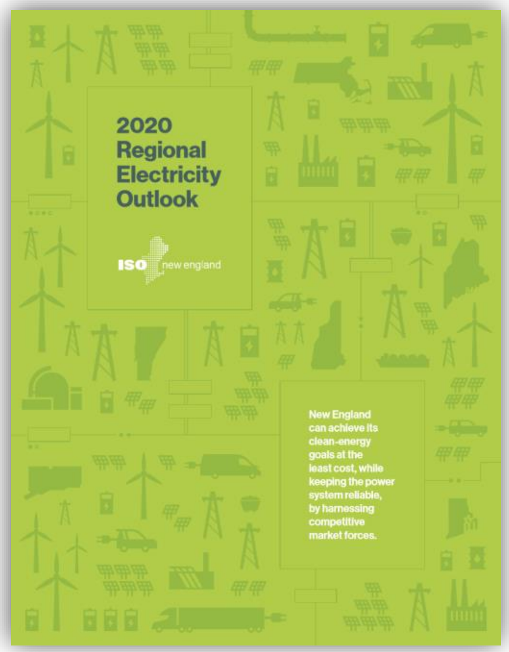
How Are Transmission Costs Allocated?

- The New England electric grid is a **tightly interconnected** system; each state shares in the benefits of reliability upgrades
- The amount of electricity demand in an area determines its **share** of the cost of new or upgraded transmission facilities needed for reliability



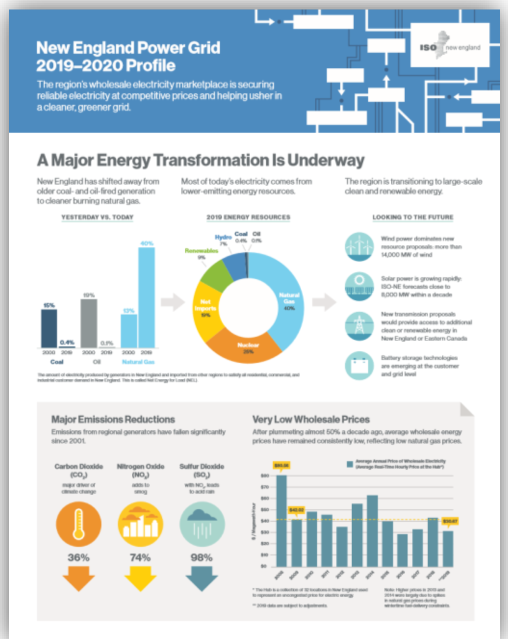
Source: 2018 Network Load by State

ISO New England Releases Several New Publications



[2020 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

FOR MORE INFORMATION…

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Questions

APPENDIX: BACKGROUND INFORMATION

Forward Capacity Market Overview

- Procures resources to meet New England's forecasted capacity needs three years in the future
- Selects a portfolio of **supply** and **demand** resources through a competitive Forward Capacity Auction (FCA) process
  - Resources must be pre-qualified to participate in the auction
  - Resources must participate and clear in the auction to be paid for capacity during the capacity commitment period
- Allows **new capacity projects** to compete in the market and set the price for capacity in the region
- Provides a long-term commitment to new supply and demand resources to encourage **investment**

Recent Forward Capacity Auction Results

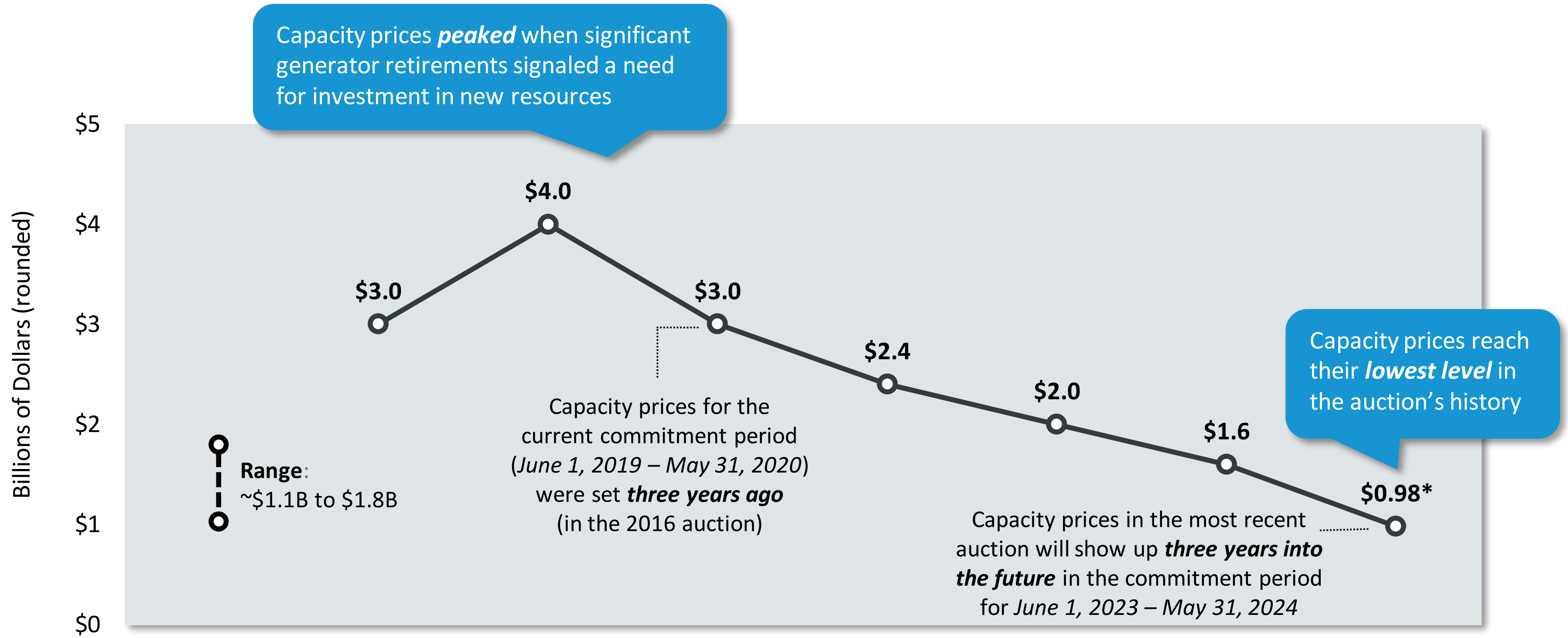
Auction Commitment Period	Total Capacity Acquired (MW)	Capacity Target (MW)	Surplus/Deficit (MW)	New Demand Resources[1] (MW)	New Generation (MW)	Auction Zones [2]	Clearing Price ($/kW-month) [3]
FCA 9 2018/2019	34,695	34,189	506	367	1,060	ROP	$9.55
						CT	
						NEMA/Boston	
						SEMA/RI	$17.73/new $11.08/existing
FCA 10 2019/2020	35,567	34,151	1,416	371	1,459	ROP	$7.03
						SENE	
						Quebec imports	
						New York imports	$6.26
						New Brunswick imports	$4.00
FCA 11 2020/2021	35,835	34,075	1,760	640	264	SENE, NNE, ROP, and NY and Quebec imports	$5.30
						New Brunswick imports	$3.38
FCA 12 2021/2022	34,828	33,725	1,103	514	174	SENE, NNE, ROP and NY imports	$4.63
						Quebec imports	$4.63 for 54 MW $3.70 for 442 MW
						New Brunswick imports	$3.16
FCA 13 2022/2023	34,839	33,750	1,089	654	837	SENE, NNE, ROP, and NY and Quebec imports	$3.80
						New Brunswick imports	$2.68
FCA 14 2023/2024	33,956	32,490	1,466	323	335	SENE, NNE, Maine, ROP, and NY, New Brunswick, and Quebec imports	$2.00

[1] Demand resources include energy efficiency, demand-response resources, and real-time emergency generation (RTEG). [2] Capacity pricing zones: In **FCA 9**, Rest-of-Pool (ROP) included WCMA, VT, NH, and ME. In **FCA 10**, Rest-of-Pool (ROP) included Western/Central MA, CT, ME, NH, and VT; the new Southeast New England (SENE) zone combined Northeastern MA/Boston and Southeastern MA/RI. In **FCA 11**, Northern New England (NNE) comprised of ME, NH, VT; Southeast New England (SENE) including NEMA/Boston, SEMA, and RI; and ROP including CT and WCMA. **In FCA 12** Southeast New England (SENE) included Southeastern MA, RI and Northeastern MA/Boston, Northern New England (NNE) included ME, NH and VT; Rest-of-Pool (ROP) included CT, Western/Central MA. **In FCA 13**, the same zones were modeled as FCA 12. **In FCA 14,** Southeast New England (SENE) included Southeastern MA, RI and Northeastern MA/Boston load zones; the Northern New England (NNE) included NH, VT and ME; Maine is a separate nested zone; Rest-of-Pool (ROP) included CT and Western/Central MA. [3] From **FCA 9 on**, a sloped demand curve has been used, allowing more or less than the capacity requirement to be procured, depending on price and reliability needs.

Capacity Market Costs Reflect Changing Supply Outlook

As a "forward" market, consumers can anticipate future changes in capacity costs

Total Capacity Market Costs



	FCA 1–7	FCA 8	FCA 9	FCA 10	FCA 11	FCA 12	FCA 13	FCA 14
Commitment periods:	**2010–2017**	**2017–2018**	**2018–2019**	**2019–2020**	**2020–2021**	**2021–2022**	**2022–2023**	**2023-2024**
Auction years:	2008–2013	2014	2015	2016	2017	2018	2019	2020
Est. dollars per kilowatt-month:	$2.95 – $4.50 per kW-mo.	$7.03**	$9.55**	$7.03	$5.30	$4.63	$3.80	$2.00

*Preliminary estimate ** Prices may be higher for some capacity zones.

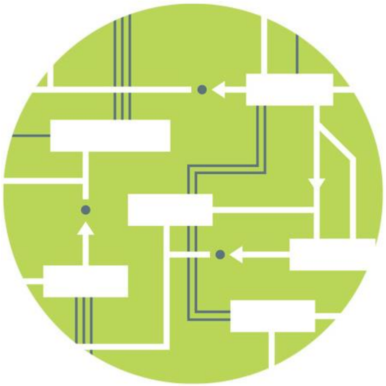
Major Components of Transmission Planning*

- The transmission planning study process begins by developing a **Study Scope** and identifying all key inputs for a Needs Assessment
- A **Needs Assessment** identifies transmission system needs to maintain the reliability of the facilities while promoting the operation of efficient wholesale electric markets
  - Reliability Needs
  - Market Efficiency Needs
  - Public Policy Transmission Needs*
- If the Needs Assessment reveals violations of reliability standards or criteria during the study period, **potential solutions** must be developed to address the identified needs

* Reflective of changes under FERC Order No. 1000

Major Components of Transmission Planning*

- If the identified reliability-based transmission need is **less than or equal to three years out**, the ISO will develop solution alternatives, in coordination with the transmission owner(s) and stakeholders
- If the identified reliability-based transmission need is **more than three years out**, a Request for Proposals (RFPs) for competitive solutions will be issued by the ISO
  - Public Policy and Market Efficiency Transmission Upgrades are developed **only** through a competitive RFP process



- The ISO, working with the New England states and stakeholders, is responsible for **identifying** public policies that are driving transmission needs
- If there are identified public policies that are driving transmission needs, the ISO is responsible for **selecting** the most cost-effective transmission project to address those public policies

* Reflective of changes under FERC Order No. 1000