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Forecasting Load on the Distribution System with Distributed Energy Resources

Distribution Systems and Planning Training for NECPUC

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VICE PRESIDENT, SYSTEM PLANNING

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

Grid Operation

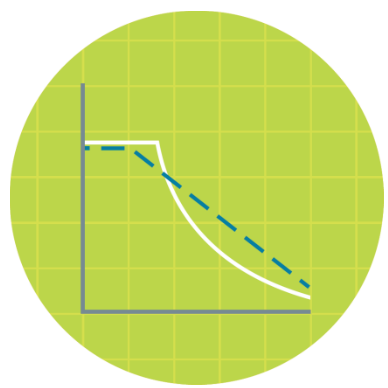
Coordinate and direct the flow of electricity over the region's high-voltage transmission system

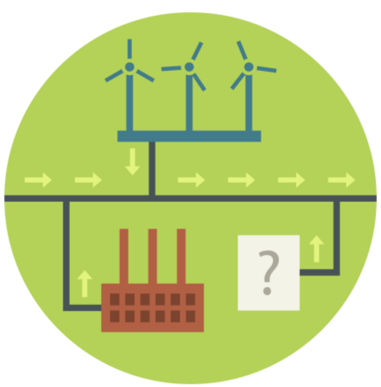
Market Administration

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





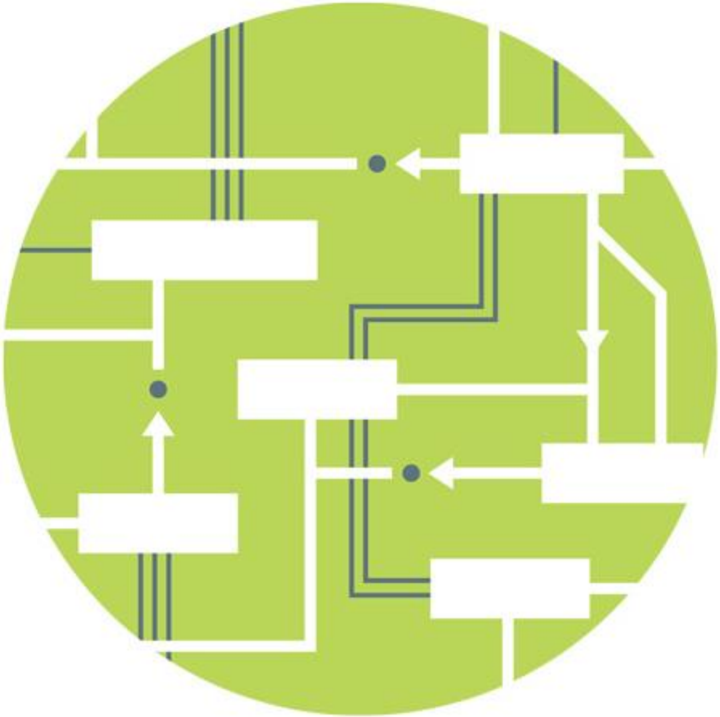
Energy Efficiency and Behind-the-Meter Solar Impact Peak Demand and Overall Electricity Use

- **7.1 million** retail electricity customers drive the demand for electricity in New England (14.7 million population)
- Region's all-time summer peak demand set on August 2, 2006 at **28,130 MW**
- Region's all-time winter peak demand set on January 15, 2004 at **22,818 MW**
- The annual growth rates for summer *peak* demand and *overall* electricity use are **0.1%** and **-0.6%**, respectively, when energy efficiency and behind-the-meter solar are factored into the forecast

Note: Without energy efficiency and solar, the region's peak demand is forecasted to grow 1% 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.

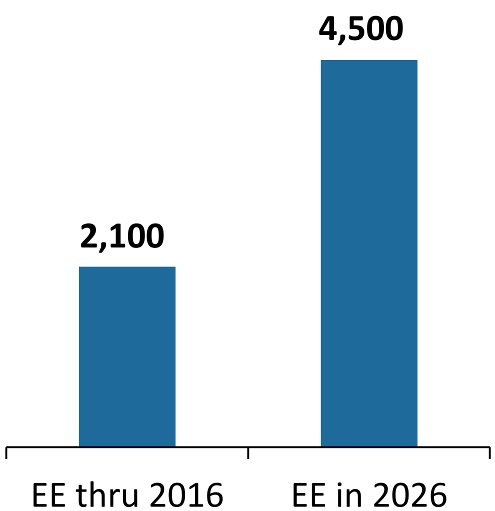
Managing Comprehensive Regional Power System Planning Is a Major Responsibility

- Manage regional power system planning in accordance with mandatory reliability standards
- Administer 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



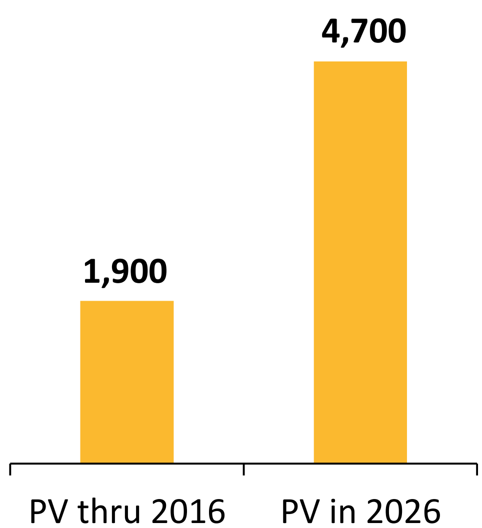
Energy-Efficiency and Renewable Resources Are Trending Up in New England

Energy Efficiency
(MW)



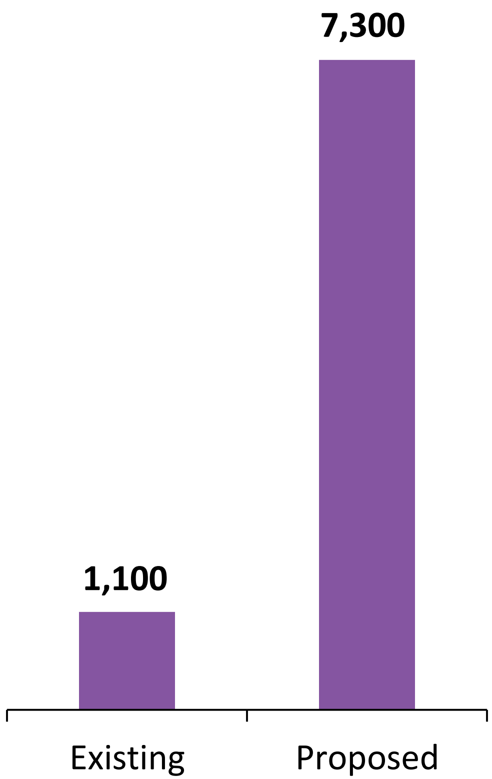
Final 2017 CELT Report, EE through 2016 includes EE resources participating in the Forward Capacity Market (FCM). EE in 2026 includes an ISO-NE forecast of incremental EE beyond the FCM.

Solar
(MW)



Final 2017 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."

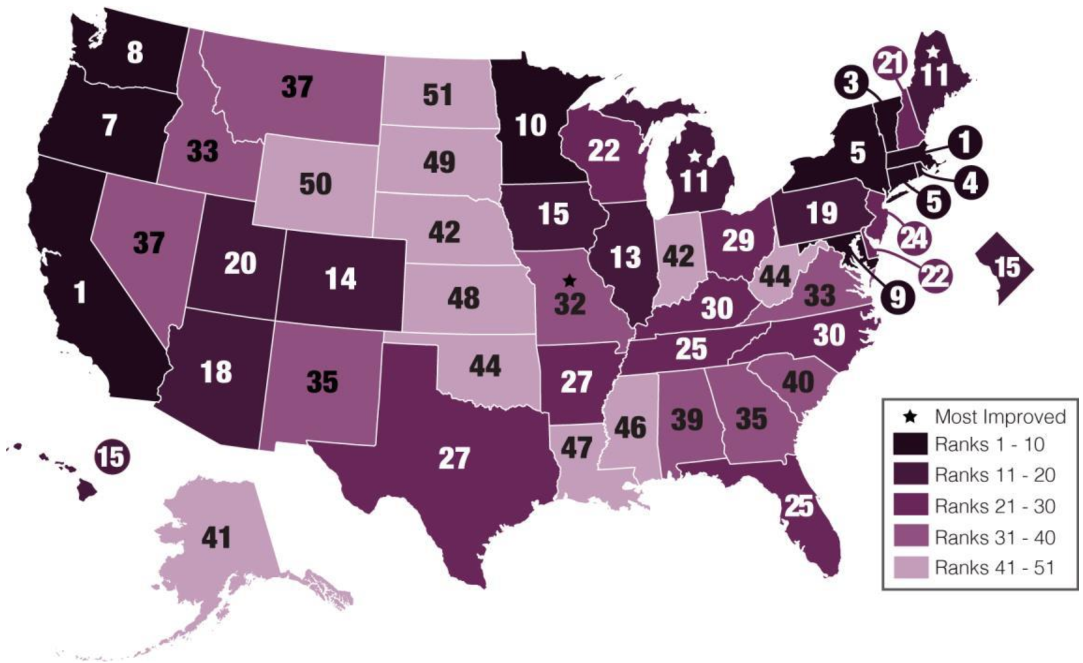
Wind
(MW)



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

Energy Efficiency Is a Priority for State Policymakers

2016 State Energy-Efficiency Scorecard



Source: American Council for an Energy-Efficient Economy

Ranking of state EE efforts by the *American Council for an Energy-Efficient Economy*:

– Massachusetts	1
– Vermont	3
– Rhode Island	4
– Connecticut	5
– Maine	11
– New Hampshire	21

- Billions spent over the past few years and more on the horizon
  - Nearly $4.5 billion invested from 2010 to 2015
  - ISO estimates $7.2 billion to be invested in EE from 2021 to 2026

Energy-Efficiency Forecast Origins

- Since 2012, the ISO has developed a state-by-state energy-efficiency (EE) forecast to project the long-term impacts of state-sponsored EE investments on New England's peak and overall demand for energy
- All forecast assumptions, data, and results are vetted through the Energy-Efficiency Forecast Working Group
- Each state has its own structure for planning and implementing EE programs, although all of the programs generally cover the residential, commercial, and industrial sectors
- Lighting and mixed-lighting measures constitute most of the savings in energy use and peak demand, and the commercial and industrial sectors provide a majority of the overall savings

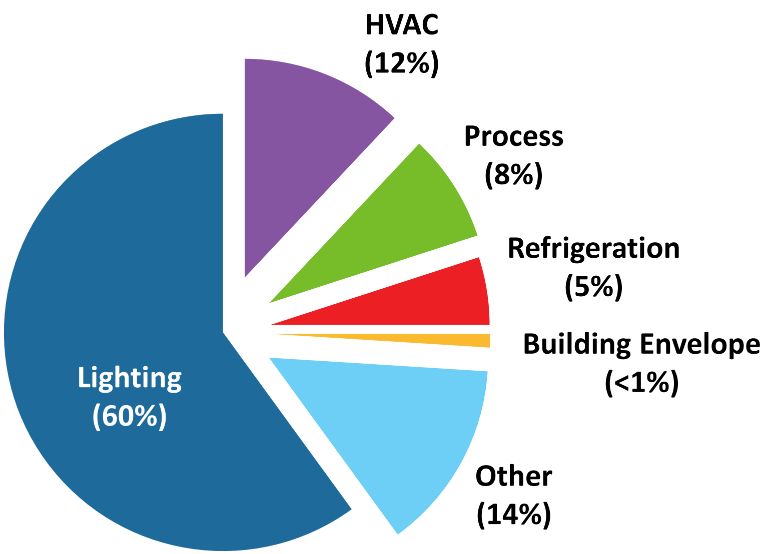
Energy-Efficiency Forecast Origins, cont.

- The savings in energy use resulting from EE programs result in demand reductions that can be bid into the Forward Capacity Market (FCM)
- The region's EE program administrators (PAs) typically bid their EE portfolios into this market
- Historical data on EE performance in the FCM provides the ISO with a solid understanding of the amount of EE available in the region in the one- to four-year future timeframe
- The EE forecast provides information about the amount of EE anticipated to be deployed over the five- to 10-year planning horizon beyond the current FCM forward obligations

Typical Energy Efficiency Measures

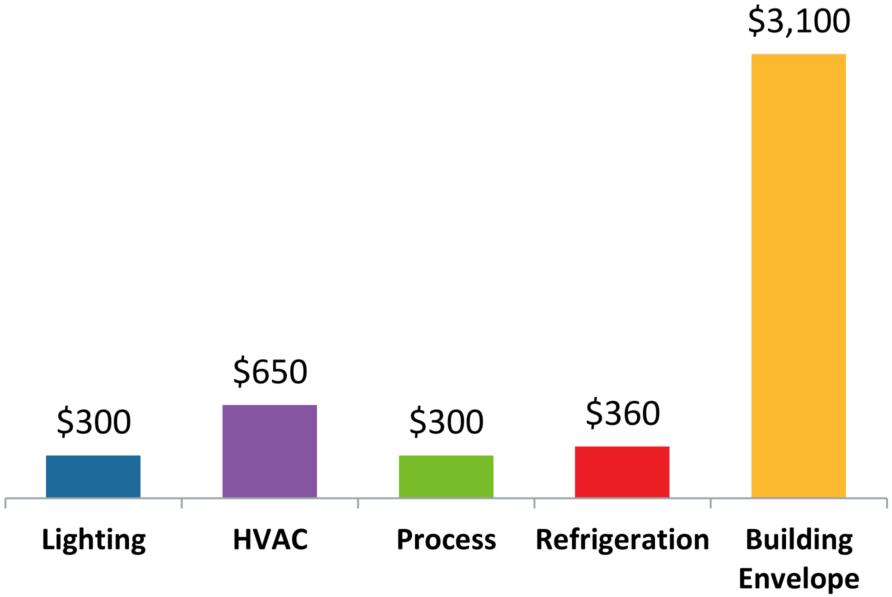
Energy Savings by Measure Type (%)

- Lighting currently accounts for the majority of regional energy savings
- In the next few years, savings from lighting are expected to decline



Production Costs ($/MWh)

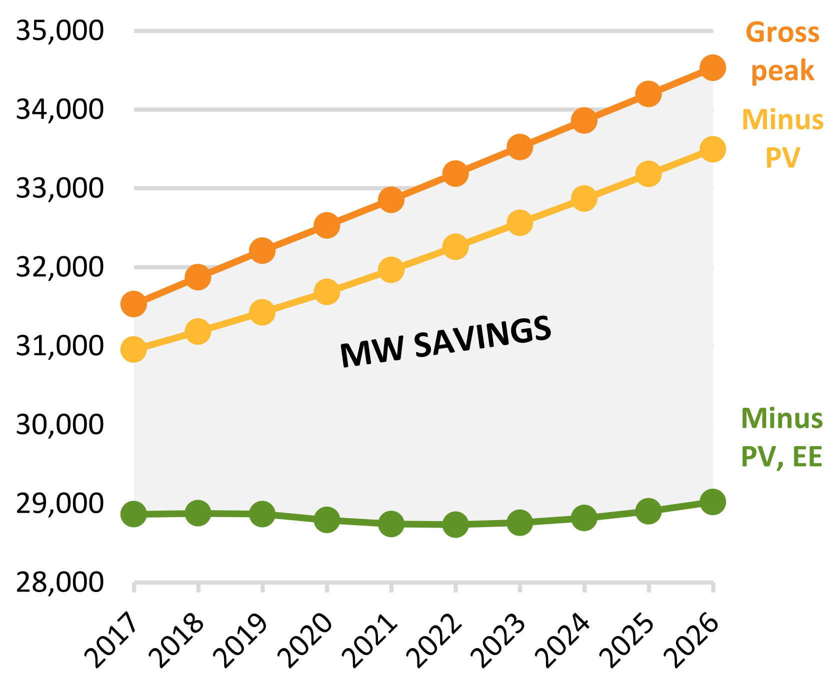
- As lighting becomes saturated, future savings will have to come from more costly measures



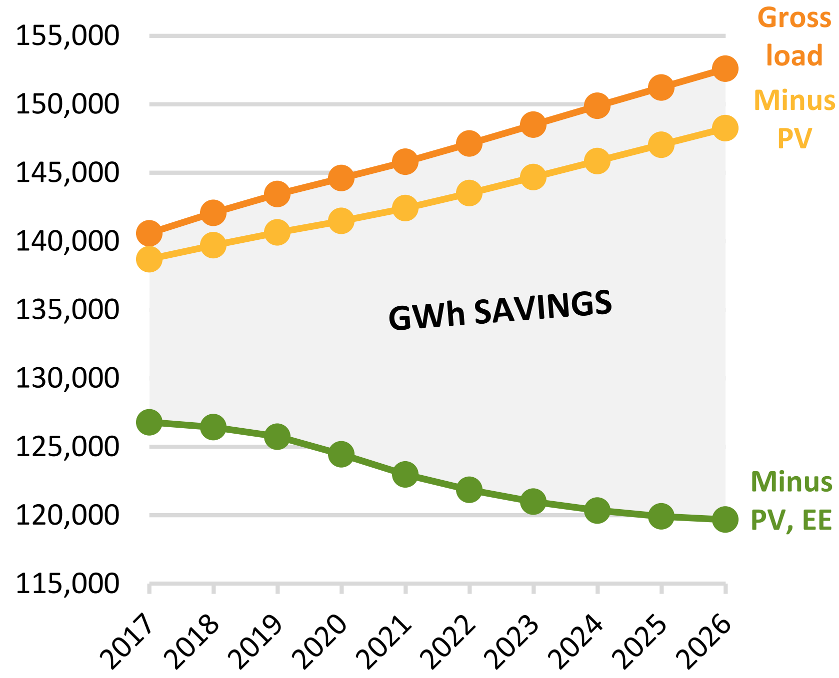
“Other” category includes: motors/drives/variable frequency drives, education, custom, compressed air, appliances, and consumer products.

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

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



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

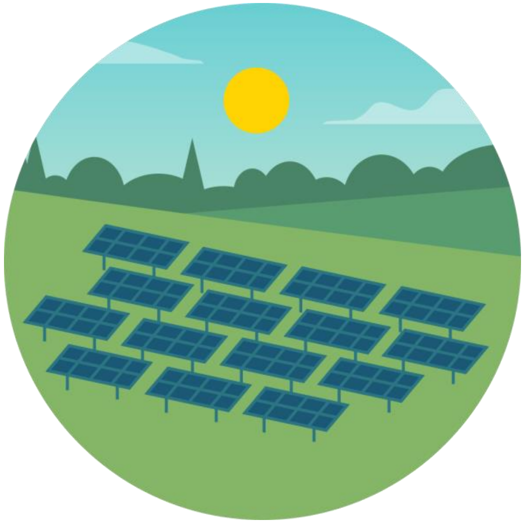


- **The gross peak and load forecast**
- **The gross peak and load forecast minus forecasted "behind-the-meter" (BTM) solar PV resources**
- **The gross peak and load forecast minus forecasted BTM solar PV, minus energy-efficiency (EE) resources in the Forward Capacity Market 2017-2020 and forecasted EE 2021-2026**

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: Final 2017 Solar PV Forecast (April 2017) and Final ISO New England Energy-Efficiency Forecast 2021-2026 (May 2017)

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 long-term incremental DG growth in New England
- 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



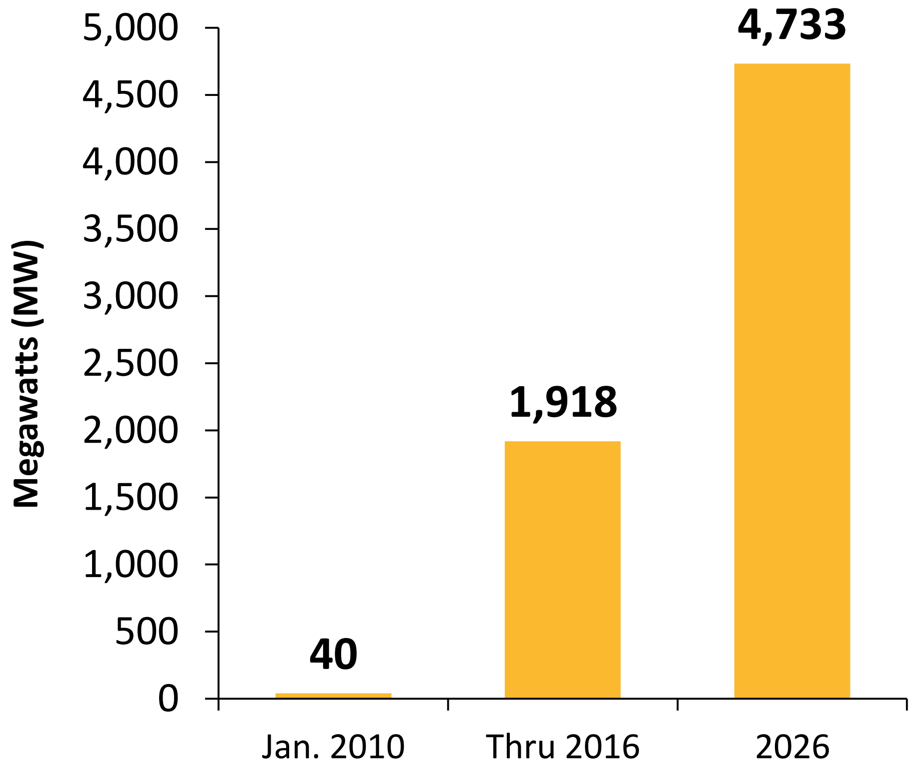
- The ISO forecasts strong growth in solar PV over the next 10 years

ISO New England Forecasts Strong Growth in Solar PV

December 2016 Solar PV Installed Capacity (MW_{ac})

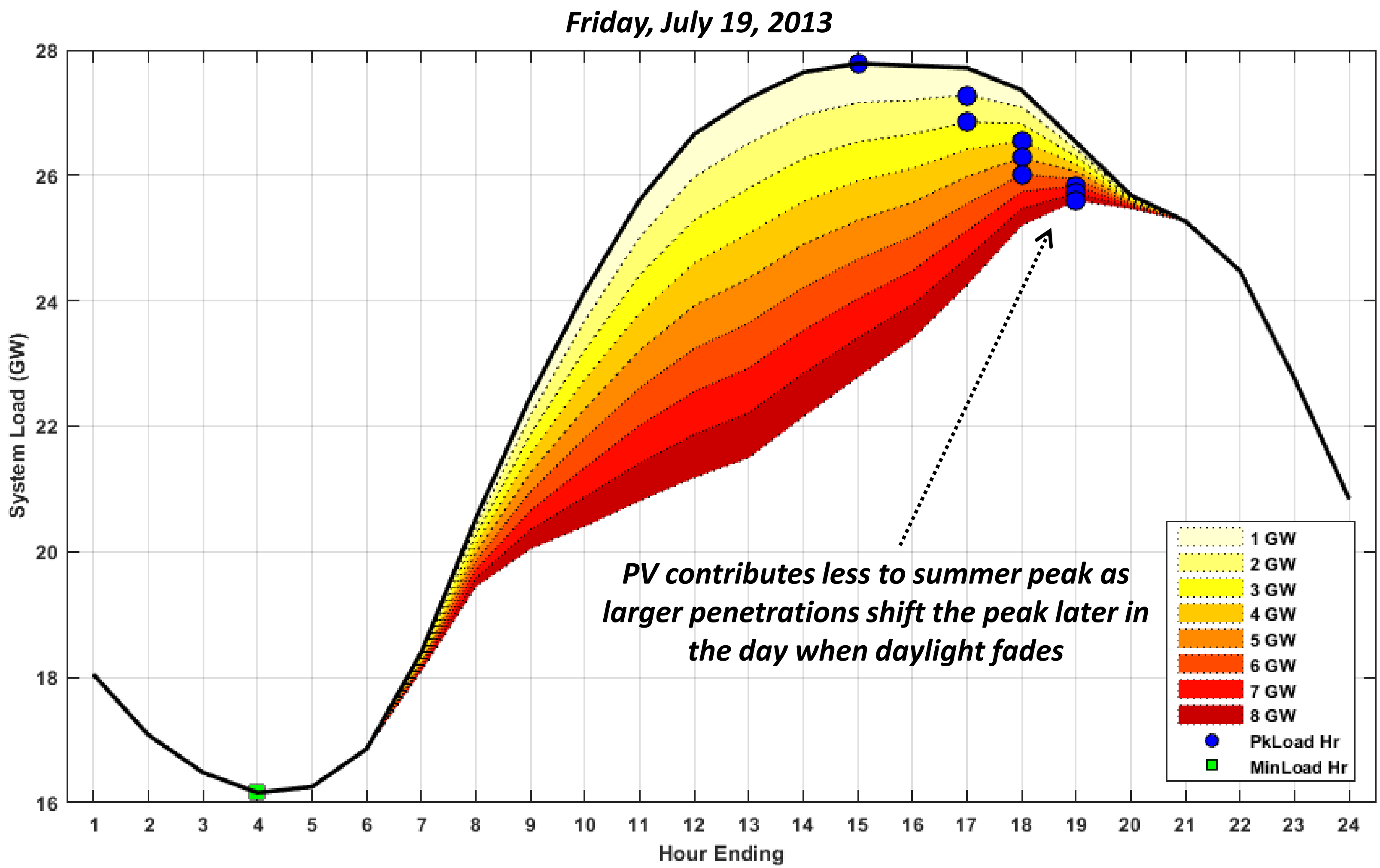
State	Installed Capacity (MW_{ac})	No. of Installations
Connecticut	281.55	23,544
Massachusetts	1,324.77	65,883
Maine	22.14	2,745
New Hampshire	54.30	5,873
Rhode Island	36.81	2,202
Vermont	198.39	7,612
New England	**1,917.96**	**107,859**

Cumulative Growth in Solar PV through 2026 (MW_{ac})

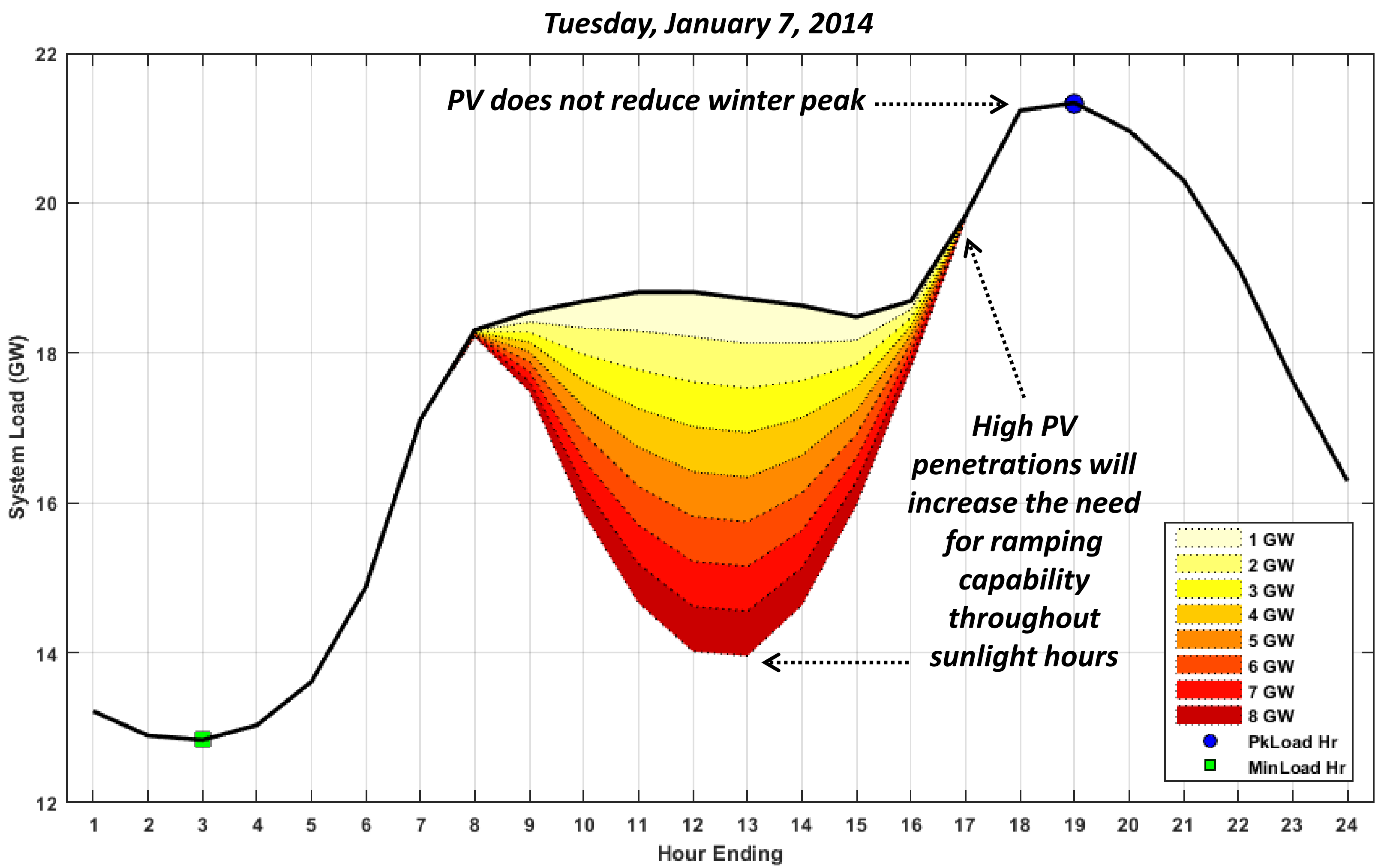


Note: The bar chart reflects the ISO's projections for nameplate capacity from PV resources participating in the region's wholesale electricity markets, as well as those connected "behind the meter." Source: Final 2017 PV Forecast (April 2017); MW values are AC nameplate.

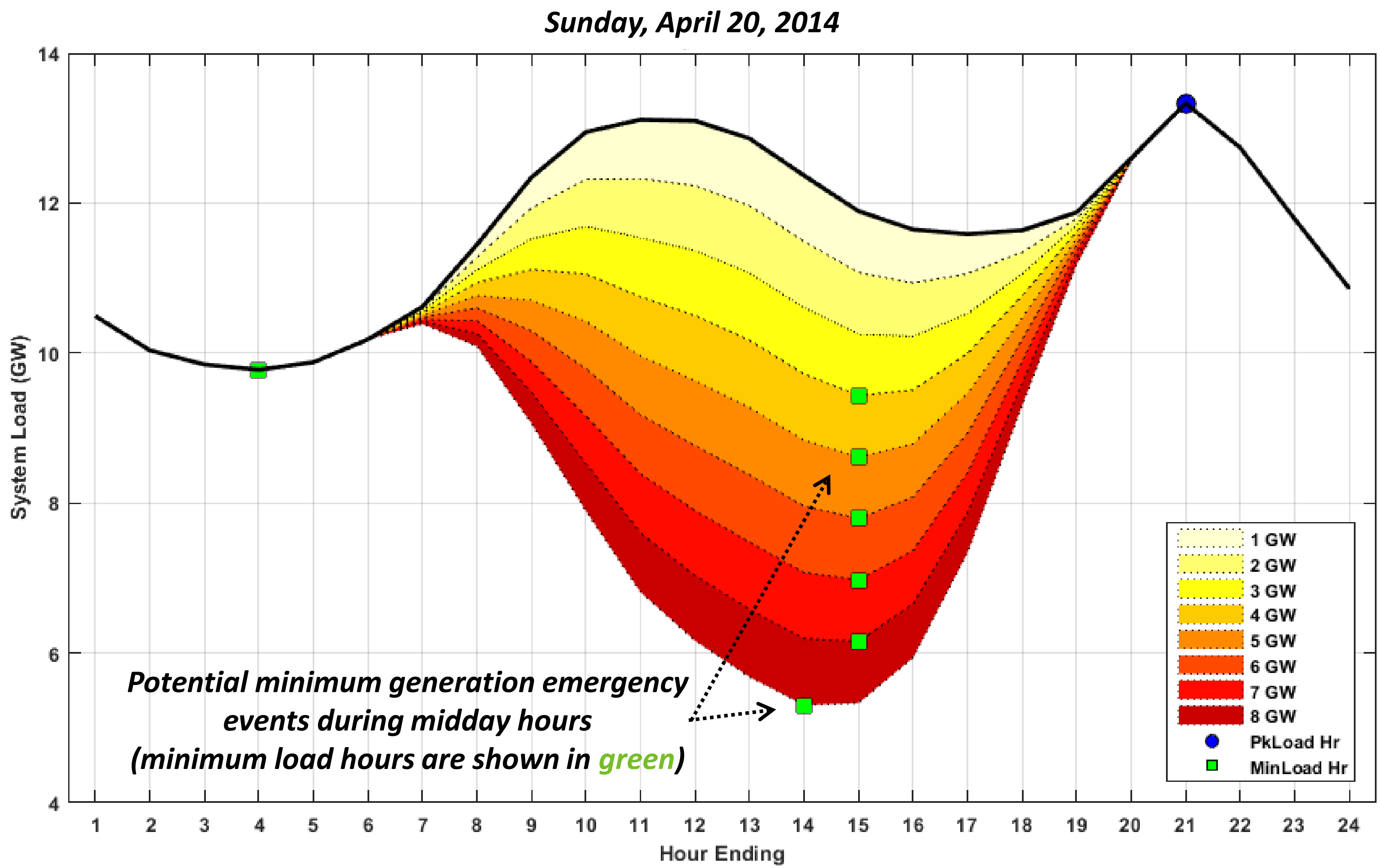
Solar PV Penetration Shifts Timing of Hourly Peaks Later in the Day During Summer



Deep Load Reductions During Winter Daylight Hours Result in Steep Ramp Into the Evening Peak

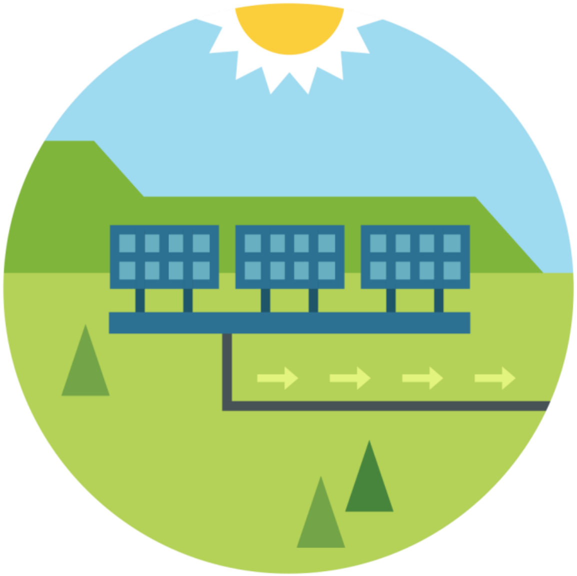


Solar in Spring/Fall Displaces Generation and Increases Need to Back Down Generation in Low-Load Hours



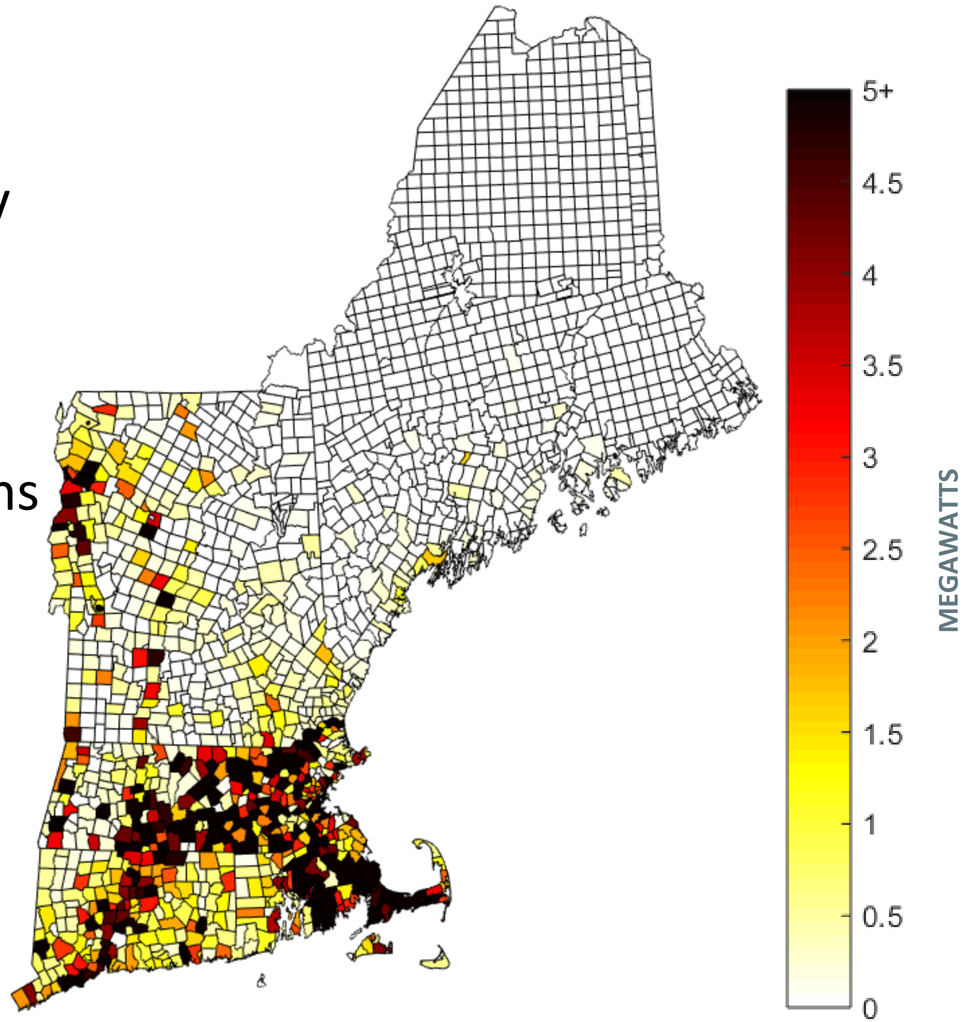
The ISO Is Leading Efforts to Account for Solar Resources Connected to the Distribution System

- 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



State Installed Solar PV "Heat Maps"

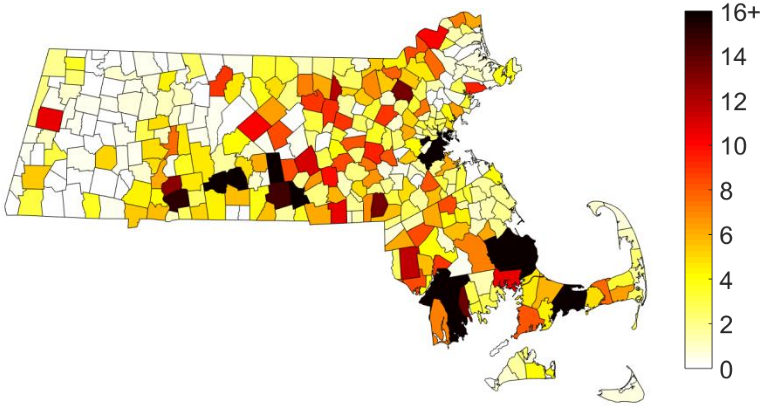
- Understanding the spatial distribution of existing solar PV resources will be critical to the ISO's ongoing integration activities within both System Planning and System Operations
- Based on the data provided by distribution owners, the ISO has aggregated the installed nameplate capacity by town within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



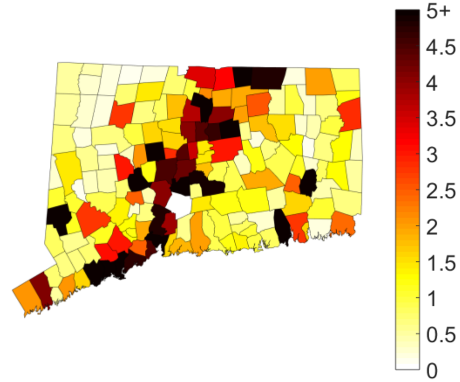
Note: Heat map reflects solar PV installed through April 30, 2017.

State Installed Solar PV "Heat Maps"

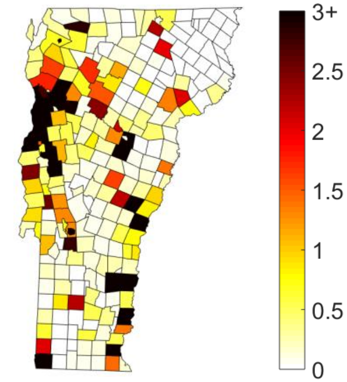
Massachusetts



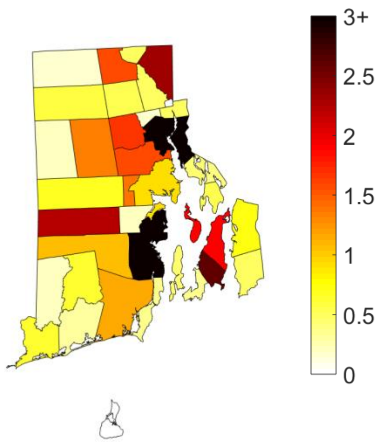
Connecticut



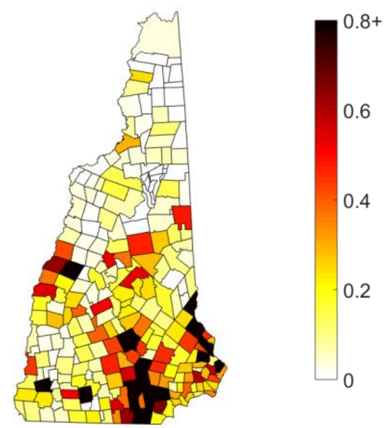
Vermont



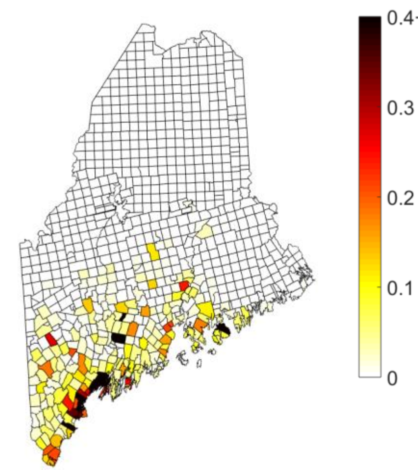
Rhode Island



New Hampshire



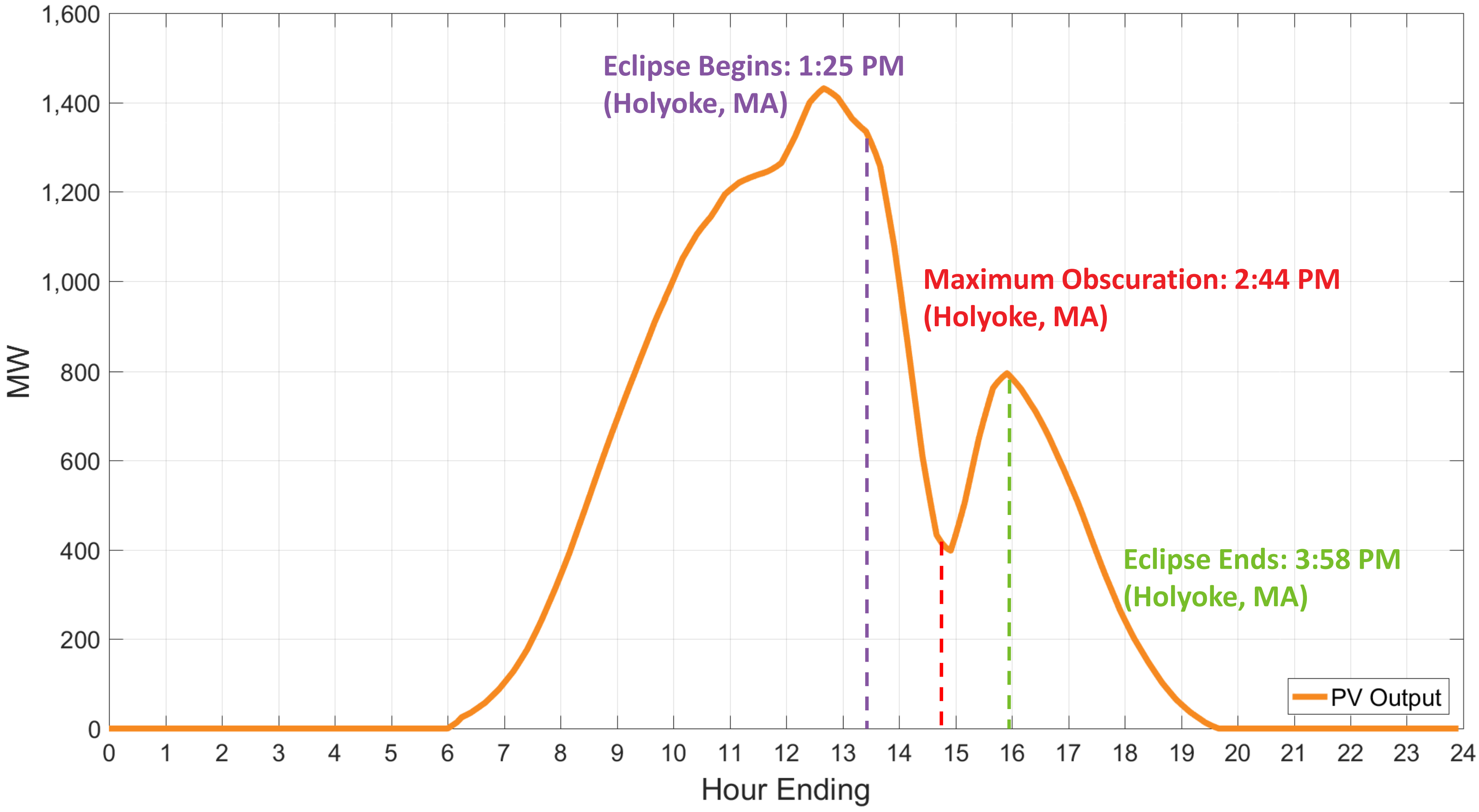
Maine



Note: Heat map reflects solar PV installed through April 30, 2017.

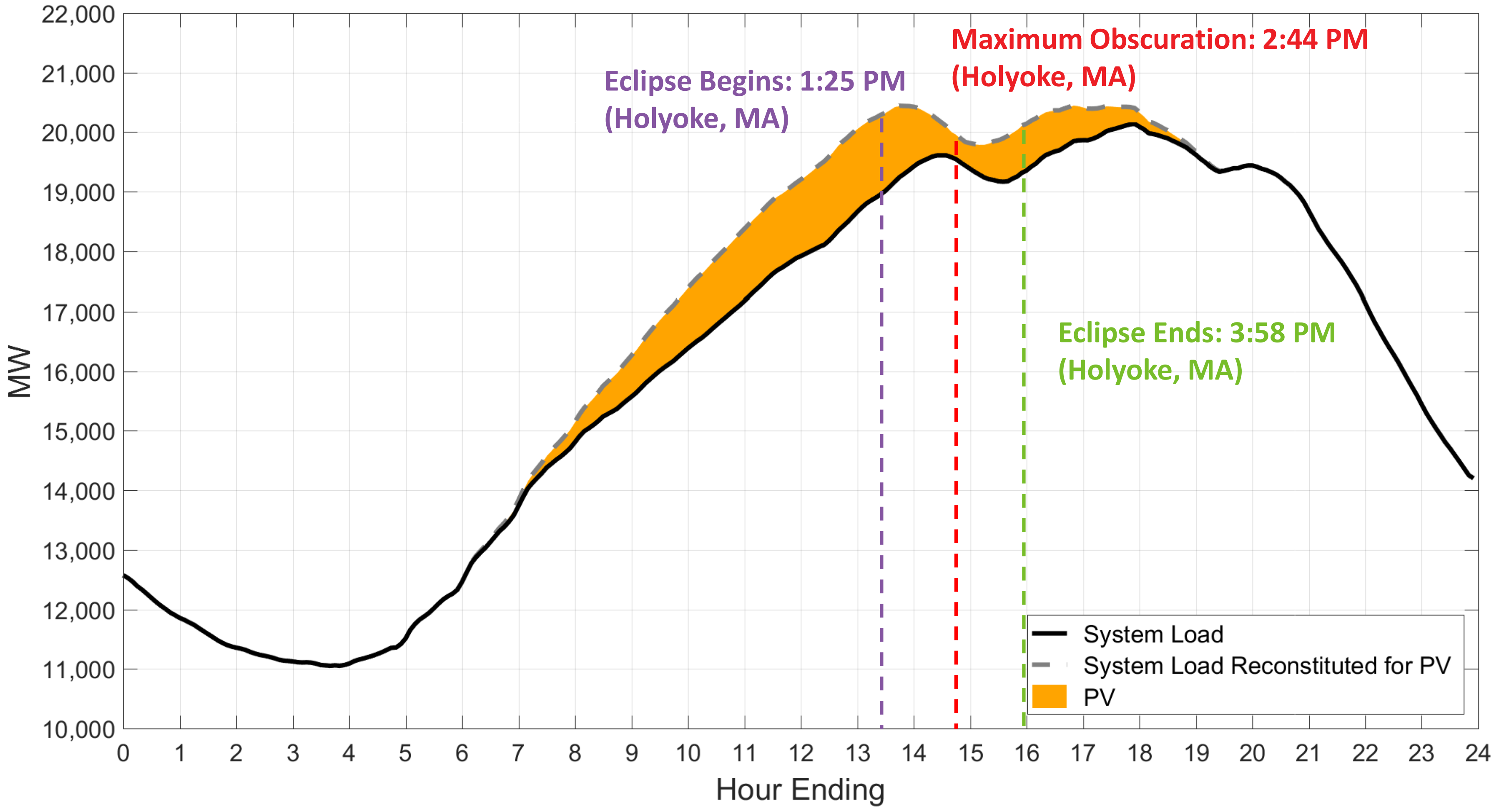
2017 Solar Eclipse – ISO-NE BTM PV Output

August 21, 2017 (5-minute resolution)



2017 Solar Eclipse – ISO-NE System Load

August 21, 2017



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

- Flexibility to Offer Negative Prices
  - Allows generators, such as 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”

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**
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- 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

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Questions