Update on Draft 2020 CELT Forecast

Planning Advisory Committee

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Objectives

- Provide a high-level update on the typical 2020 CELT forecasts, which will be discussed in more detail at the April PAC meeting:
  - Gross energy, summer demand, and winter demand forecasts
  - Energy efficiency (EE) forecast
  - Photovoltaic (PV) forecast
- Provide an overview of the heating and transportation electrification forecasts that are new in CELT 2020
  - The focus of this presentation

Introduction

- The ISO annually develops 10-year forecasts of energy and demand that are published as part of the Capacity, Energy, Loads, and Transmission (CELT) report
  - All assumptions used and resulting draft forecasts are discussed at the Load Forecast Committee (LFC)
- The *gross load forecast* reflects a forecast of load:
  - Before reductions from Demand Capacity Resources
    - Includes energy efficiency (EE), passive distributed generation (DG) resources, and price-responsive demand (PRD)
  - Before reductions from BTM PV
  - After load additions associated with forecasts of transportation and heating electrification
    - These are new forecasts for inclusion in CELT 2020
- The *net load forecast* reflects the gross load forecast minus forecasts of EE and BTM PV
  - The annual BTM PV forecast is developed with input from the Distributed Generation Forecast Working Group (DGFWG)
  - The annual EE forecast is developed with input from the Energy Efficiency Forecast Working Group (EEFWG)
- All forecasts presented herein are draft and subject to change

UPDATE ON 2020 CELT FORECASTS

2020 Gross Load, Energy Efficiency, and Photovoltaic Forecasts

2020 Gross Energy and Demand Forecast

- Other than incorporating the forecasted impacts of heating and transportation electrification, ISO made no methodological changes for the 2020 forecast cycle
  - Electrification forecasts will be discussed later in this presentation
- CELT 2019 summer and winter demand models performed well during the past year, especially during days with highest demand
- Relative to the 2019 CELT values, the 2020 draft gross forecasts:
  - Energy: The gross energy forecast for the region is higher than the 2019 CELT forecast by 0.4% in 2024 and 1.5% in 2028
  - Summer demand: The gross 50/50 summer peak demand forecast for the region is higher than the 2019 CELT forecast by 0.8% (254 MW) in 2024 and 1.5% (466 MW) in 2028
  - Winter demand: The gross 50/50 winter peak demand forecast for the region is higher than the 2019 CELT forecast by 2.1% (497 MW) for the winter of 2024/25 and higher by 4.2% (1,032 MW) for the winter of 2028/29
- Links to Load Forecast Committee materials
  - Long-Term Load Forecast Methodology Overview (September 27, 2019)
  - Evaluation of Historical CELT Forecast Performance (September 27, 2019)
  - 2020 Economic and Draft Energy Forecast (December 20, 2019)
  - Draft 2020 Summer Peak Forecast (February 18, 2020)
  - Final Draft 2020 Energy and Seasonal Peak Forecasts (March 23, 2020) [*will be posted soon*]

2020 Energy Efficiency (EE) Forecast

- In order to capture anticipated changes in the EE landscape, ISO improved the EE forecast methodology for the 2020 CELT:
  - Forecast utilizes state-level projections of end-uses to be targeted by EE program activity
  - Reflects a more granular approach with separate forecasts for two sectors:
    - Commercial & Industrial
    - Residential & Low Income
- Comparison between the 2019 CELT the draft 2020 EE forecast
  - Annual energy savings are approximately 8% lower in 2028
  - Summer peak demand savings are approximately 5% higher in 2028
  - Winter peak demand savings are approximately 3% higher in 2028
- Energy Efficiency Forecast Working Group links
  - Discussion of updates to the EE forecast model methodology (September 13, 2019)
  - Draft 2020 EE forecast (February 13, 2020)

2020 Photovoltaic (PV) Forecast

- The 2020 PV forecast reflects:
  - Updated PV installation data provided by Distribution Owners
  - Updated information from the New England states about PV policy drivers
  - Accounting for PV that is expected to participate in wholesale markets
  - Assumed impacts of PV panel degradation over the forecast horizon
  - Discount factors intended to capture uncertainty in the forecast
- Relative to the 2019 CELT, the 2020 PV forecasts:
  - Total nameplate PV forecast is approximately 11.2% higher in 2028
  - BTM PV nameplate forecast is approximately 10% higher in 2028
  - Estimated BTM PV summer peak load reductions are approximately 7.4% higher in 2028
- Distributed Generation Forecast Working Group links:
  - Updated state DG policy information (December 5, 2019)
  - Update on Estimating Summer Peak Demand Impacts of BTM PV (March 20, 2020)
  - Final draft 2020 PV forecast (March 20, 2020)

2020 HEATING ELECTRIFICATION FORECAST

Background

- The 2020 heating electrification forecast focuses on the adoption of air-source heat pumps (ASHPs), which is currently the most prevalent heat pump technology
  - Consideration of other technologies, such as ground-source heat pumps (GSHPs), may be warranted in future forecasts
- Heating electrification forecast is developed for winter months only (January-April, and October-December)
- Load Forecast Committee presentations:
  - September 27, 2020: Heating Electrification Update
  - November 18, 2019: Update on 2020 Heating Electrification Forecast
  - December 20, 2019: Draft 2020 Heating Electrification Forecast
  - February 18, 2020: Final Draft 2020 Heating Electrification Forecast

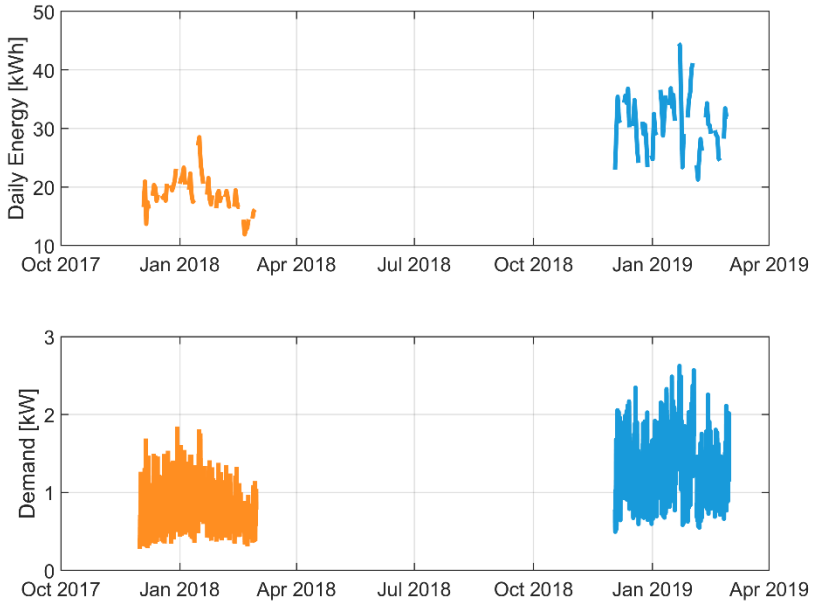
Introduction

- The ISO recognizes heating electrification is a nascent trend, and expects that improvements will be needed as policy drivers and state initiatives are further developed and additional data become available
- There are two general components to the forecast:
  1. Forecast the adoption of ASHPs for each state and the region over the next ten years
  2. Use data-driven assumptions to convert the ASHP adoption forecast into estimated impacts on monthly energy and demand by state
     - Develop monthly demand and energy impacts per installed ASHP based on recent historical demand data associated with residences with ASHPs

Assumptions Based on ASHP Data

Advanced Metering Infrastructure (AMI) Data Analysis

- Assumptions are based on analysis and regression modeling performed on the average hourly electricity consumption from 18 residential AMI profiles, each of which had an ASHP installed between the winters of 2017/2018 and 2018/2019
  - Enables a direct comparison of winter electricity consumption before and after ASHP adoption
  - All profiles from residences in northeastern MA
- The resulting average profile reflects a diversity of ASHP applications:
  - A mixture of natural gas and oil legacy heating fuels
  - Variety of ASHP heating capacities



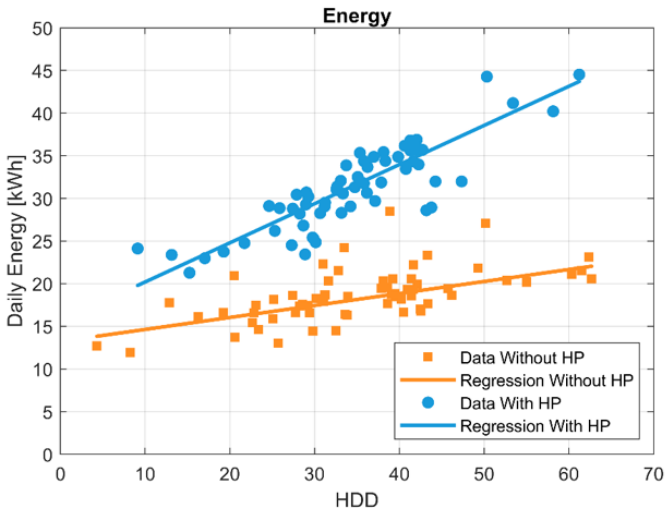
Data Source: Sagewell, Inc.

- The plots show the average weekday profile during the two consecutive winters analyzed
  - Top plot is average daily energy; bottom plot is average hourly demand
  - Orange plots are prior to ASHP adoption; blue plots are after ASHP adoption
  - Increase in both energy and demand after ASHP adoption is clearly illustrated
- ISO recognizes this is a relatively small AMI sample, and will continue to work with stakeholders to pursue additional data sources as heating electrification efforts mature in the region

Estimating Energy and Demand Impacts

Development of Response Functions

- ISO developed a regression-based approach to leverage AMI and weather data to derive response functions
  - Response functions are used to estimate ASHP impacts as a function of weather
- Separate regression models were developed for energy and demand using the average AMI profile before and after ASHP installation
  - Heating degree days (HDD) was used as the weather variable since it is included in both energy and demand forecast models
  - Top plot is for energy and bottom is demand (HE 18), weekdays only
  - Orange points are for data prior to ASHP and blue points are for data after ASHP installation
  - Orange and blue lines show the regression line for each set of data
- *Model differences* reveal the incremental increase in electric energy and demand as a function of weather (i.e., HDDs) due to ASHP adoption



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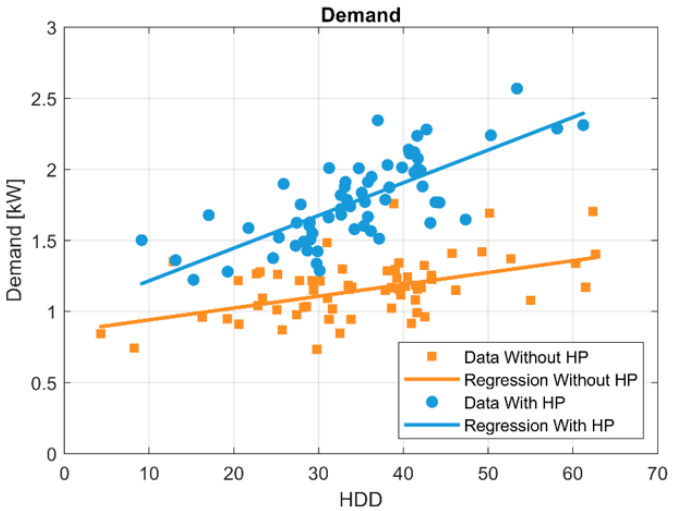


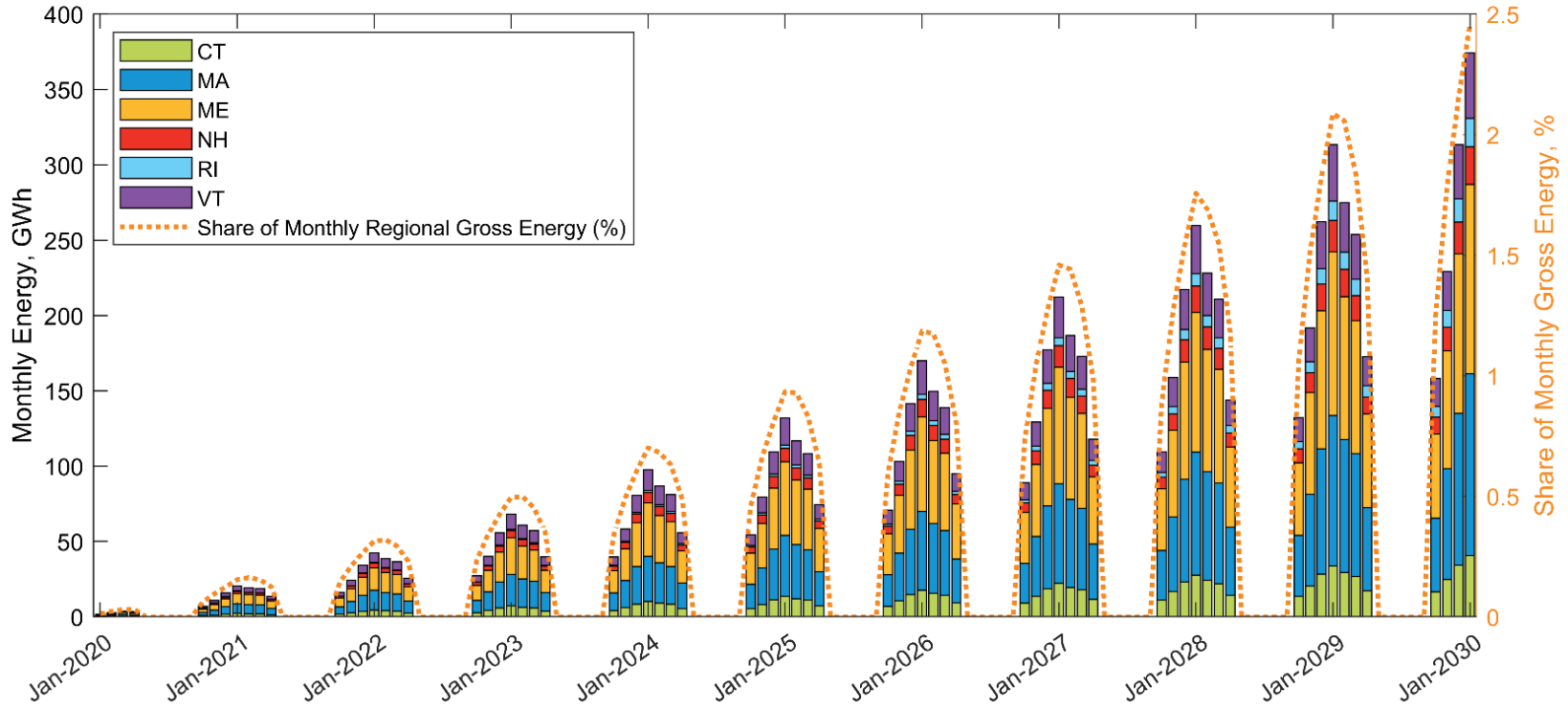
Final Draft 2020 ASHP Adoption Forecast

- ISO worked with each state to develop reasonable projections of ASHP adoption
- The values below are net of ASHP installations assumed to replace legacy electric resistance heat and are used to estimate energy and demand impacts

Year	Annual ASHP Installs (Thousands)						
	CT	MA	ME	NH	RI	VT	ISO-NE
2020	4.2	12.8	12.2	2.6	0.4	5.4	35.3
2021	4.8	14.7	15.0	3.0	0.5	5.8	43.9
2022	5.6	16.9	18.3	3.3	0.8	6.4	51.2
2023	6.4	19.4	21.6	3.7	1.2	6.8	59.1
2024	7.3	22.3	25.9	4.2	1.8	7.4	68.9
2025	8.4	25.6	27.1	4.7	2.7	8.0	76.6
2026	9.7	29.5	28.5	5.2	4.1	8.6	85.6
2027	11.2	33.9	29.9	5.8	6.2	9.2	96.2
2028	12.8	39.0	31.4	6.5	9.2	9.8	108.9
2029	14.8	44.9	33.0	7.3	13.8	10.5	124.3
Cumulative Total	**85.3**	**258.9**	**243.0**	**46.3**	**40.8**	**77.9**	**749.9**

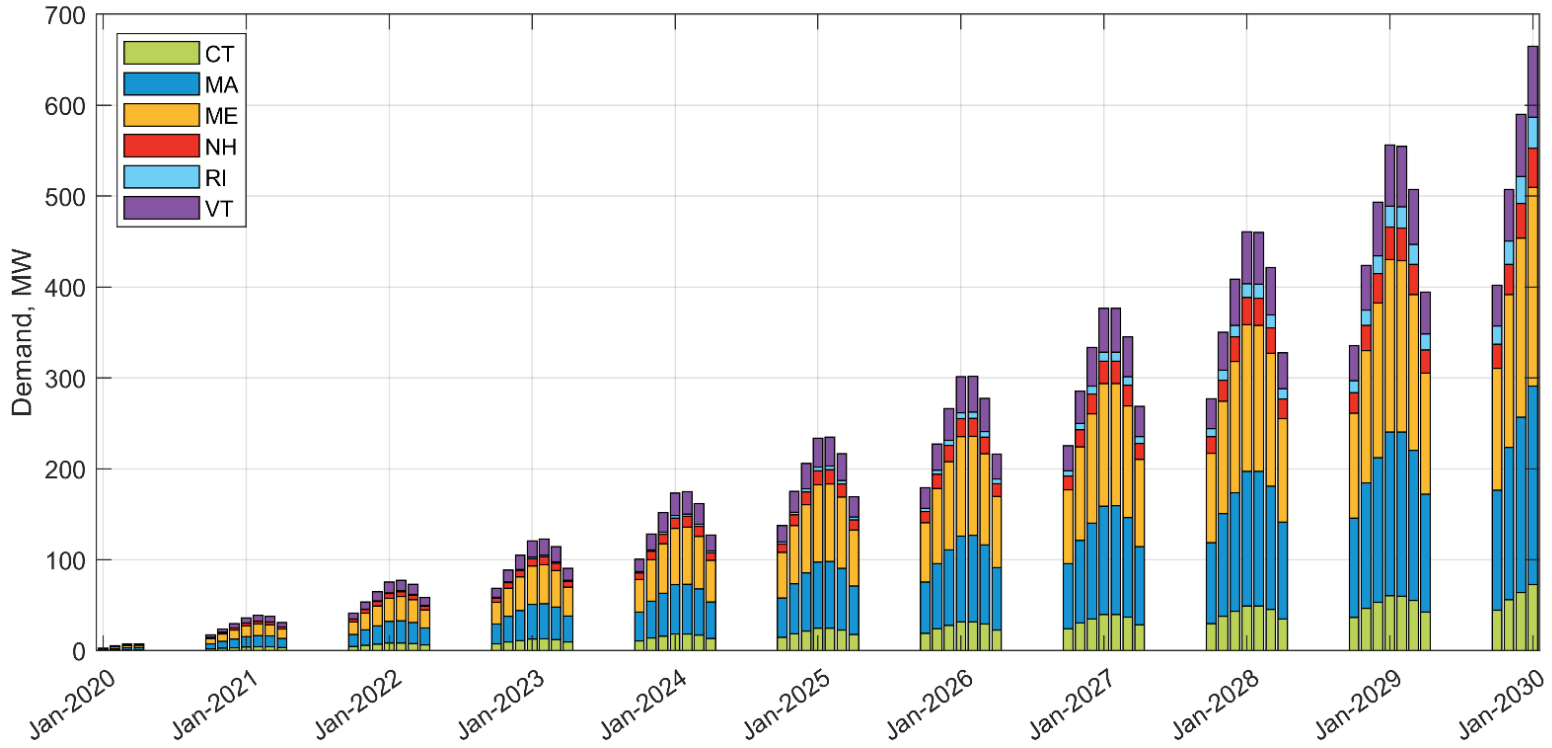
Final Draft 2020 Heating Electrification Forecast

Monthly Energy (GWh)



Final Draft 2020 Heating Electrification Forecast

Monthly Demand (MW)



2020 TRANSPORTATION ELECTRIFICATION FORECAST

Background

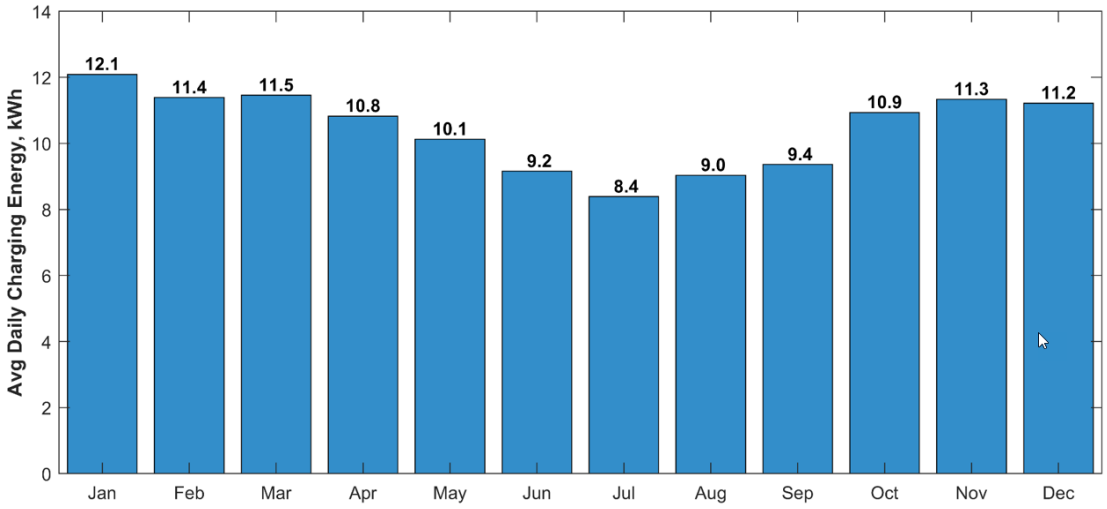
- The 2020 transportation electrification forecast focuses on adoption of electrified light-duty vehicles (LDV), including plug-in hybrid and battery electric vehicles (PHEVs and BEVs)
  - Consideration of electrification of other, non-LDV vehicle classes (e.g., freight vehicles, electric buses) may be warranted in future forecasts
- Load Forecast Committee presentations:
  - September 27, 2020: Transportation Electrification Update
  - November 18, 2019: Update on 2020 Transportation Electrification Forecast
  - December 20, 2019: Draft 2020 Transportation Electrification Forecast
  - February 18, 2020: Final Draft 2020 Transportation Electrification Forecast

Introduction

- There are two general components to the electric vehicle (EV) forecast:
  1. Forecast the adoption of electrified LDVs for each state and the region over the next ten years
     - Adoption values to include battery-electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV)
  2. Data-driven assumptions to convert the EV adoption forecast into estimated impacts on monthly energy and demand by state
     - Include monthly demand and energy impacts per EV based on recent historical EV charging data licensed from ChargePoint, Inc. (see below)
- ISO developed energy and demand assumptions based on an aggregate EV charging profile reflecting between 118 and 247 EV drivers across the region between June 2018 and May 2019
  - Data licensed from ChargePoint, Inc.
  - Aggregate profile reflects 78% residential and 22% non-residential charging
  - Additional information on ISO's analysis of ChargePoint data can be found in slides 10-19 of the November 18, 2019 LFC presentation

Estimating Energy Impacts of EV Adoption

- Monthly energy is based on results of the ChargePoint data analysis
- The adjacent bar chart illustrates monthly kWh/day per EV used to estimate monthly energy
- Values reflect a 6% gross-up for assumed transmission and distribution losses

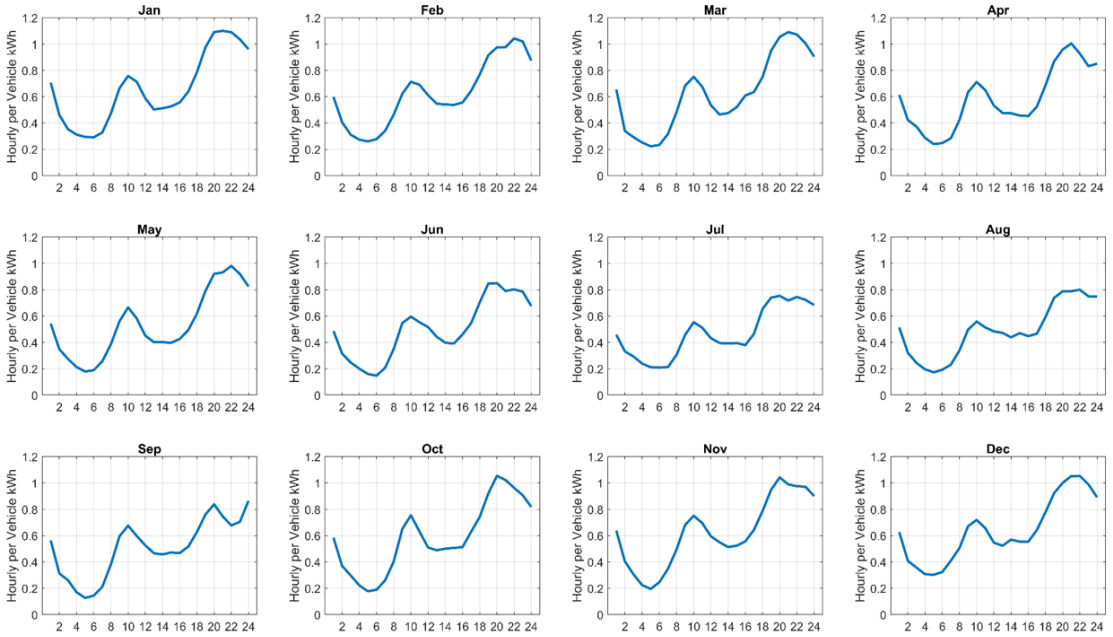


Data source: ChargePoint, Inc.

EV Hourly Demand

- For applications that include hourly analysis, EV demand will be modeled hourly
  - E.g., probabilistic ICR analysis
- Other forecast applications and reporting require a deterministic peak value (e.g., CELT report), and for which:
  - Winter peak demand:
    - Use the monthly average EV demand from HE 18-19
    - January-April, October-December
  - Summer demand impacts should reflect expectations of peak shifting due to increasing BTM PV penetrations (see next 2 slides)

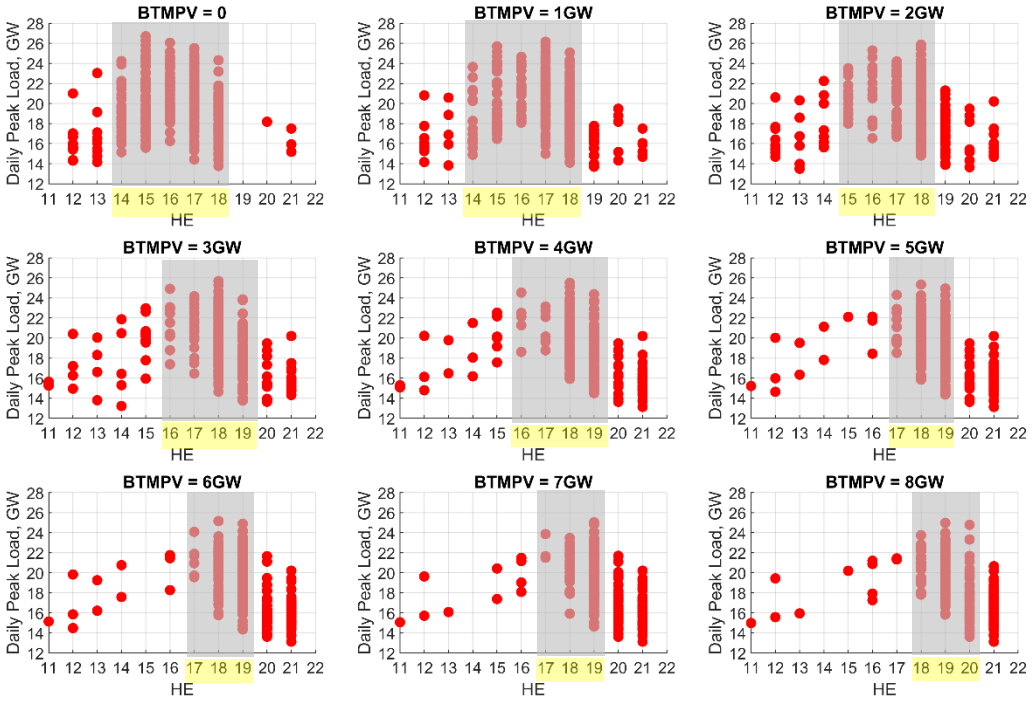
Weekday EV Profiles



Data source: ChargePoint, Inc.

Summer Peak Net Load as BTM PV Increases

- Hourly load and BTM PV data from the summers (July/August) of 2014-2019 were analyzed to simulate net loads with increasing penetrations of BTM PV
- Scatter plot shows the hour ending (HE) and magnitude (in GW) of net peak load as BTM PV increases
- Gray areas reflect estimated window of hours peak load may occur
  - Peak loads become later in afternoon as BTM PV penetrations increase
  - Yellow areas highlight peak hours



Interaction of EV Summer Demand and BTM PV

- For forecast applications and reporting that require a deterministic peak value, EV demand during the summer months is estimated as the average monthly EV demand during the summer peak hours tabulated to the right
  - May through September
- Hours reflect the effect of shifting peak demand due to BTM PV, according to the total PV nameplate (binned in GW increments) in long-term forecast

Year	PV Nameplate Bin (GW) *	Summer Peak Hours
2020	3	16, 17, 18, 19
2021	4	16, 17, 18, 19
2022	4	16, 17, 18, 19
2023	5	17, 18, 19
2024	5	17, 18, 19
2025	5	17, 18, 19
2026	6	17, 18, 19
2027	6	17, 18, 19
2028	6	17, 18, 19
2029	7	17, 18, 19

* Based on 2019 PV Forecast values

Final Draft 2020 EV Adoption Forecast

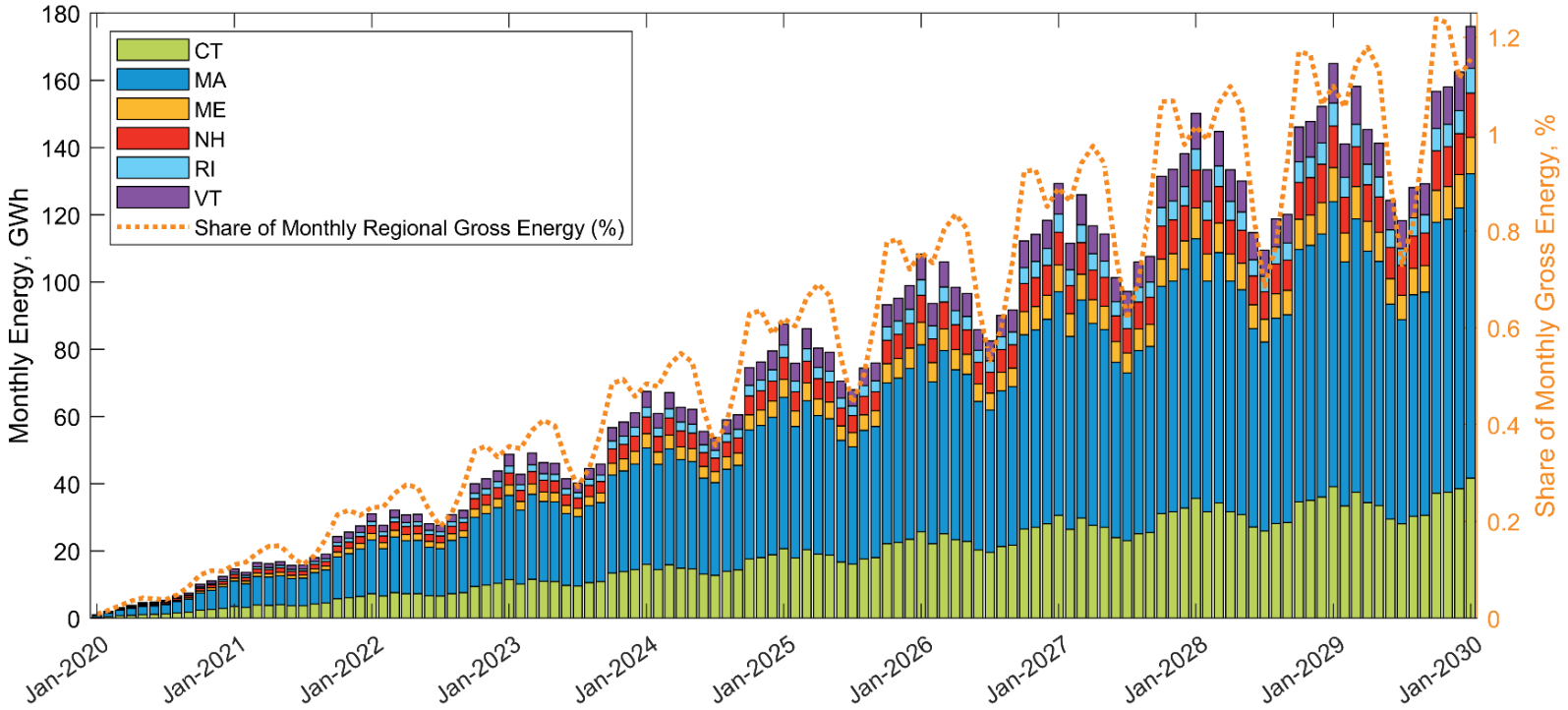
2019 Annual Energy Outlook Forecast (EIA Reference Case)

- Forecast of new EV LDV sales for New England
- Incremental sales from 2020-2029 tabulated for use in 2020 draft forecast
- Allocated to states based on state shares of 2018 EV registrations

Year	NE	CT	MA	ME	NH	RI	VT
2020	35,653	8,449	18,329	2,181	2,672	1,499	2,523
2021	43,199	10,237	22,209	2,642	3,238	1,816	3,057
2022	47,020	11,143	24,173	2,876	3,524	1,976	3,327
2023	49,783	11,798	25,594	3,045	3,731	2,092	3,523
2024	53,005	12,561	27,250	3,242	3,973	2,228	3,751
2025	55,737	13,209	28,655	3,409	4,177	2,343	3,944
2026	55,921	13,252	28,750	3,420	4,191	2,351	3,957
2027	57,136	13,540	29,374	3,495	4,282	2,402	4,043
2028	58,032	13,753	29,835	3,549	4,349	2,439	4,107
2029	60,197	14,266	30,948	3,682	4,512	2,530	4,260
Estimated Total	**515,683**	**122,208**	**265,119**	**31,540**	**38,649**	**21,675**	**36,492**

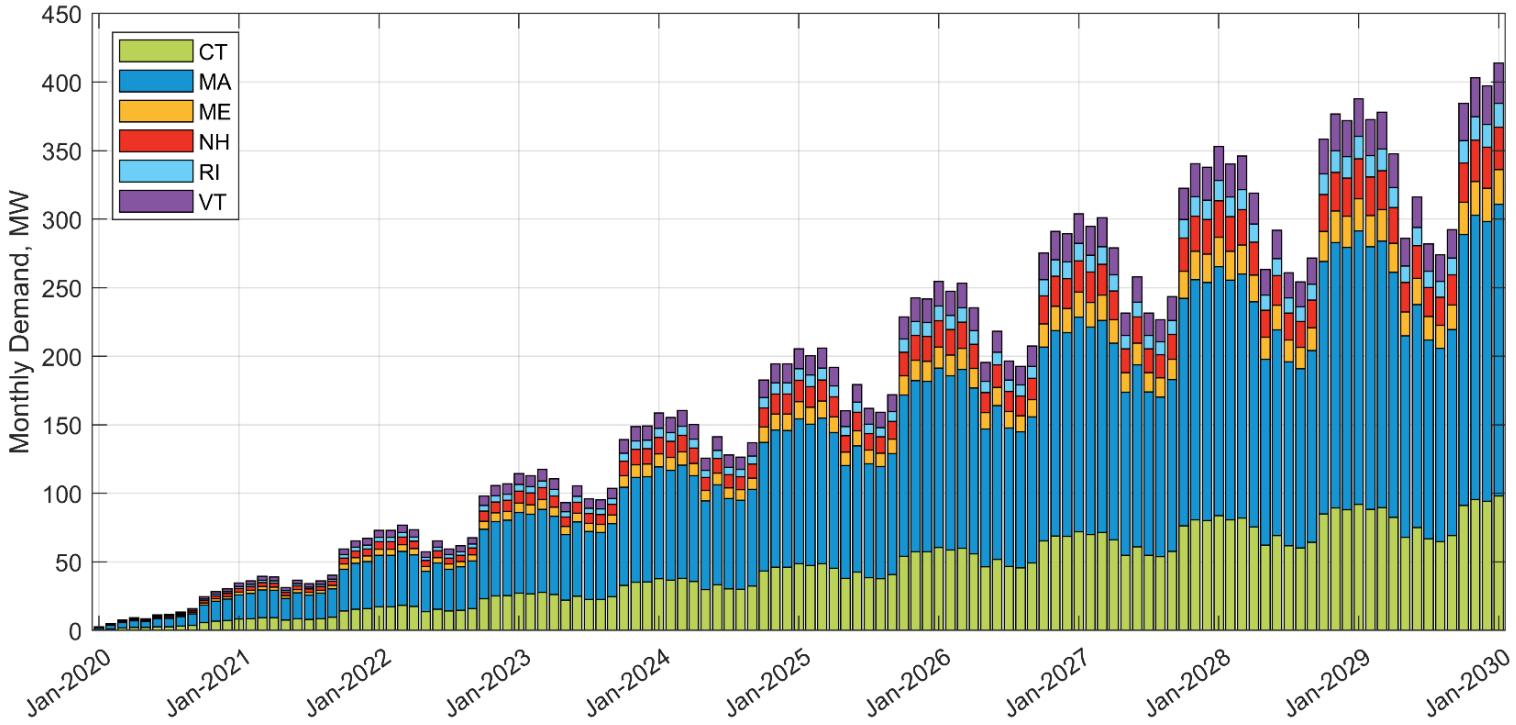
Final Draft 2020 EV Forecast

Monthly Energy (GWh)



Final Draft 2020 EV Forecast

Monthly Demand (MW)



Summary and Next Steps

- Updates on the CELT 2020 forecasts were provided
- Heating and electrification forecasts have been developed and will be reflected in both gross and net energy and demand forecasts as part of CELT 2020
  - Electrification forecasts will also be available as stand-alone forecasts in CELT 2020 (e.g., similar to the annual PV forecast)
- Additional information on CELT 2020 gross and net forecasts will be discussed at the April 23 PAC meeting
  - Regional gross/net energy forecasts
  - Regional gross/net summer demand forecasts
  - Regional gross/net winter demand forecasts
- ISO is working to make publicly-available the 2020 “Forecast Data” spreadsheet by April 23, 2019, to ensure that all sub-regional forecast data is available to stakeholders at that time

Questions