ISO New England 101

Connecticut Power and Energy Society
New Energy Professionals

Visitor Safety and Security

Essential Locations

- Restrooms
- Emergency exits
- Automated external defibrillators (AEDs)
- Designated smoking areas

Internet Security

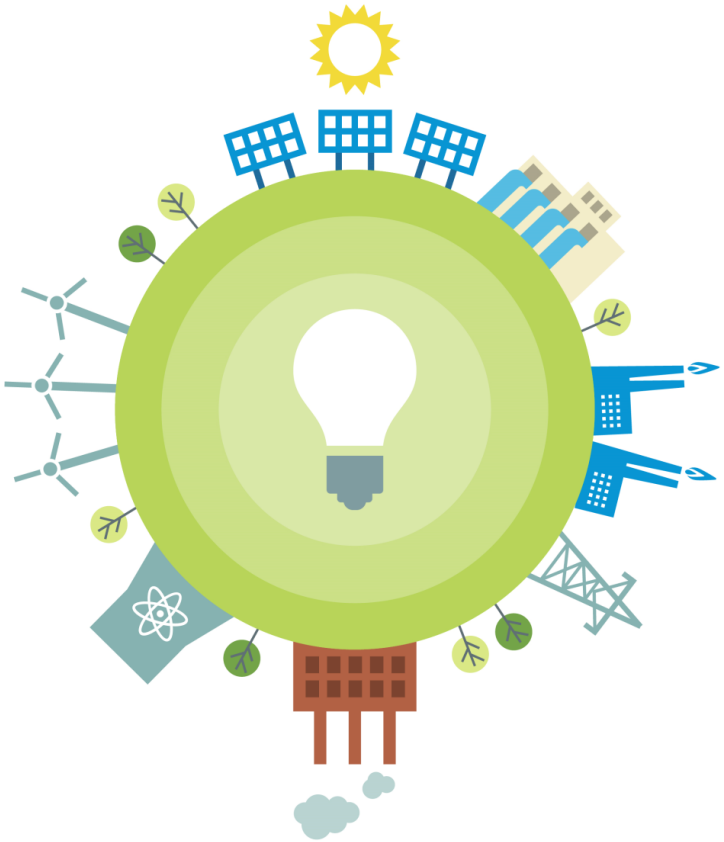
- Personal **hot spots** or MiFi **are prohibited**
- Use only the approved ISO-NE WiFi to connect to internet

Physical Security

- Other than main lobby, you **must wear badge and be escorted at all times**
- Always **sign out and return badges** at reception area (even if leaving and returning)
  - Place badge in drop box if receptionist is not present
  - Reception desk is open from 7:30 a.m. to 4:30 p.m.
- To exit the facility, push the button at the call box before the gate (red button at Holyoke campus) and the guard will open the gate

Overview of “ISO 101”

- About ISO New England
- Transmission & System Planning Overview
- Regional Update
- Control Room Tour



ABOUT ISO NEW ENGLAND

Kerry Schlichting, External Affairs Representative

ISO New England (ISO) Has 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 Keeps Power Flowing Across the Region Every Minute of Every Day

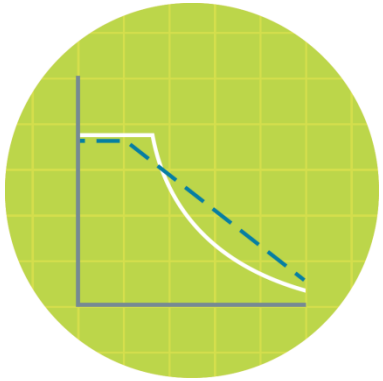
ISO New England Performs Three Critical Roles to Ensure Reliable Electricity at Competitive Prices

Grid Operation

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

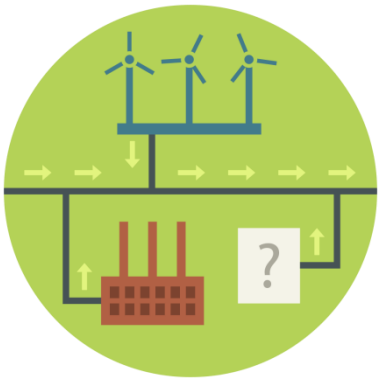
Market Administration

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



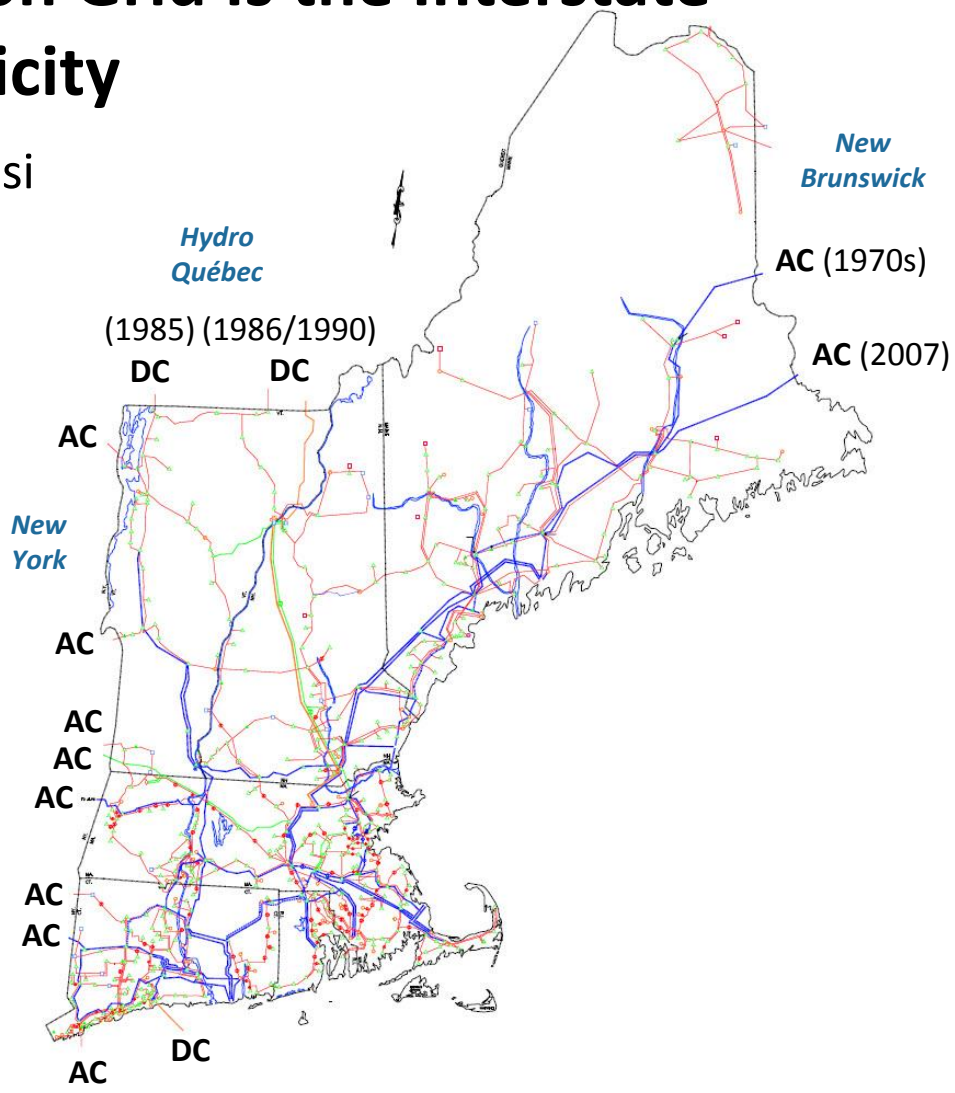
Power System Planning

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 transmissi lines (115 kV and above)
- **13 transmission interconnections** to power systems in New York and Eastern Canada
- **17%** of region's energy needs met by imports in 2018
- **$10.6 billion** invested to strengthen transmission system reliability since 2002; **$1.7 billion** planned
- Developers have proposed multiple transmission projects to access **non-carbon-emitting resources** inside and outside the region



Note: AC stands for Alternating Current and DC stands for Direct Current

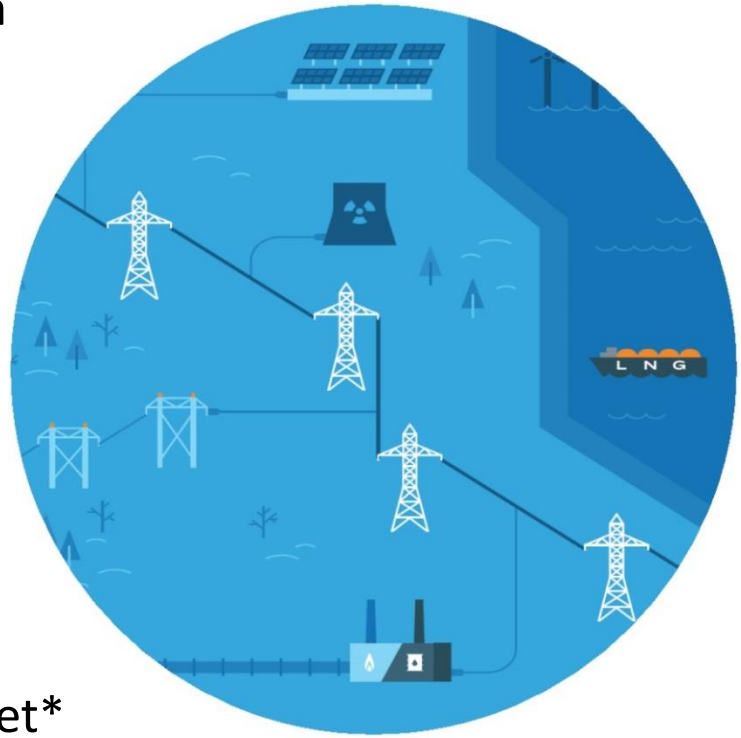
Demand Patterns Are Changing

- **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
  - **-0.2%** annual growth rate for summer peak demand (with EE and BTM solar)
  - **-0.9%** 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 0.8% annually and the region's overall electricity demand is forecasted to grow 0.9% annually. Summer peak demand is based on the "90/10" forecast for extreme summer weather.

Generation and Demand Resources Are Used to Meet New England's Energy Needs

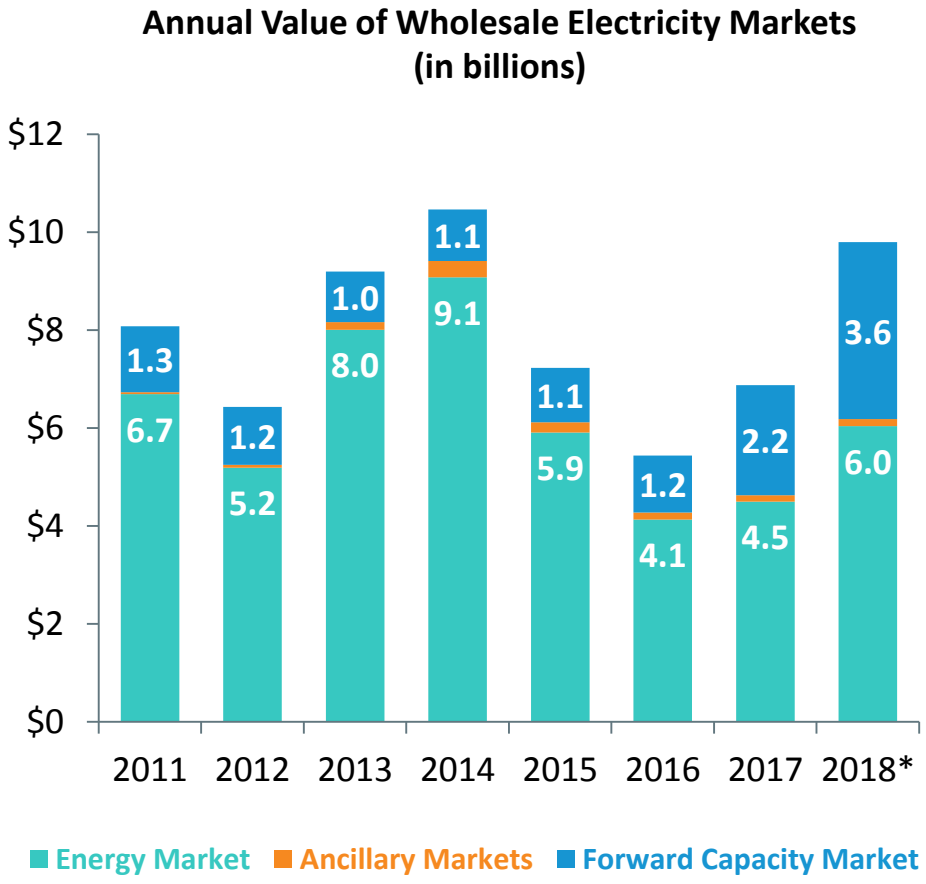
- **350** dispatchable generators in the region
- **31,000 MW** of generating capacity
- **18,600 MW** of proposed generation in the ISO Queue
  - Mostly wind and natural gas
- **5,200 MW** of generation have retired or will retire in the next few years
- **400 MW** of active demand response and **2,500 MW** of energy efficiency with obligations in the Forward Capacity Market*
  - Effective June 1, 2018, demand resources have further opportunities in the wholesale markets



* In the Forward Capacity Market, demand-reduction resources are treated as capacity resources.

Many Resources Compete to Supply Electricity in New England's Wholesale Markets

- Close to **500** buyers and sellers in the markets
- **$9.8 billion** traded in wholesale electricity markets in 2018
  - **$6.0 billion** in energy markets
    - Increased costs driven by **cold weather** and higher wholesale electric energy prices in January
  - **$3.8 billion** in capacity and ancillary services markets
    - Increased costs driven by resource **retirements** and higher clearing prices in Forward Capacity Market
- Extensive analysis and reporting of market results



* Data is preliminary and subject to resettlement

TRANSMISSION & SYSTEM PLANNING OVERVIEW

Dan Schwarting, Transmission Planning

Have you bought one of these devices recently?

Build houses

Open businesses

Close businesses

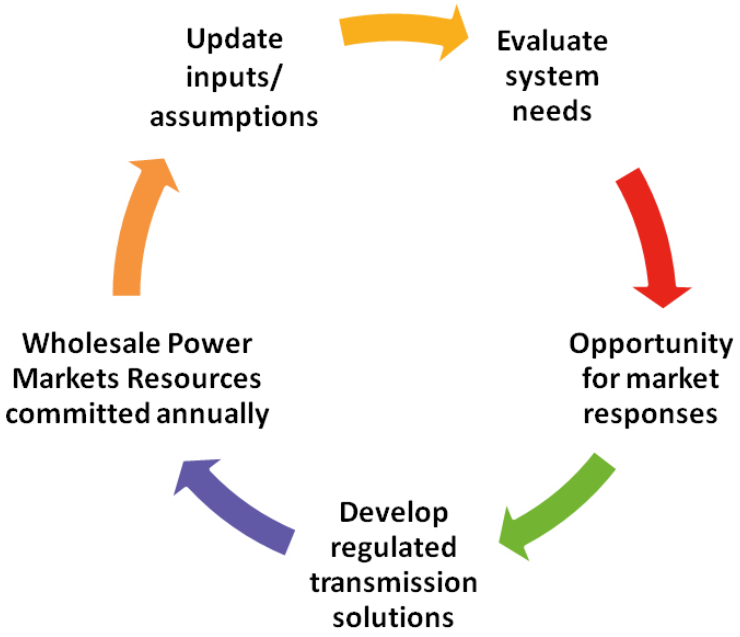
A3

New England's System Planning Process

Continuous, Adaptive, and Successful

Open and transparent 10-year planning horizon reflects:

- Updates to inputs and assumptions
- Evaluation of future system needs
- Market responses
- Timing of future resource needs
- Information to marketplace and stakeholders
- Coordination with neighboring areas



Regional System Plan (RSP) 17 looks at system needs for 2017-2026

System Planning > Plans and Studies > Regional System Plan and Related Analyses

Reliability Standards Guide Regional Planning

- North American Electric Reliability Corporation (NERC)
  - Reliability standards for the Bulk Electric System in North America
- Northeast Power Coordinating Council (NPCC)
  - Basic criteria for the design and operation of the Bulk Power System in the Northeast
- ISO New England (ISO-NE)
  - Reliability standards for the New England area Pool Transmission Facilities

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

NPCC, Inc.

ISO new england

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

All of our processes are governed by a **FERC-approved tariff**

System Planning Activities

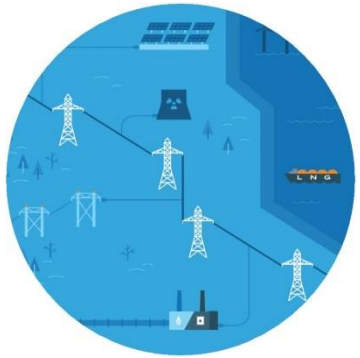
Ensuring Reliable Operations in the Future

Resource Adequacy and Interconnection

- Forecasting regional electric energy use
  - Including energy efficiency and solar photovoltaic
- Determine annual resource needs by:
  - Monitoring resource mix and fuel security including renewable resource integration
  - Analyzing retirements for reliability impact
- Administering the ISO Generation Interconnection Queue
- Administering the Forward Capacity Market (FCM)
- Conducting Economic Studies

Transmission Planning

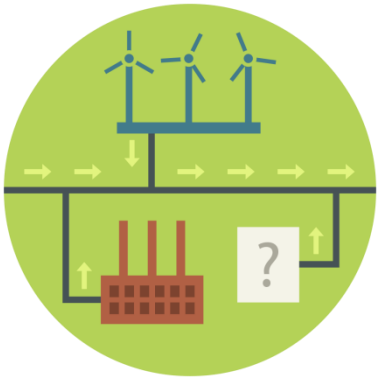
- Performing transmission reliability analysis
- Developing solutions or issuing a request for competitive solutions
- Reviewing transmission costs
- Planning for public policy
- Conducting interregional planning activities



Resource Adequacy

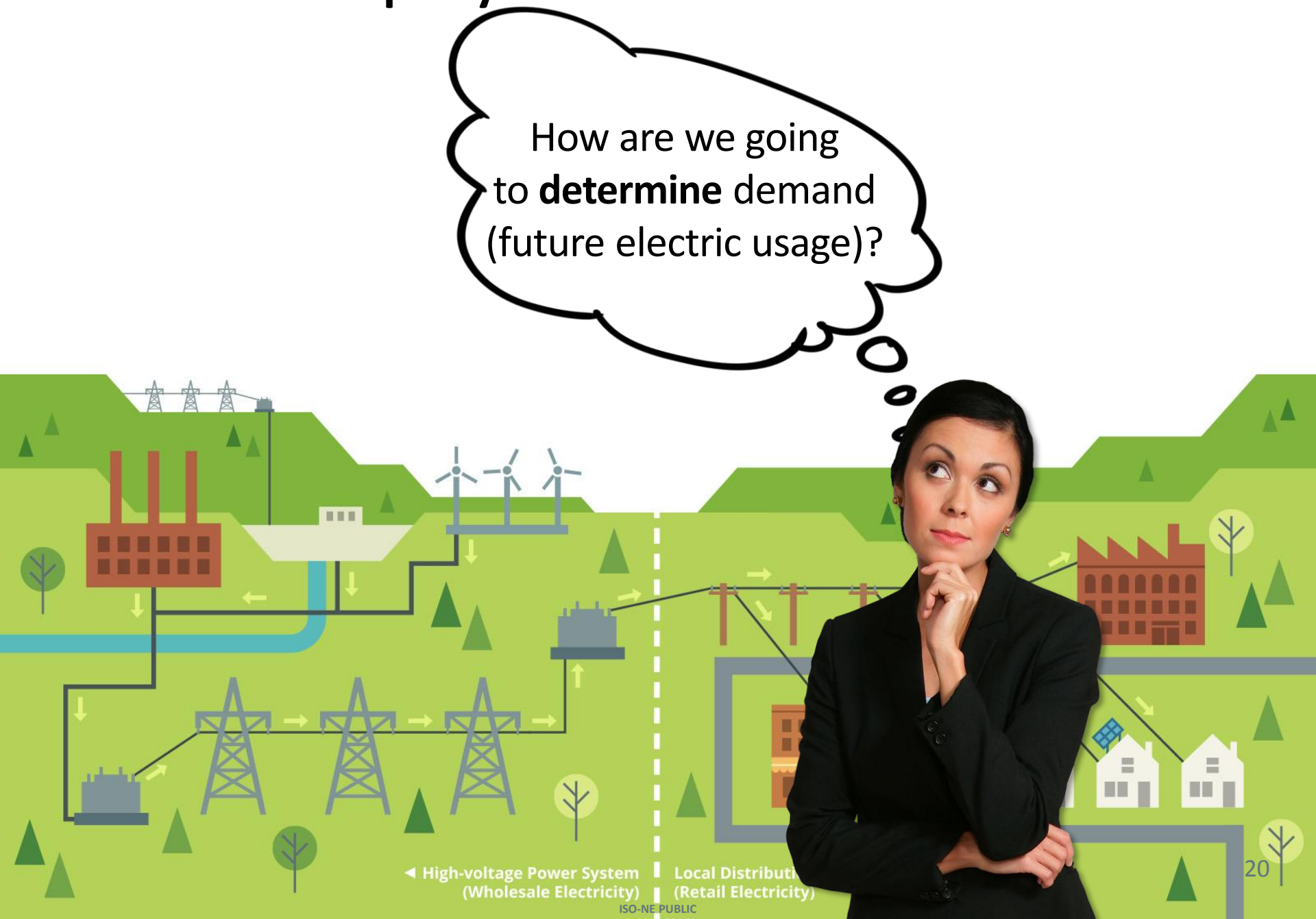
Overview of Resource Adequacy (RA)

- Identify **amount** and **location** of resources the system needs to ensure resource adequacy and *how* the region meets short-term needs



- Planning to maintain resource adequacy requires:
  - Forecasts of future electricity demand
  - Installed Capacity Requirement (ICR) calculations
  - Qualification of resources providing capacity and reserves
  - Operable capacity analyses that consider future scenarios of load forecasts
  - Assessment of ever-changing operating conditions and resource mix
- Yearly system capacity requirements determined through ICR calculation
  - ICR accounts for uncertainties, contingencies, and resource performance under a wide range of existing and future system conditions
- Resource Adequacy assessments feed markets and other planning functions

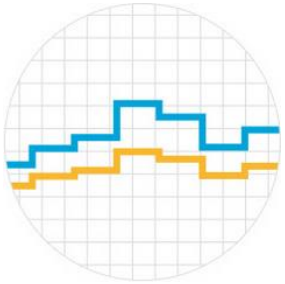
Resource Adequacy



Forecasting Regional Electric Energy Use

Energy forecasts are driven by key factors, including:

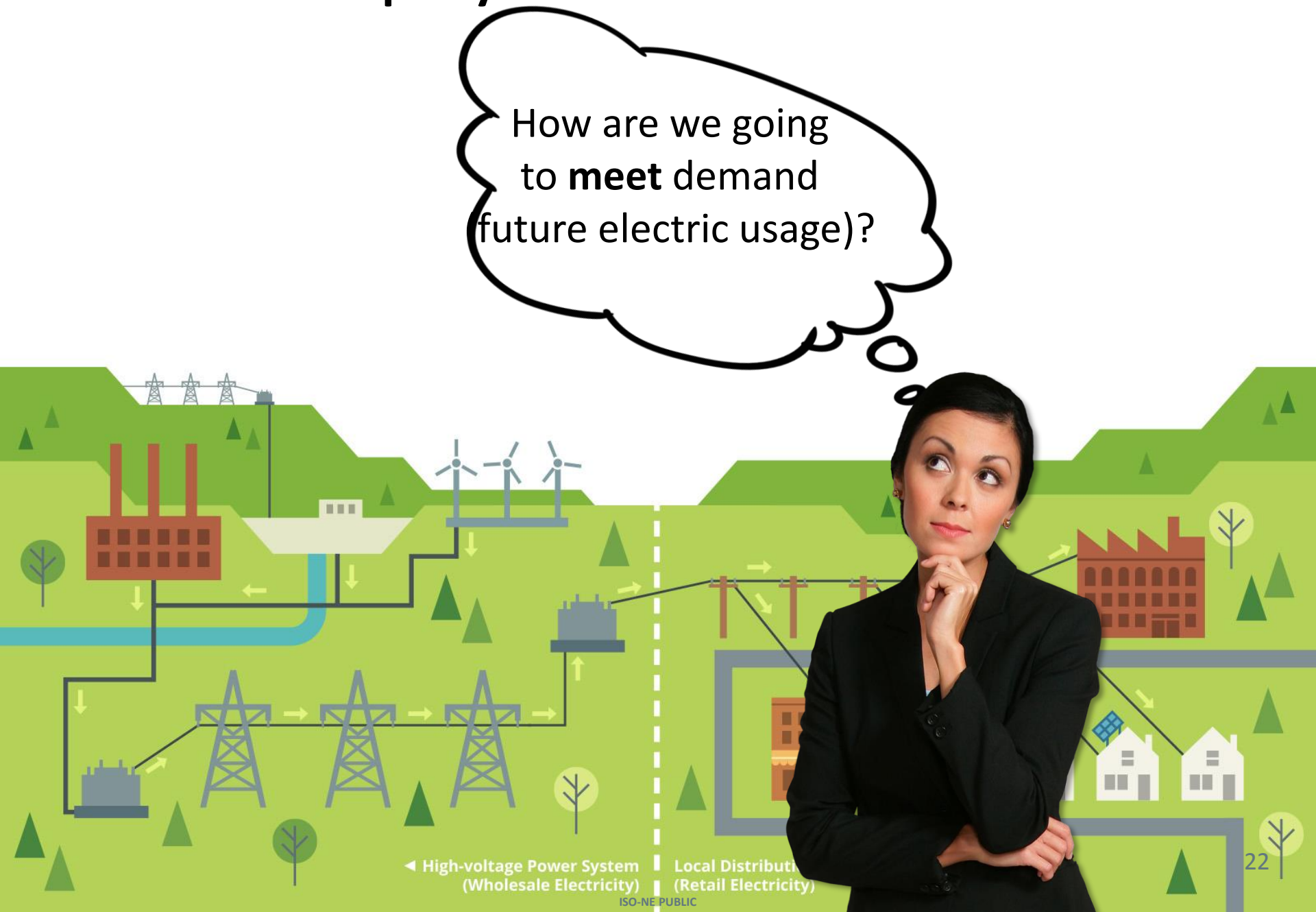
- Economic activity and outlook
- Weather and load patterns
- Residential, industrial, and commercial demand
- Historical and projected energy efficiency
- Distributed generation, especially photovoltaics
- Pending or proposed legislation, regulation, and standards



Demand reductions are taken into consideration

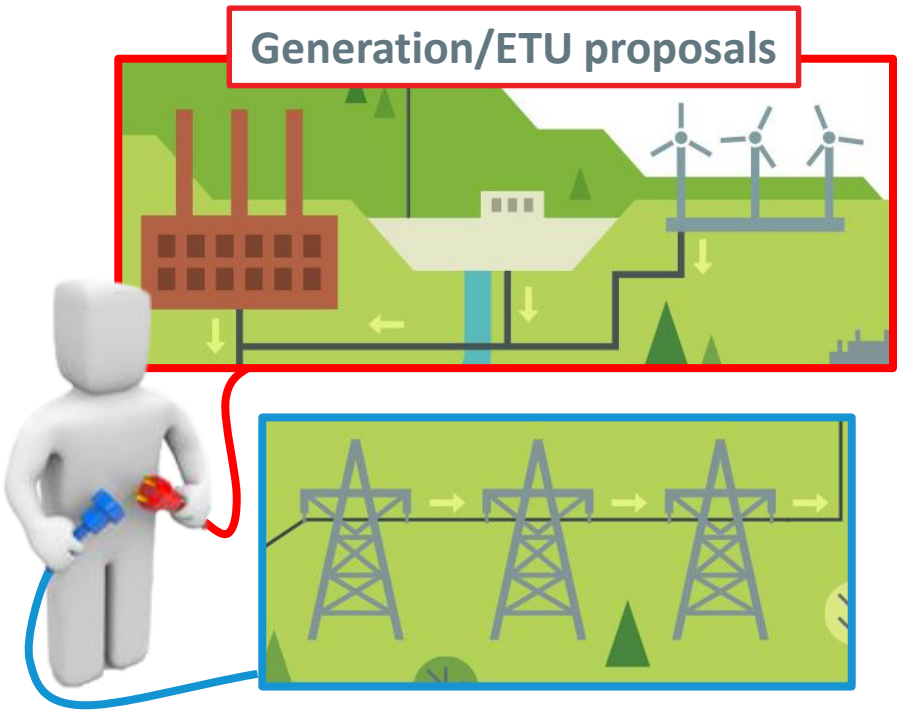
- Energy-efficiency (EE) forecast
  - Projected demand response resources associated with energy efficiency measures
- Distributed generation (DG) forecast
  - Generally less than five MW resources, not visible to ISO directly

Resource Adequacy



Connecting Resources to the Power System

ISO administers FERC generator interconnection process

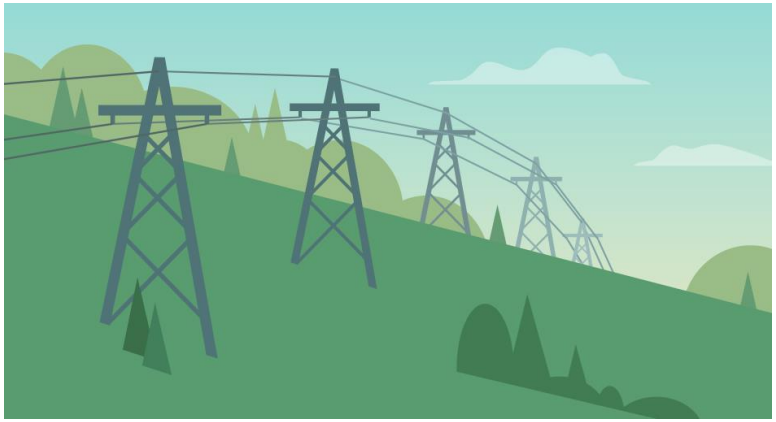


- **Proposals are:**
  - Maintained in interconnection queue
  - Subject to ISO reliability review
  - Studied in order received
- **End result is a three-party interconnection agreement among:**
  - ISO New England
  - Generator/Elective Transmission Upgrade (ETU) project sponsor
  - Interconnecting transmission owner

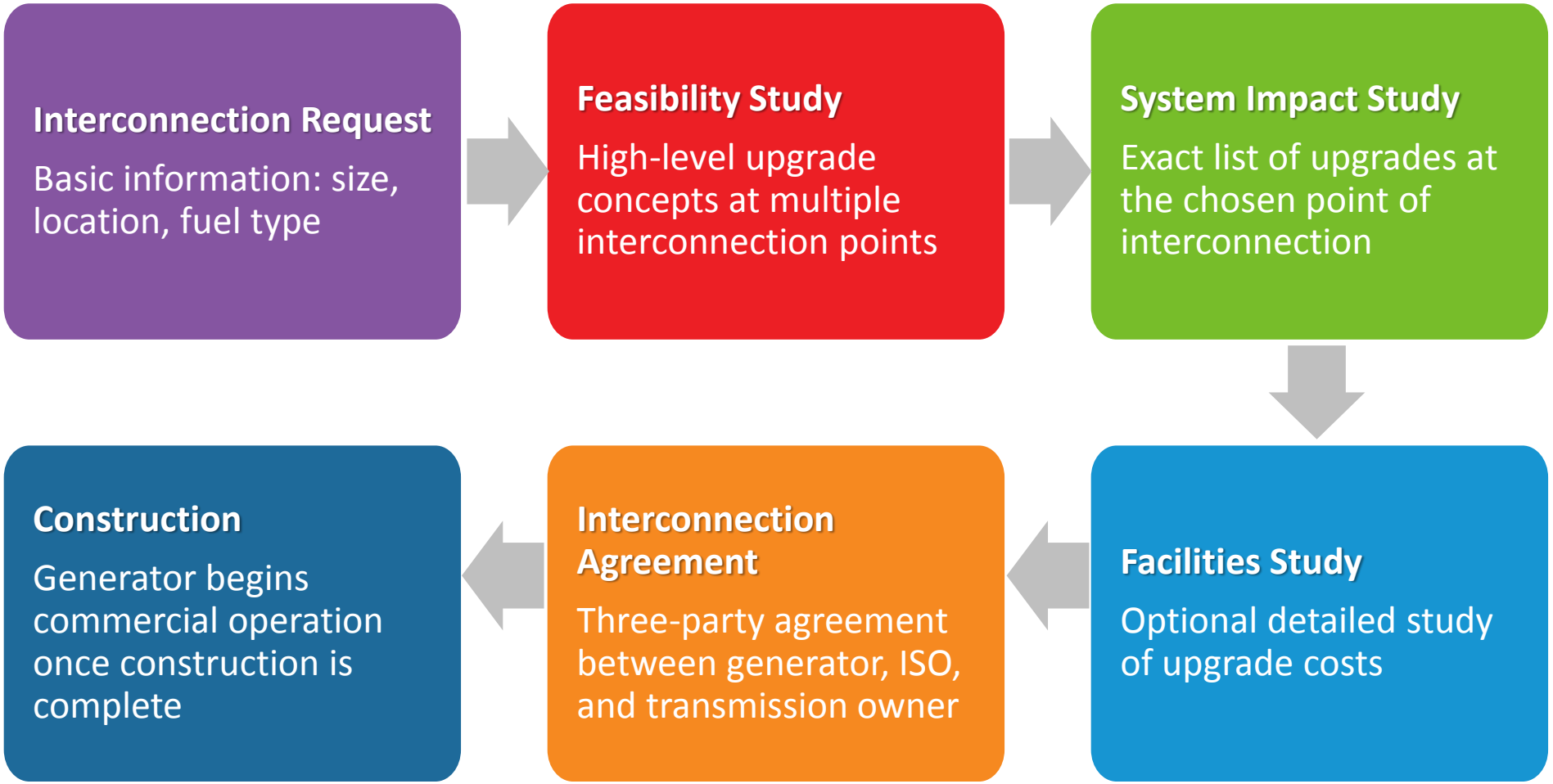
Elective Transmission Proposals

Elective Transmission Upgrade (ETU)

- **Upgrade or interconnection** to PTF of New England transmission system
- Voluntarily funded by entity or entities that agreed to pay for all upgrade costs
- Not identified as needed for reliability but studied by ISO to ensure they can interconnect reliably



Interconnection Process – Basic Flow



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

Forward Capacity Market (FCM)

- Resource types that can participate – generators, demand resources, imports and imports coupled with an ETU
- Procure enough capacity to meet New England's forecasted installed capacity requirement or demand three years in advance
- Provide compensation for capacity cost of generation, import, or demand resource
- Attract new resources to constrained regions
- Every resource that participates in FCM needs to be qualified

For more information, go to Markets and Operations > Markets Data and Information > Forward Capacity Market > FCM Participation Guide

Resource Paths to Commercial Operation

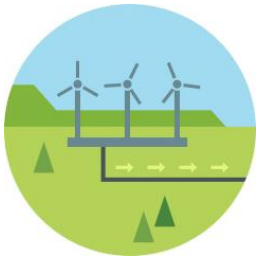
FERC Jurisdictional
Interconnection process is ISO's responsibility

Generator Interconnection Process
- Defined and disciplined
- Clear timelines/milestones
- Average study ~15 months

Forward Capacity Market (FCM)
- Optional participation
- Different timelines/milestones ~40 months

State Interconnection Process
- Each state process is different
- More flexibility in timelines
- Study times vary

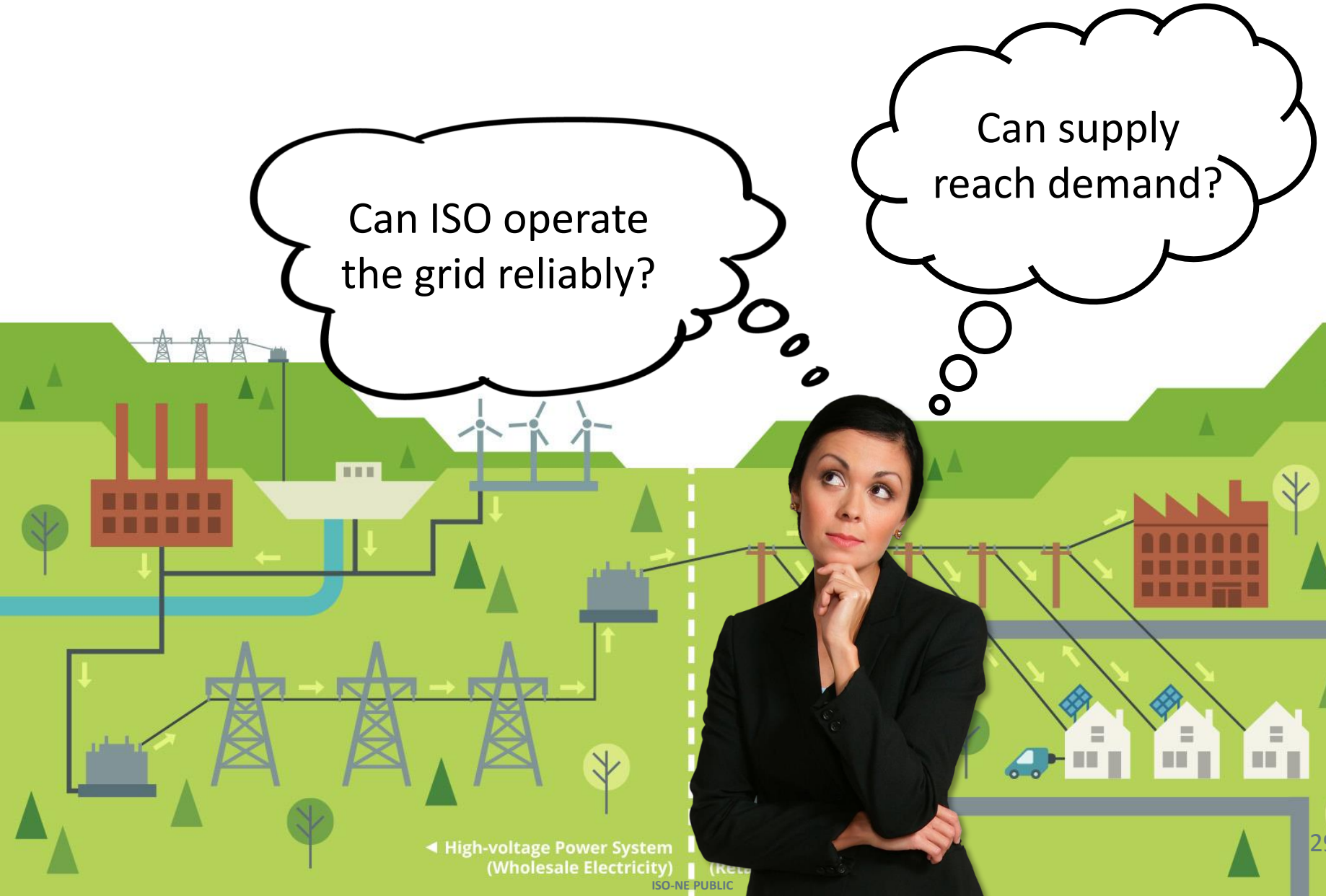
Proposed Project



Commercial Operation

Non-FERC Jurisdictional
Interconnection process is transmission owner's responsibility

Transmission Planning



Regional Transmission Planning

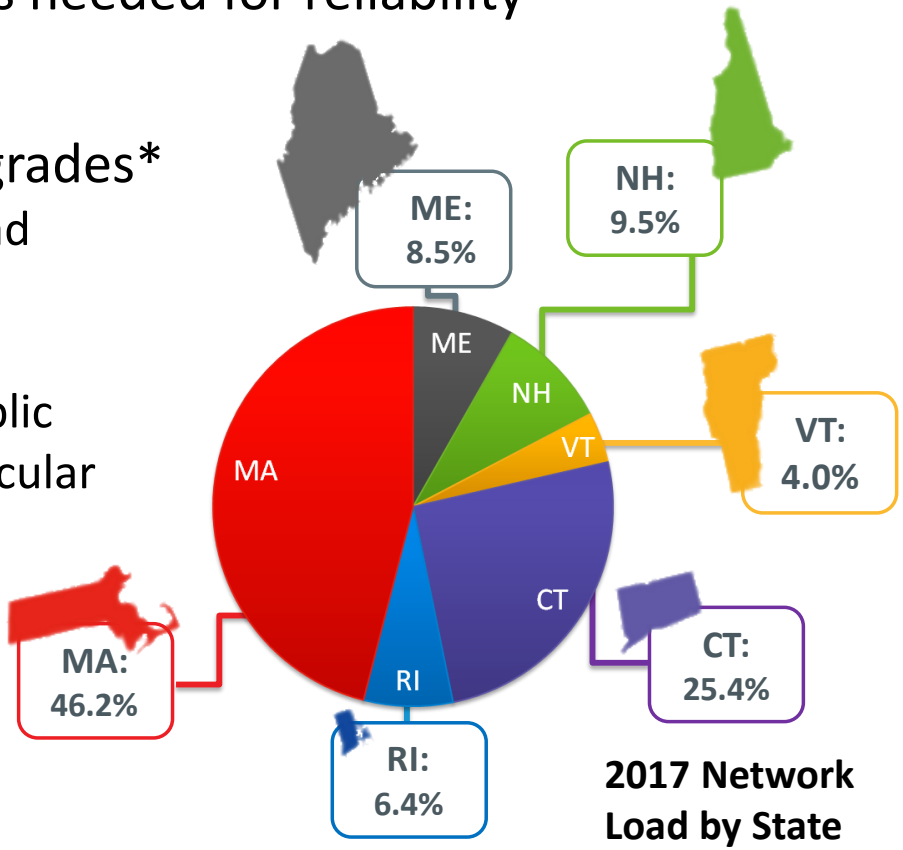
- ISO New England is responsible for planning the regional transmission system over the ten-year planning horizon
  - Summarized in Regional System Plan
  - Stakeholder engagement through Planning Advisory Committee
- ISO New England can select new projects to address three categories of transmission system needs:
  - **Reliability** projects: maintaining the ability to deliver bulk power considering load growth, generator retirements, and other future changes
  - **Market Efficiency** projects: reducing energy costs by increasing the ability to obtain power from cheaper sources
  - **Public Policy** projects: expanding the transmission system as needed for the successful implementation of public policy

Introduction to Transmission Planning

3 minute video

How Are Transmission Costs Allocated?

- Each state shares benefits of reliability and market efficiency upgrades
- Electricity demand in an area determines its share of cost of new or upgraded transmission facilities needed for reliability or market efficiency
- For public policy transmission upgrades*
  - 70% of the cost upgrades are spread throughout region
  - 30% of costs are allocated on load ratio basis among states with a public policy planning need that the particular project addresses

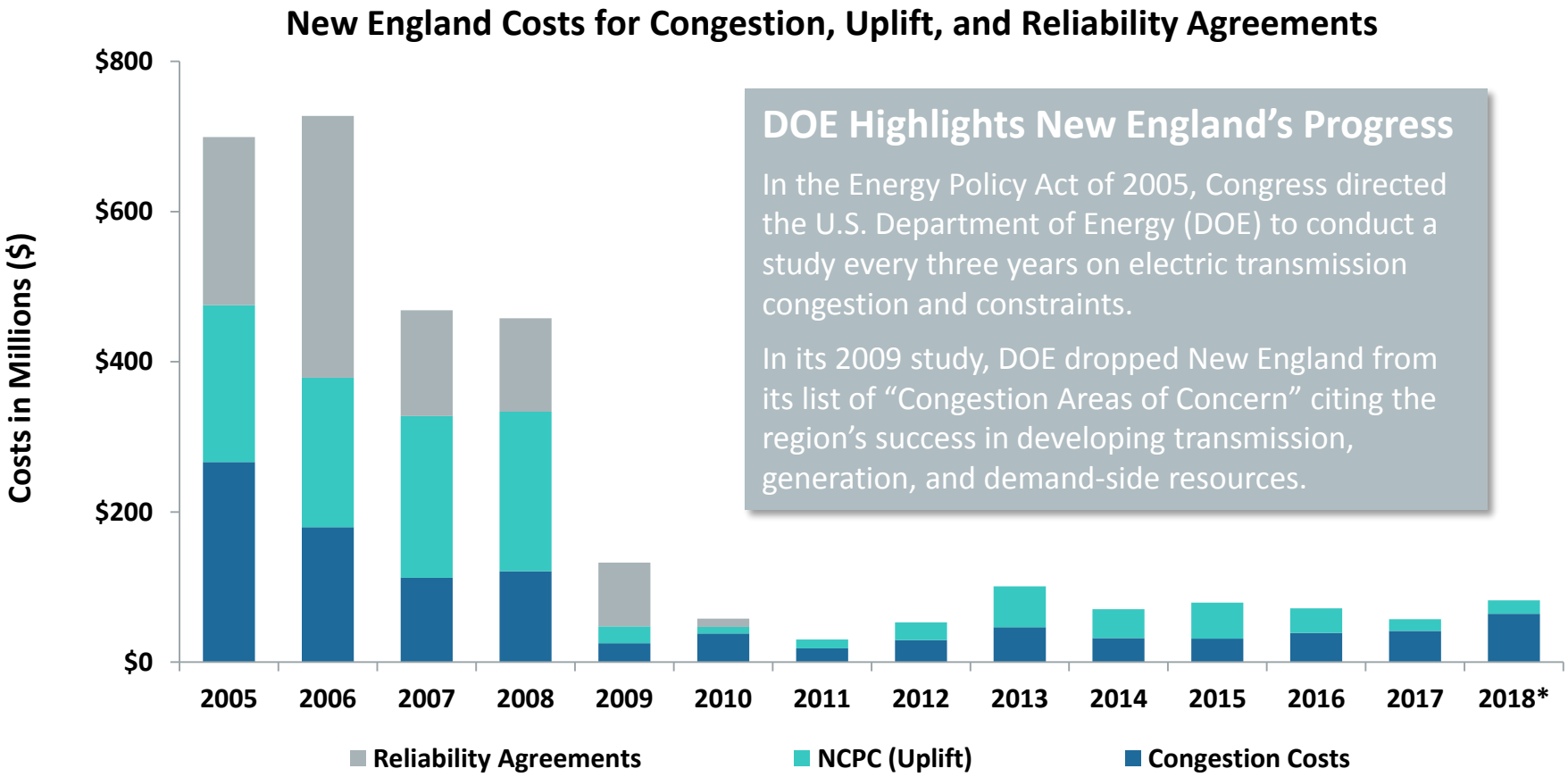


2017 Network Load by State

**Reflective of changes under FERC Order No. 1000*

Transmission Provides Benefits Beyond Reliability

Transmission and Resource Developments Have Reduced Energy and Reliability Costs



DOE Highlights New England's Progress

In the Energy Policy Act of 2005, Congress directed the U.S. Department of Energy (DOE) to conduct a study every three years on electric transmission congestion and constraints.

In its 2009 study, DOE dropped New England from its list of "Congestion Areas of Concern" citing the region's success in developing transmission, generation, and demand-side resources.

Note: Congestion is a condition that arises on the transmission system when one or more restrictions prevents the economic dispatch of electric energy from serving load. Net Commitment-Period Compensation is a payment to an eligible resource that operated out of merit and did not fully recover its costs in the energy market. Reliability Agreements are special reliability contracts between the ISO and an approved generator whereby the generator continues to operate, even when it is not economical to do so, to ensure transmission system reliability. Sources: Regional System Plans, ISO-NE Annual Markets Reports. *2018 data subject to adjustment.

Regional Plans Reflect State Initiatives

States are active in regional planning process and establish their own priorities and planning objectives

- New England states have many goals related to energy and the environment
  - Conservation and load management programs
  - Financial incentives for certain types of resources, such as solar photovoltaic generation
  - Renewable portfolio standards
  - Regional cap-and-trade program to control greenhouse gas emissions
- State efforts coordinated by the New England States Committee on Electricity (NESCOE)
- ISO-NE's planning accommodates and coordinates with these goals
  - Energy Efficiency and Distributed Generation forecasts
  - Public Policy Transmission Upgrades
  - Integrating Sponsored Policy Resources into FCM

ISO New England seeks input on assumptions and presents study results at the Planning Advisory Committee (PAC), open to all interested stakeholders

Questions

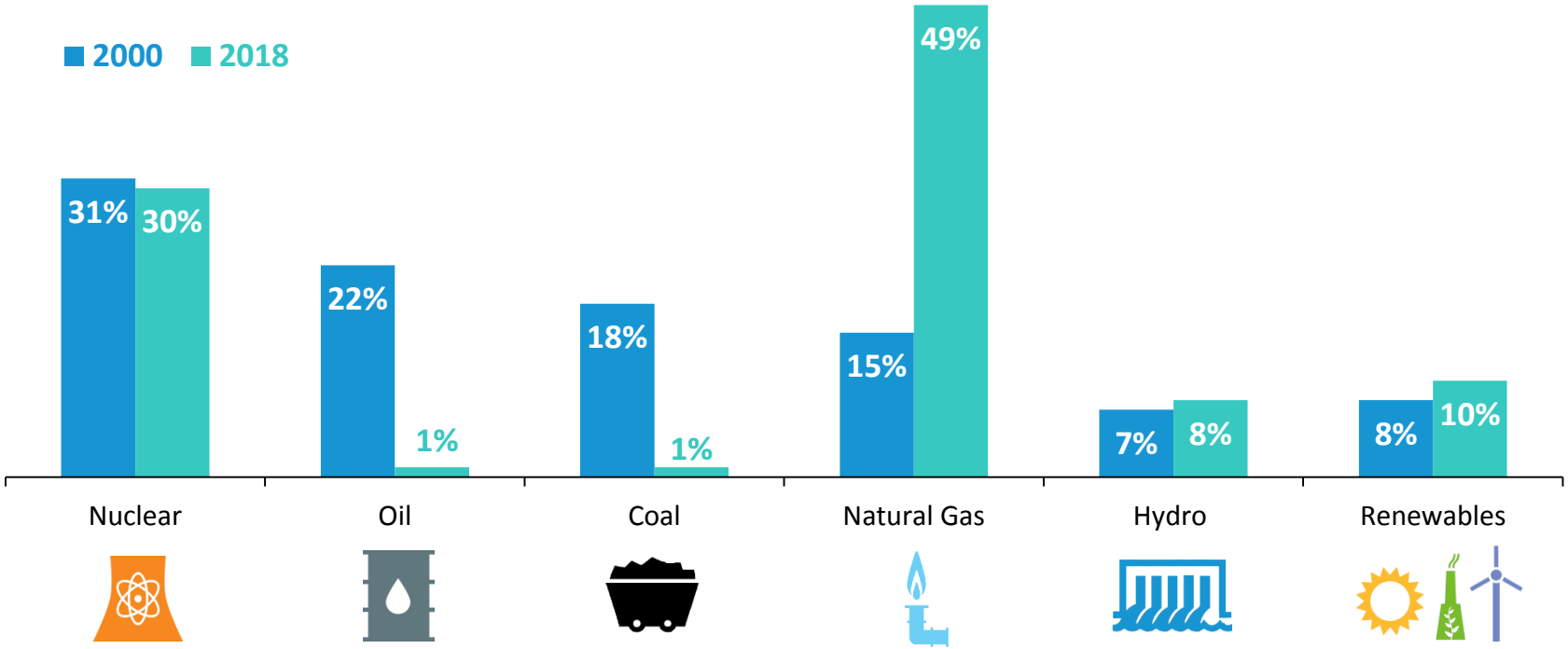
REGIONAL UPDATE

Kerry Schlichting, External Affairs

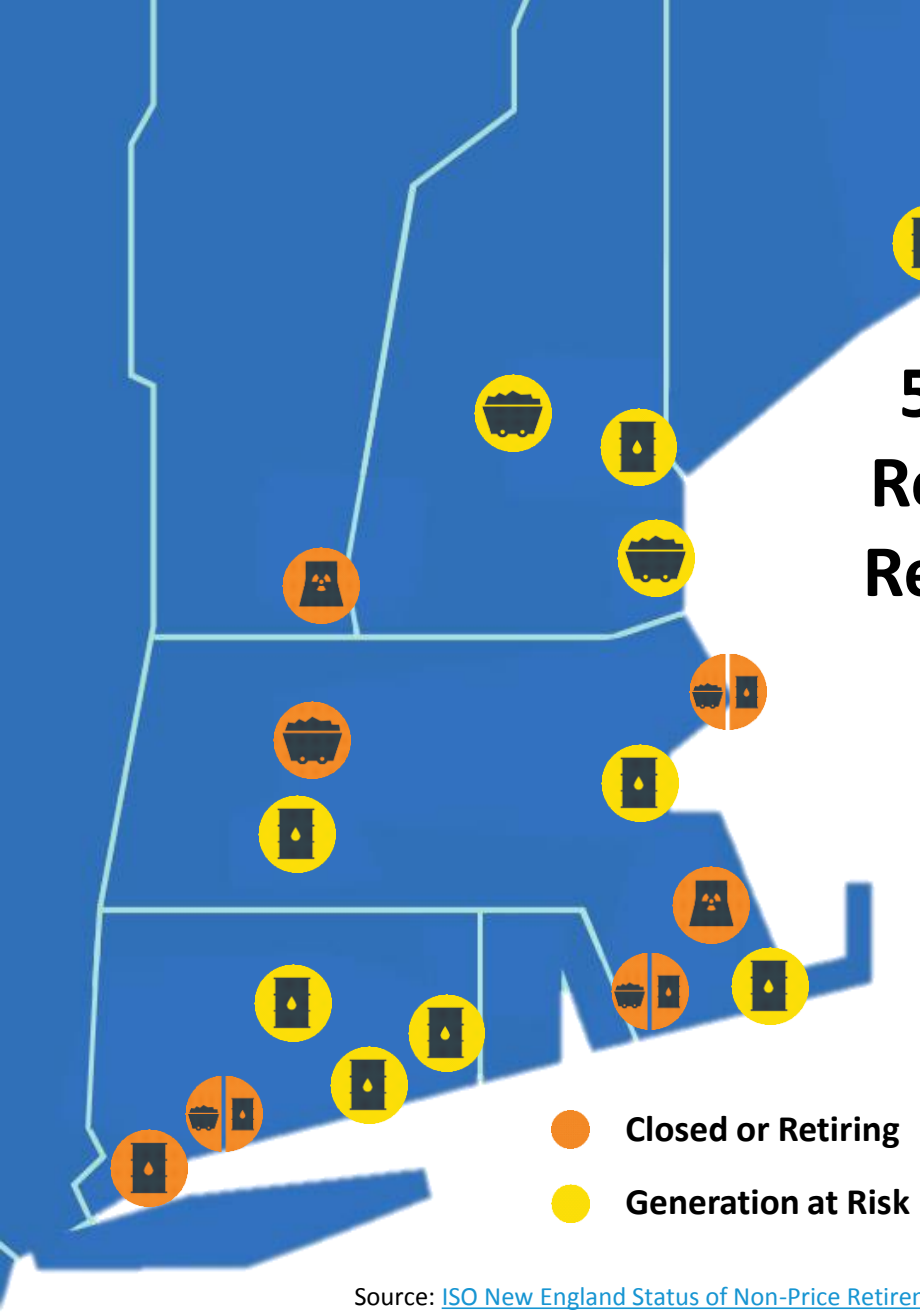
Dramatic Changes in the Energy Mix

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. 2018)



Source: ISO New England Net Energy and Peak Load by Source
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.

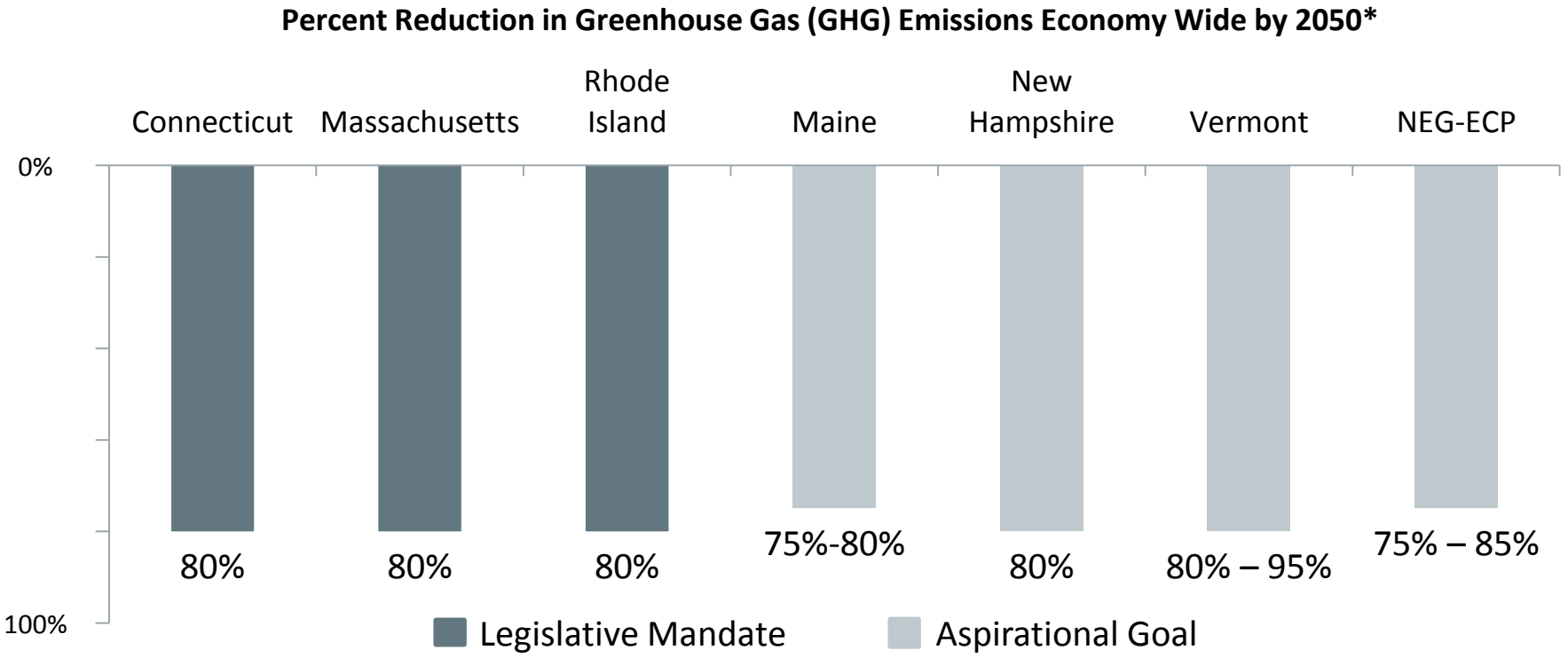


Since 2013, More Than 5,200 MW of Generation Have Retired or Announced Plans for Retirement in the Coming Years

- 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 supply is constrained in New England

Source: ISO New England Status of Non-Price Retirement Requests and Retirement De-list Bids; August 17, 2018

States Have Set Goals for Reductions in Greenhouse Gas Emissions: *Some Mandated, Some Aspirational*



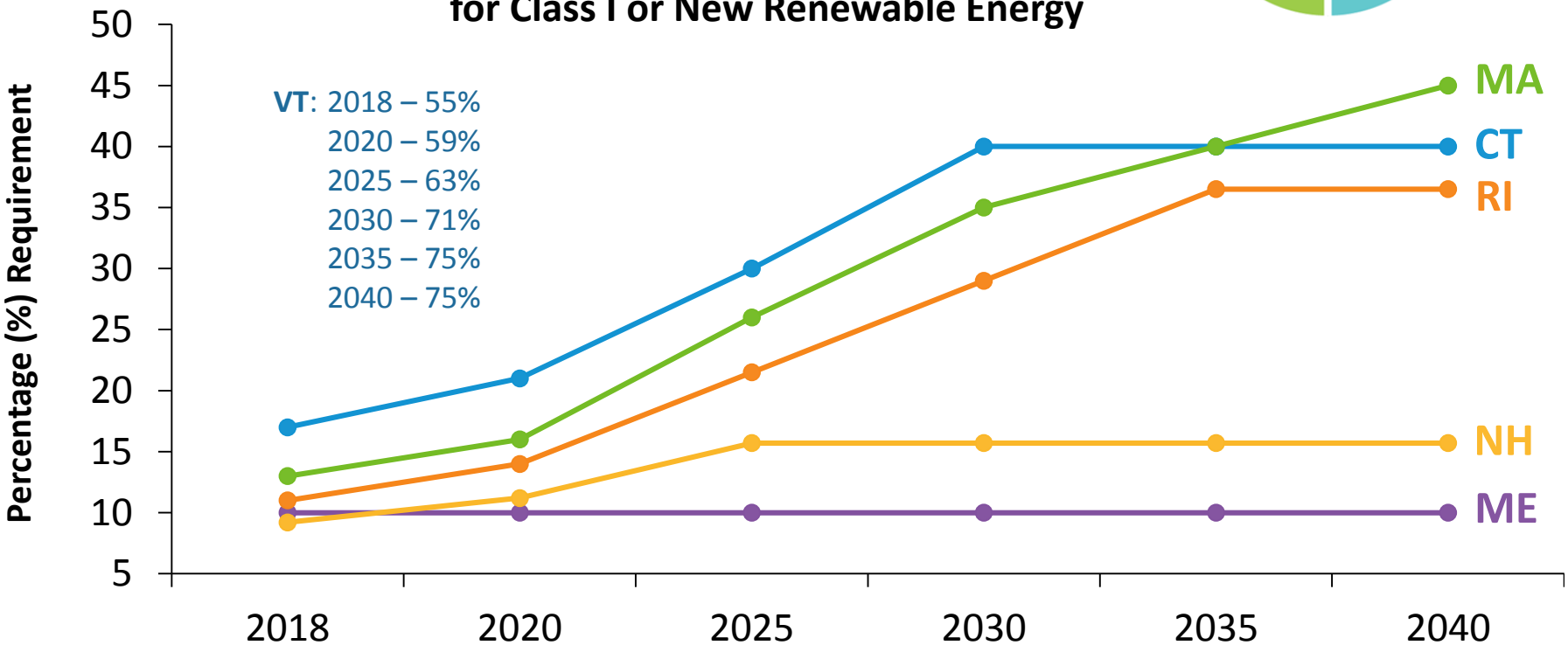
The New England states are promoting GHG reductions on a state-by-state basis, and at the regional level, through a combination of legislative mandates (e.g., CT, MA, RI) and aspirational, non-binding goals (e.g., ME, NH, VT and the New England Governors and Eastern Canadian Premiers).

* MA, RI, NH, and VT use a 1990 baseline year for emissions reductions. CT and the NEG-ECP use a 2001 baseline. ME specifies reductions below 2003 levels that *may* be required "in the long term." For more information, see the following ISO Newswire article: http://isonewswire.com/updates/2017/3/1/the-new-england-states-have-an-ongoing-framework-for-reducin.html.

Renewable Energy Is on the Rise

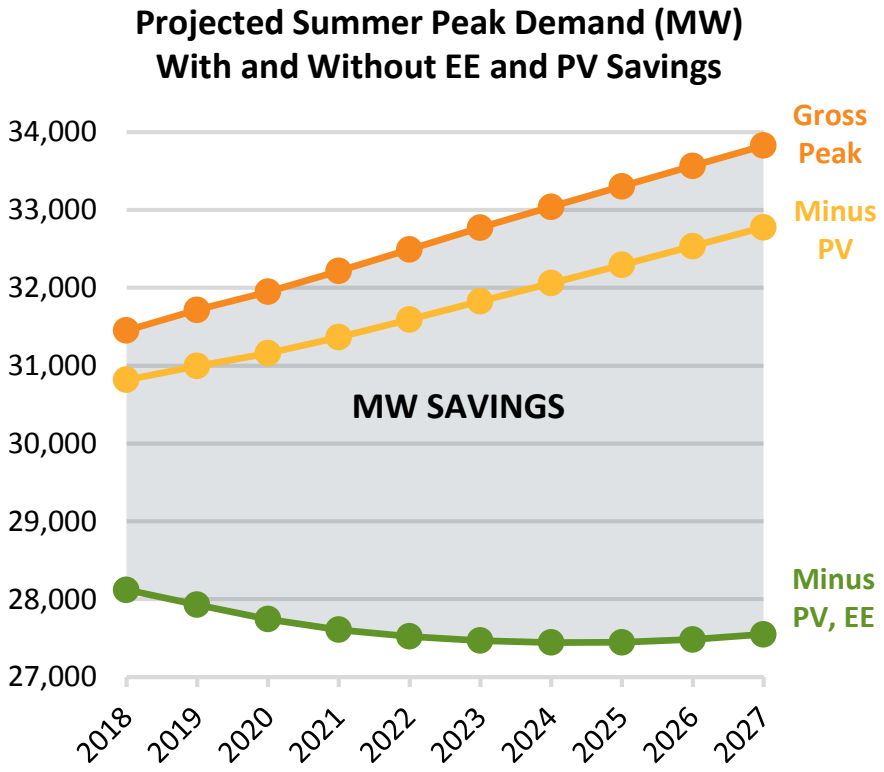
State policy requirements are a major driver

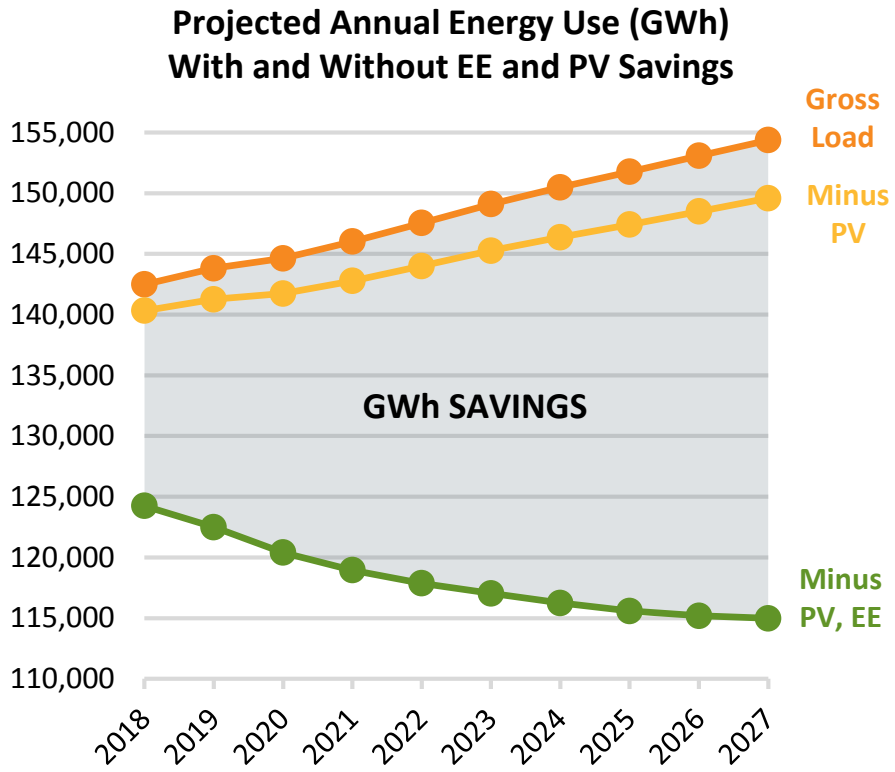
State Renewable Portfolio Standard (RPS)* for Class I or New Renewable Energy



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 RPS requirement plateaued at 10% in 2017 and is set to expire in 2022 (but has been held constant for illustrative purposes). 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.

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





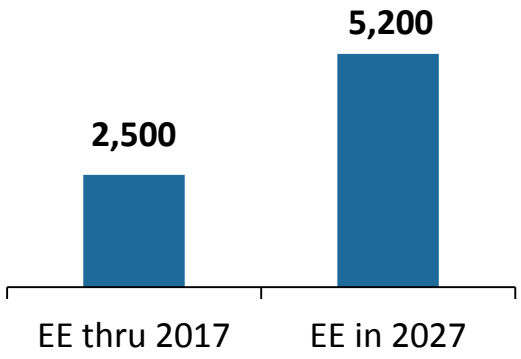
- The gross peak and load forecast
- The gross peak and load forecast minus existing and anticipated "behind-the-meter" (BTM) solar PV resources
- The gross peak and load forecast minus existing and anticipated BTM solar PV and energy efficiency

Note: Summer peak demand is based on the "90/10" forecast, which accounts for the possibility of extreme summer weather (temperatures of about 94° F).
Source: ISO New England 2018-2027 Forecast Report of Capacity, Energy, Loads, and Transmission (2018 CELT Report) (May 2018)

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

Energy Efficiency

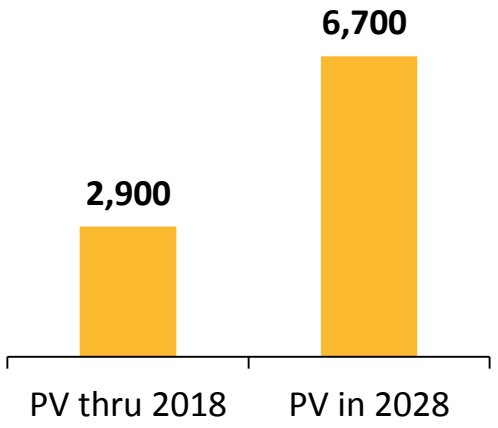
(MW)



Final 2018 CELT Report, EE through 2017 includes EE resources participating in the Forward Capacity Market (FCM). EE in 2027 includes an ISO-NE forecast of incremental EE beyond the FCM.

Solar

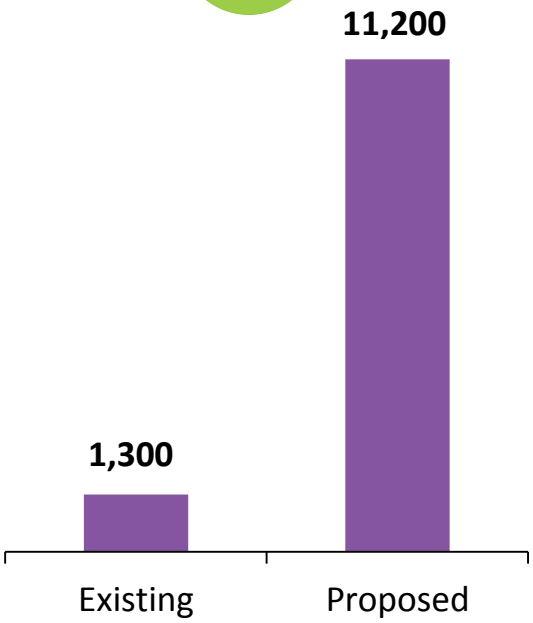
(MW)



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

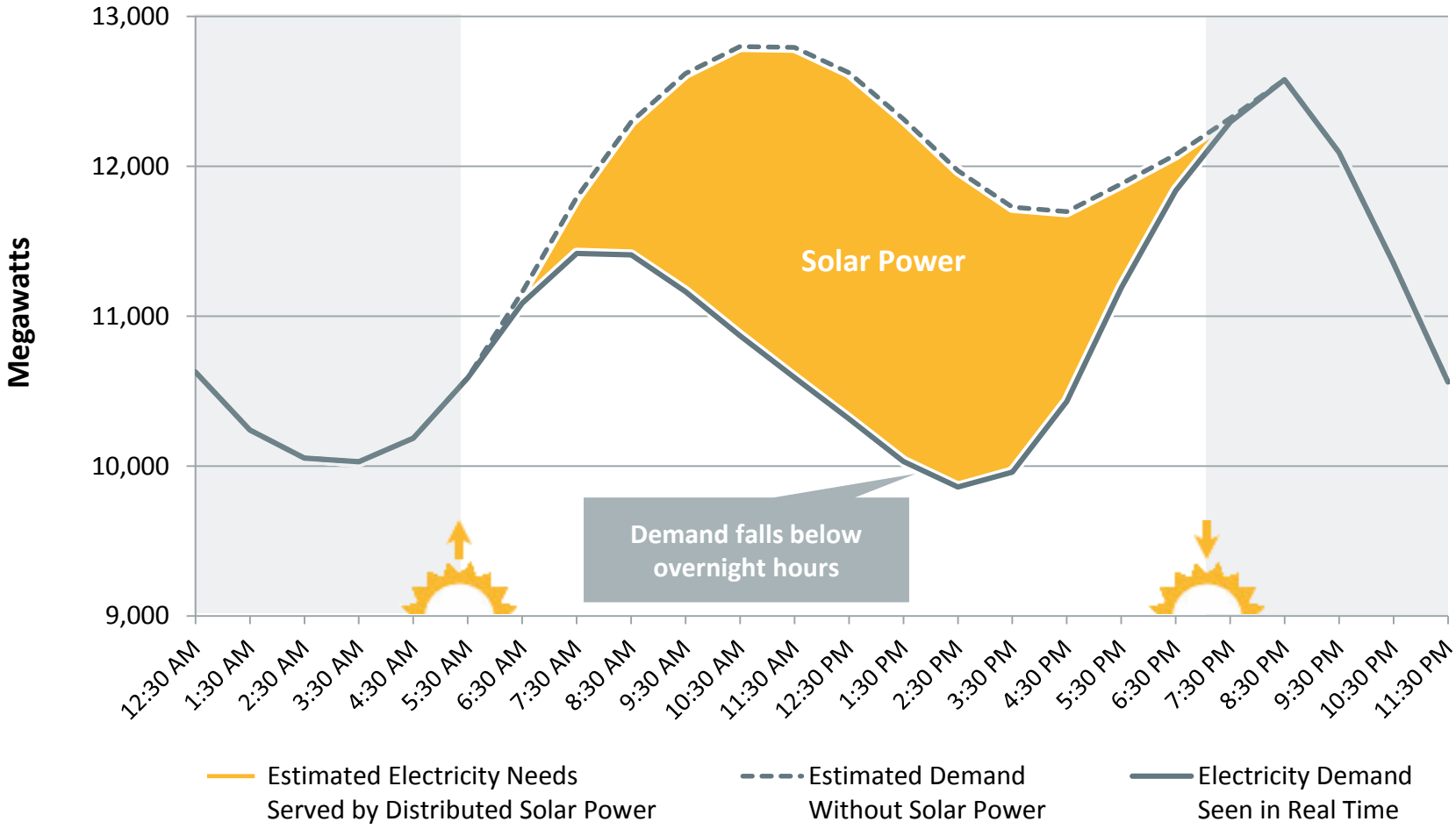
(MW)



Nameplate capacity of existing wind resources and proposals in the ISO-NE Generator Interconnection Queue; some wind proposals include battery storage.

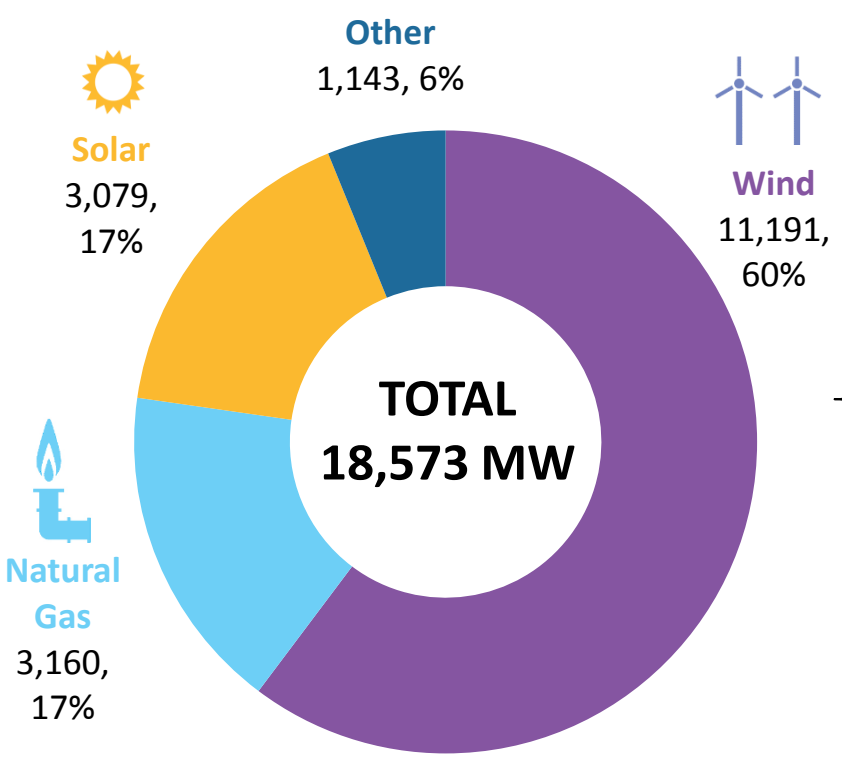
Historic Dip in Midday Demand with Record-High Solar Power Output on April 21, 2018

At 1:30 p.m., behind-the-meter solar reduced grid demand by more than 2,300 MW



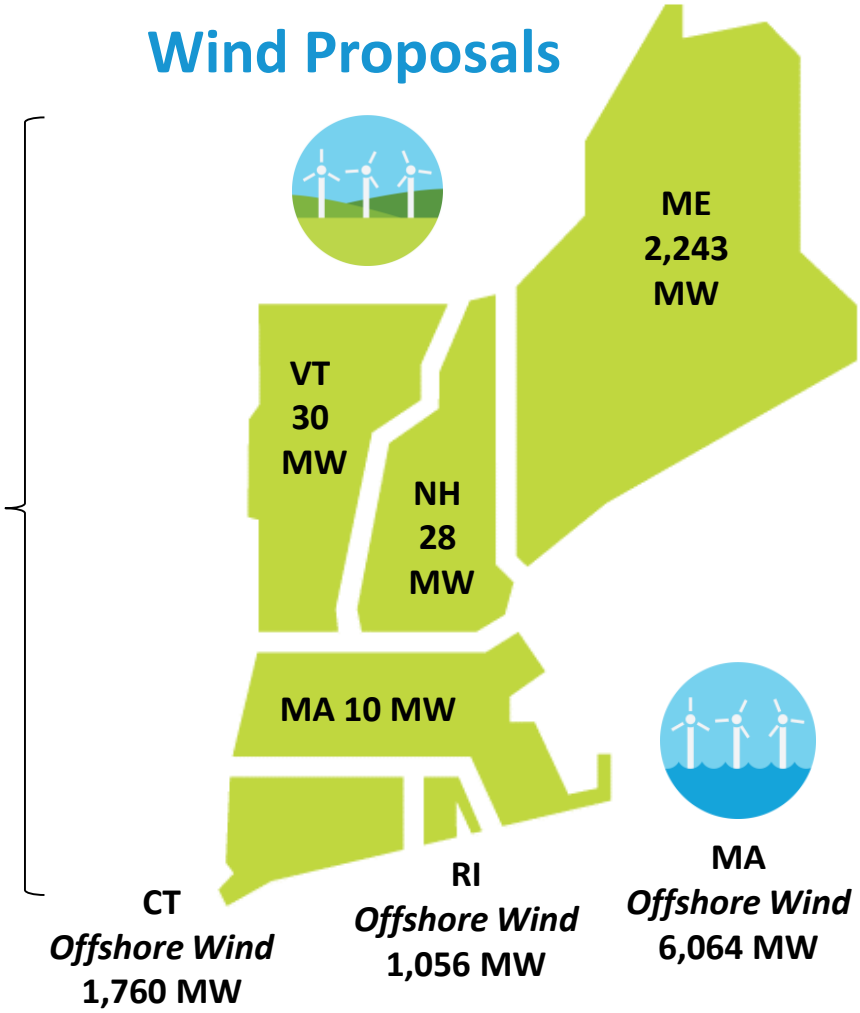
Wind Power Comprises Nearly Two Thirds of New Resource Proposals in the ISO Interconnection Queue

All Proposed Generation



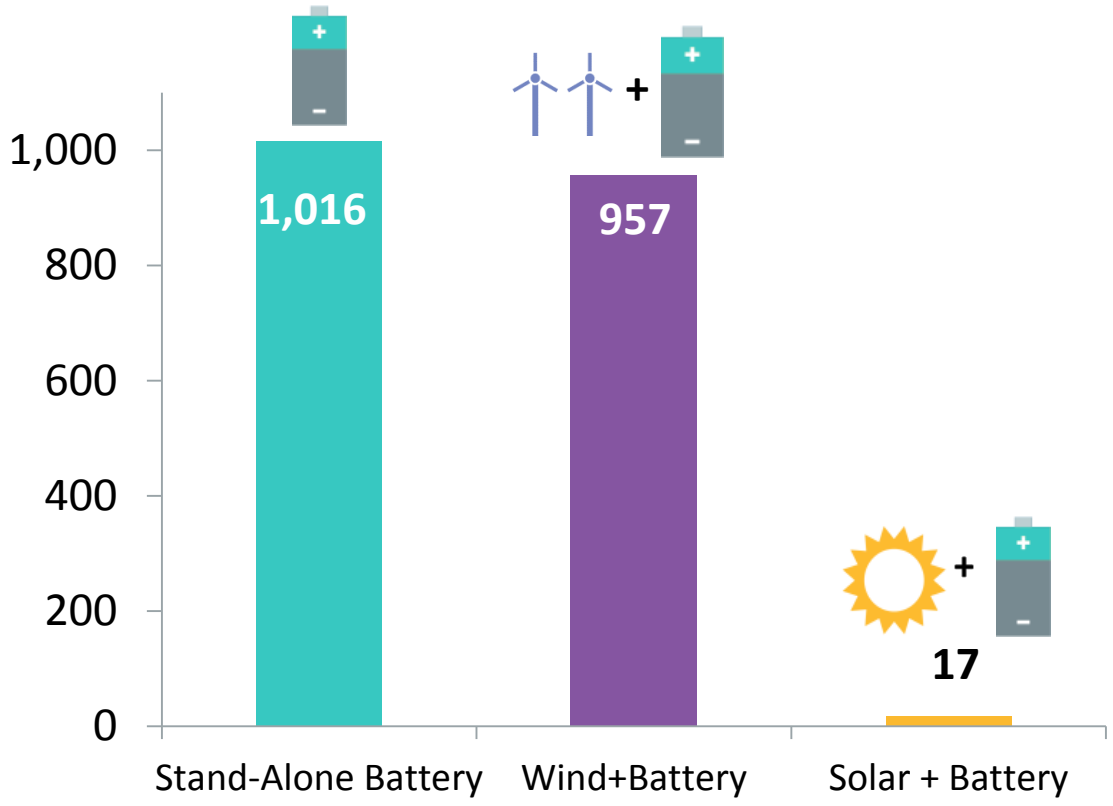
Source: ISO Generator Interconnection Queue (March 2019)
FERC and Non-FERC Jurisdictional Proposals; Nameplate Capacity Ratings
Note: Some natural gas proposals include dual-fuel units (with oil backup) and battery storage. Some wind and solar proposals include battery storage.

Wind Proposals



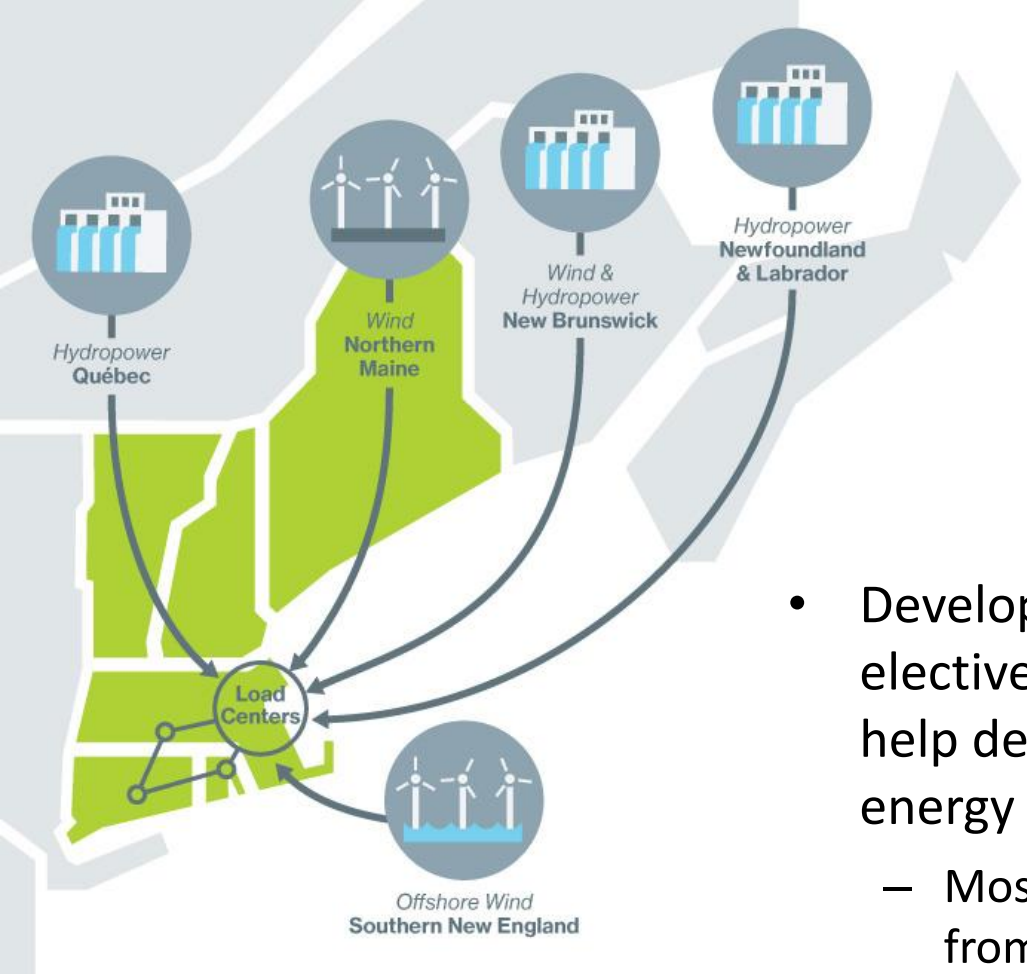
Stand-Alone and Paired Battery Storage Requests Are Emerging in Sizeable Quantities in the ISO Interconnection Queue

Battery Storage Proposals (Stand-Alone and Paired with Renewables)



- Since the 1970s, the predominant grid-scale energy storage has come in the form of **pumped-storage hydro**
- From 2008 through 2015, a **flywheel system** provided regulation service in a pilot program
- Since 2017, two grid-scale battery storage resources have been installed in the region

Source: ISO Generator Interconnection Queue (March 2019)



Map is representative of the types of projects announced for the region in recent years

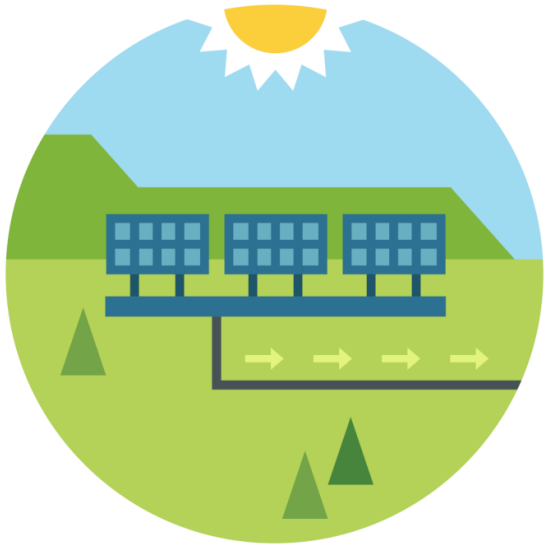
Developers Are Proposing Large-Scale Transmission Projects to Help Deliver Clean Energy to Load Centers

- Developers are proposing more than **15** elective transmission upgrades (ETUs) to help deliver nearly **13,000 MW** of clean energy to New England load centers
  - Mostly Canadian hydro and onshore wind from northern New England
- Wind projects make up roughly **60%** of new resource proposals in the ISO Generator Interconnection Queue, but many are remote

Source: ISO Interconnection Queue (March 2019)

The ISO Is Leading Efforts to Account for Solar Resources Connected to the Distribution System

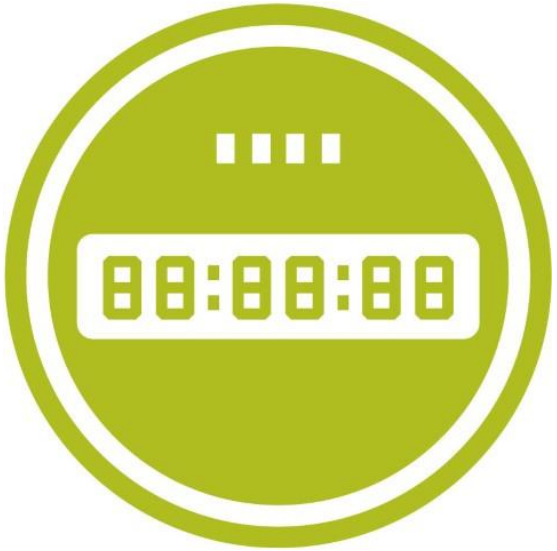
- **Forecasting Long-Term Solar Growth**
  - The ISO tracks historical growth and predicts levels of solar development 10 years into the future
  - The solar forecast is used in transmission planning and market needs assessments
- **Forecasting Short-Term Solar Performance**
  - The ISO creates daily forecasts of solar generation production to improve daily load forecasts and situational awareness for grid operators
- **Improving Interconnection Rules**
  - The ISO is engaged with industry stakeholders to strengthen interconnection standards and reduce reliability concerns



The ISO Is Improving the Ability of Intermittent Resources to Participate in the Wholesale Markets

- **Flexibility to Offer Negative Prices**
  - Allows generators, like wind, the opportunity to operate during low-load conditions when they otherwise might be curtailed
- **Updated Elective Transmission Upgrade (ETU) Rules**
  - Improve the interconnection study process for ETUs and ensure these resources are able to deliver capacity and energy into the wholesale electricity markets
- **Flexibility to Operate Up to a Certain Level**
  - Allows the ISO to better manage transmission congestion in a way that will maximize the use of low-cost renewable resources and alleviate the need for curtailments
  - Known as “Do-not-Exceed Dispatch Order”

The Forward Capacity Market Is Attracting New Resources Amid Retirements

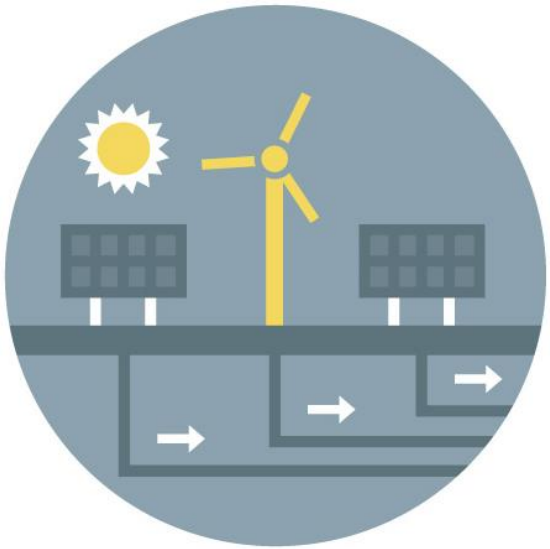


Demand Resources

energy-efficiency and active demand response resources

Natural Gas Resources

efficient and fast-starting gas resources, many with dual-fuel capability



Renewable Resources

onshore and offshore wind, solar photovoltaics, and fuel cells

FCA #13 Featured the First Substitution Auction for Sponsored Policy Resources

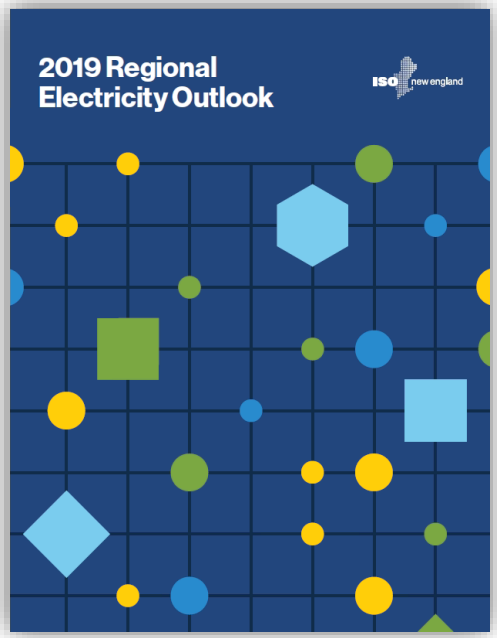
- The first *Competitive Auctions with Sponsored Policy Resources* (CASPR) **substitution auction** was held in conjunction with FCA #13 for state-sponsored resources seeking commitments in the 2022-2023 timeframe
- The CASPR design is intended to:
  - **Accommodate** sponsored policy resources into the Forward Capacity Market over time, and
  - **Preserve** competitively based capacity pricing for other resources

- The substitution auction closed with **Vineyard Wind**, an offshore wind project in development off the coast of Massachusetts, assuming an obligation of **54 MW** from an existing resource that will retire in 2022-2023

Conclusions

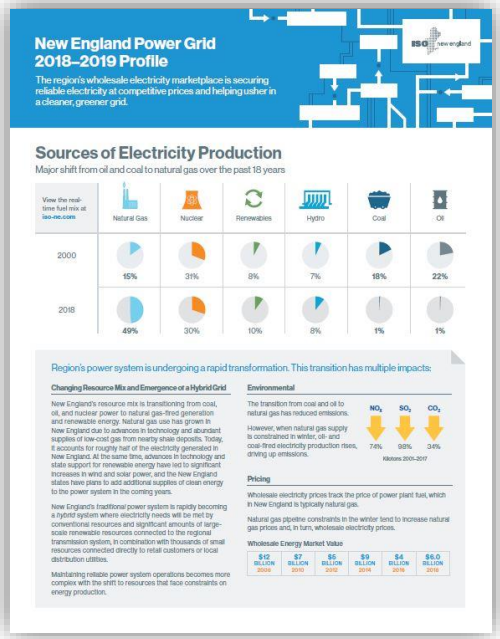
- New England's electric grid is rapidly changing and a hybrid grid is emerging
- The ISO is actively taking **renewable** and **distributed** resources into account through its **planning, operations, and markets** processes
- Storage and DERs can participate in the markets **today** and the ISO recently made **rule changes** to better integrate storage (and other technologies) into the markets
- The ISO is looking **at further enhancements** to better incorporate technologies into the markets and value reliability services
- The region will need **flexible resources and transmission** to help balance the quantities of new, renewable resources coming online

ISO New England Releases Several New Publications



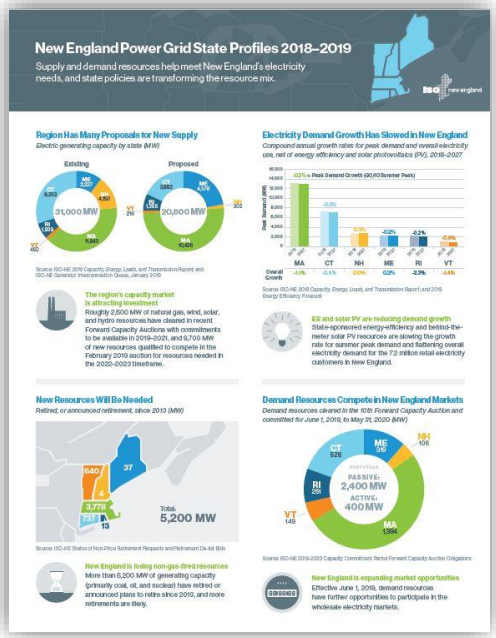
2019 Regional Electricity Outlook

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

Join Us for the June 20 Consumer Liaison Group Meeting in Westborough

- Consumer Liaison Group (CLG) meetings are:
  - A **forum** for sharing information between ISO New England and electricity consumers in the region
  - **Developed** by the CLG Coordinating Committee and **facilitated** by ISO New England
  - **Free** and **open** to the public

Join Us!

New England Consumer Liaison Group (CLG)

June 20, 2019

Noon — 3:30 p.m.

DoubleTree Westborough Hotel

5400 Computer Dr – Westborough, MA

P | 508.366.5511

The CLG is the consumers' voice in the electric industry.

Meetings are free and open to the public.

For more information on the CLG, please visit the CLG webpage.

Register

Questions? Contact Mary Louise "Weezie" Nuara:
413.540.4481 or mnuara@iso-ne.com

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

Energize Your Career: Intern at the ISO!

- Spend the summer working with industry experts on projects that matter.
- Apply what you've learned in school and develop marketable skills.
- Learn the nuts and bolts of the wholesale electric power industry.

Now hiring
Summer 2019
Interns! Apply now to start your career in the energy industry

FOR MORE INFORMATION…

Subscribe to the *ISO Newswire*

ISO Newswire is your source for regular news about ISO New England and the wholesale electricity industry within the six-state region

Log on to ISO Express

ISO Express provides real-time data on New England's wholesale electricity markets and power system operations

Follow the ISO on Twitter

@isonewengland

Follow the ISO on LinkedIn

@iso-new-england

Download the ISO to Go App

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

GET IT ON Google Play

Download on the App Store

Questions