APRIL 29, 2025
PLANNING ADVISORY COMMITTEE (PAC)

2025 Final Forecast

Energy and Seasonal Peak Forecasts

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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
- The ISO has developed a new hourly forecast methodology that will be used for the CELT 2025 report and other annual load forecast publications
  - These forecasts are the main focus of this presentation; however, ISO's 2025 gross load forecast based on pre-existing methodology is also discussed
- Draft forecasts were discussed at the March 19, 2025 Planning Advisory Committee (PAC) meeting
- Final forecasts will be published in the 2025 CELT Report

CELT 2025 Load Forecast Timeline

Working Group and Committee Meetings

- Load Forecast Committee (LFC)
  - September 27, 2024 – Introduction to the 2025 long-term load forecast, updates to forecast data sources, forecast modeling, initial results and next steps
  - November 8, 2024 – Enhancements to heating, transportation, and BTM PV forecasts for CELT 2025
  - December 13, 2024 – Electrification adoption forecast updates, trend variables in the base load forecast, base load modeling and preliminary results
  - February 21, 2025 – Draft electric vehicle forecast, draft heat pump forecast, draft annual energy and peak demand forecast
  - March 28, 2025 – Final draft annual energy and seasonal peak forecasts, gross load forecasts for ARAs
- Distributed Generation Forecast Working Group (DGFWG)
  - December 9, 2024 – State DG policy updates from MA, CT, RI, VT, NH, and ME, DER Forecast Improvements
  - February 10, 2025 – DGFWG DER PV interconnection data update, Draft 2025 PV forecast
  - March 24, 2025 – Final 2025 PV forecast, Update on DER storage
- Energy Efficiency Forecast Working Group Meetings (EEFWG)
  - September 30, 2024 –EE forecast process changes for CELT 2025, introduction to statistically adjusted end-use (SAE) modeling
  - December 9, 2024 – Trend variables in the base load forecast

BACKGROUND & REVIEW

Long-Term Forecast Components for CELT 2025

- Each of the 4 load components entail distinct modeling steps which have been updated or changed for CELT 2025
- The base load forecast reflects significant updates as discussed at the December 13th LFC meeting
- The HP, EV, and BTM PV forecasts have undergone improvements to enable:
  - Adoption forecasting and potential future accounting at the county level
  - Hourly modeling
  - Inclusion of climate-adjusted weather data

Base Load Forecast

- Statistically modeled based on historical load reconstituted for BTM PV
- Is combined with electrification forecasts to yield the gross and net load forecasts

DER (BTM PV) Forecast

- Adoption forecasting based on NREL's dGen™ tool
- Demand reductions derived using zonal, historical hourly capacity factors

Heat Pump (HP) Forecast

- Adoption forecast along possible heating pathways
- Demand derived from simulated weather-dependent building heating needs and HP coefficient of performance (COP) curves

Electric Vehicle (EV) Forecast

- Adoption forecast for 5 vehicle types
- Demand derived from weather-sensitive battery efficiency curves and daily charging profiles

Key Elements of the Hourly Methodology

Re-defining Gross Load

- $Load_{Gross} = Load_{Net} + BTM\ PV$
- Historical and forward looking impacts of EE are captured via historical trends and SAE drivers included as inputs to the model

Temporal Granularity

- Modeling includes simulations of all hours for all load components, enabling the forecast to capture the dynamic interplay between components and their profiling

Hierarchical Forecasting

- Regional forecast is the sum of zonal forecasts to capture the spatial diversity of weather and load characteristics
- Zonal EV, HP, and BTMPV forecasts start at the county-level

Improved Base Load Modeling

- A daily energy model that feeds 24 individual hourly models
- Combination of linear regression and neural networks
- Expanded set of weather and calendar explanatory variables

Expanded Weather Data

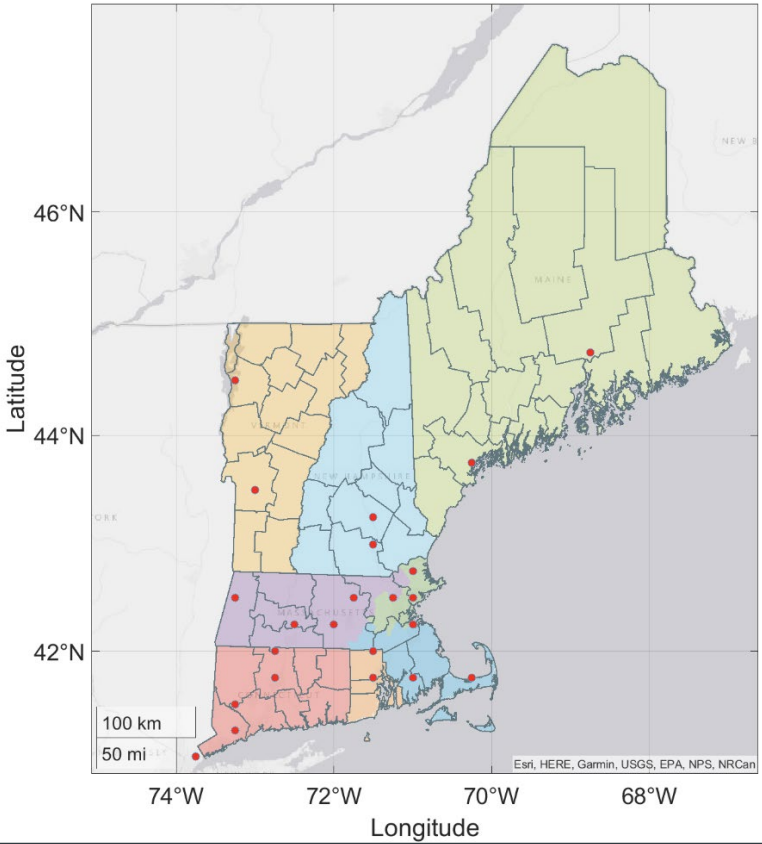
- Use of ERA5 reanalysis weather data from ECMWF
- Climate-adjusted weather data reflecting 70 weather years
- 23 weather locations, 8 weather concepts

Extended Forecast Horizon

- All load components are forecast out 20+ years, enabling the forecast to support longer-term planning studies

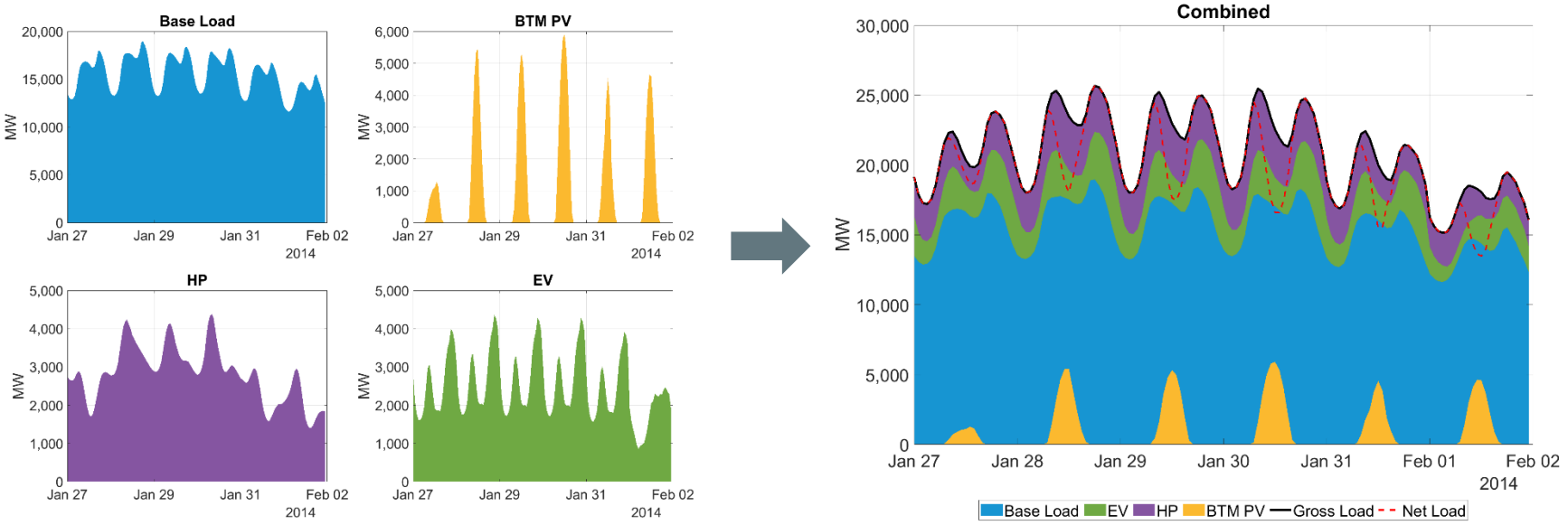
Advancements to Forecast Components

- Development of hourly forecasts
  - Each forecast component is simulated on an hourly basis for the entire forecast horizon
  - Each year's forecast is based on 70 years of climate-adjusted weather
- County-level forecast accounting implemented to EV, HP, and BTMPV forecasts
  - Map illustrates county boundaries overlayed with load zones
    - Red dots indicate weather stations
    - County forecasts utilize weather at station closest to county center
  - County-level forecasts are aggregated to load zones before combining with the base load forecast

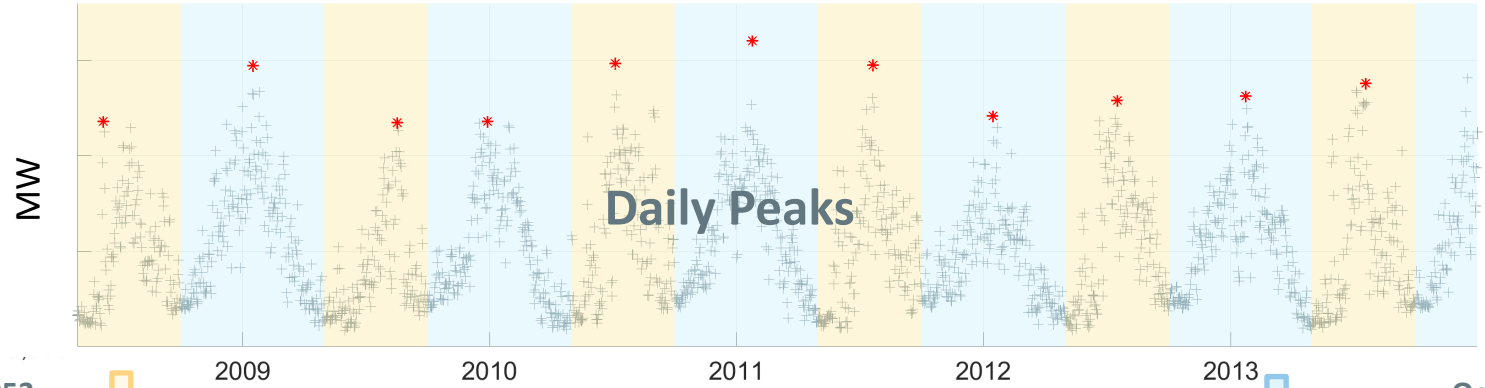


Load Forecast Compilation

- Each forecast component (base load, EV, HP, and BTM PV) reflects coincident weather over a 70-year simulation period and are combined into forecasts of net and gross load for each zone and the region



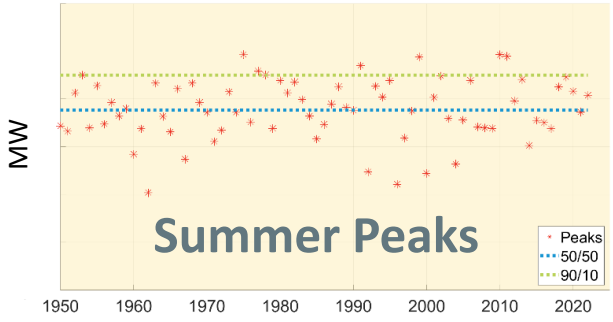
Calculation of Seasonal Peaks



Nov 1953…

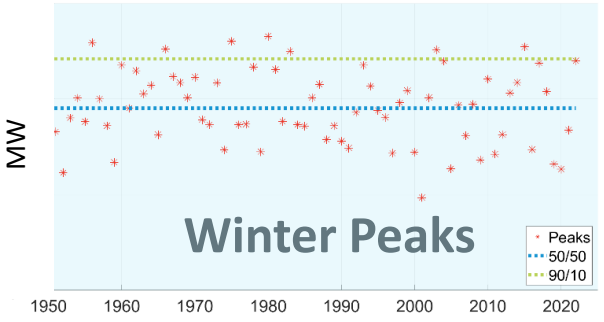
…Oct 2023

Summer Winter



Seasonal Peak Methodology

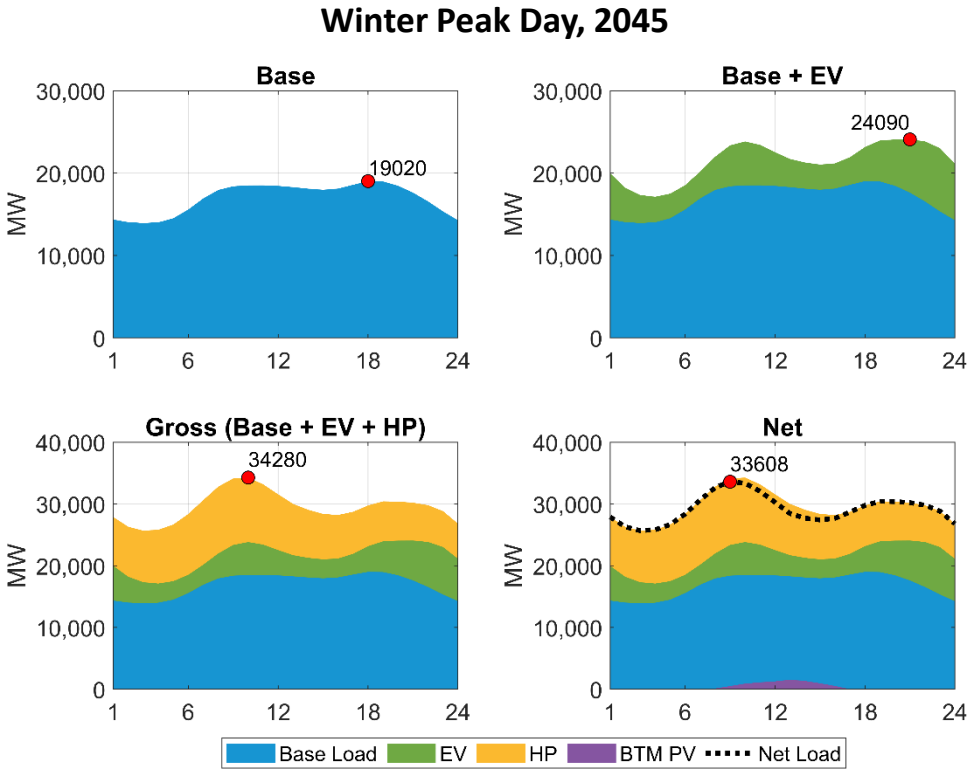
1. For a given forecast year, select seasonal peaks from each simulation year (70 values)
2. Calculate 50th and 90th percentiles from resulting seasonal peaks
3. Repeat for each forecast year



Demand Impacts of Load Components

Waterfall Approach

- The hourly forecast results in a dynamic interplay of modeled load components
  - Peak hour shifts due to the growth of one component affect the peak attribution of other components
  - Attribution of peak load values to components is path dependent
- A waterfall approach to the attribution of peak load contributions is used to standardize this forecast accounting
- Waterfall method steps (refer to plot):
  1. Base = Base peak load value
     19,020 MW
  2. EV = (Base+EV) – Base
     24,090 – 19,020 = 5,070 MW
  3. HP = Gross – (Base+EV)
     34,280 – 24,090 = 10,190 MW
  4. BTMPV = Gross – Net
     34,280 – 33,608 = 672 MW



Final CELT 2025 Forecast

Annual Energy, Summer Peak, and Winter Peak

- The following slides summarize the final CELT 2025 annual energy and seasonal, coincident peak demand forecasts resulting from the new hourly forecast methodology
  - Given that hourly forecasts are net of EE and do not involve a separate EE forecast, the forecasts presented herein focus on net energy and demand forecasts
  - A gross load forecast based on pre-existing methodology is included in this presentation starting on slide 29
    - This forecast is required by the tariff to support ICR calculation for the remaining FCM ARAs
- The following inputs are reflected in the results
  - Final refinements to base load modeling inputs since draft results
  - Final 2025 HP and EV forecasts, reflecting minor updates to EV forecast since draft results
  - Final 2025 BTM PV forecasts (impacts net forecast only)
    - 2024 forecast used in draft results
  - Transmission and distribution gross up applied to EV, HP, and BTM PV forecasts, which was not included in draft results
    - 8% gross up applied to seasonal peaks
    - 6% gross up applied to energy
- As part of the hourly forecast, BTM PV forecast now impacts both summer and winter peak demand

FINAL ELECTRIFICATION FORECASTS

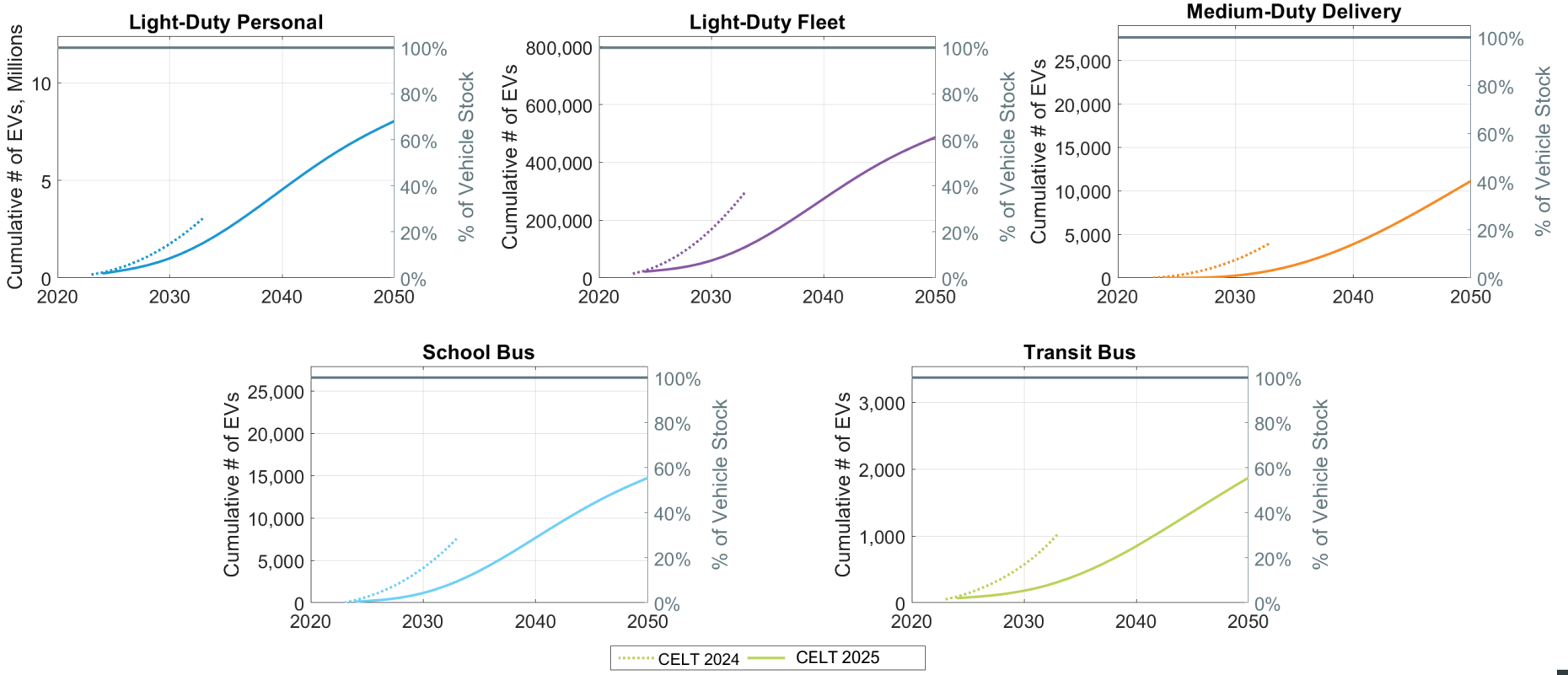
Final 2025 EV and HP Adoption Forecasts

Updates from CELT 2024

- EV adoption for the CELT 2025 forecast has been revised downward across all vehicle categories
  - Comprehensive vehicle registration data has indicated that prior forecasts have exceeded actual EV registrations
  - Additional details can be found in the Draft 2025 Electric Vehicle Forecast
- HP adoption has been updated to align with the most recently available program and policy data
  - Connecticut:
    - 30% reduction in overall adoption
  - New Hampshire:
    - Greater emphasis placed on partial-displacement adoption
  - Massachusetts:
    - Greater emphasis placed on full-displacement adoption
    - 15% reduction in overall adoption
  - Additional details can be found in the Draft 2025 Heat Pump Forecast

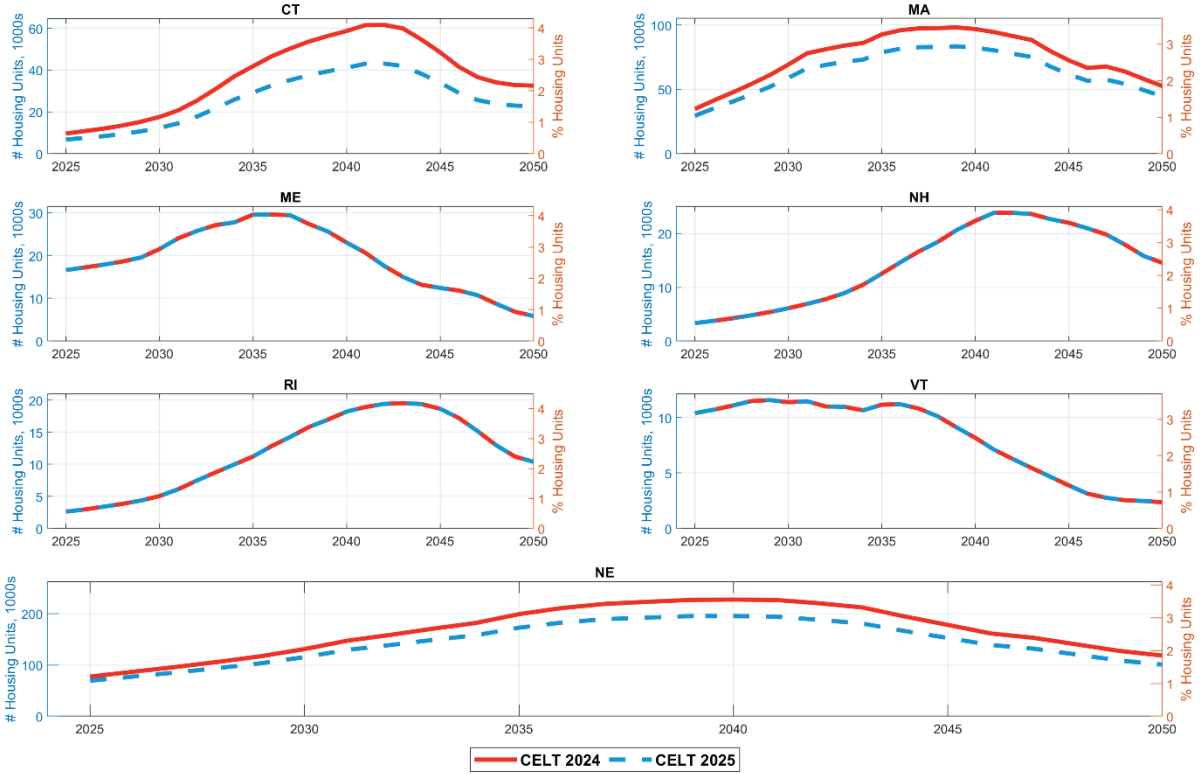
Final 2025 EV Adoption Forecast

Cumulative EV Stock for New England



Final 2025 Residential Space Heating Adoption

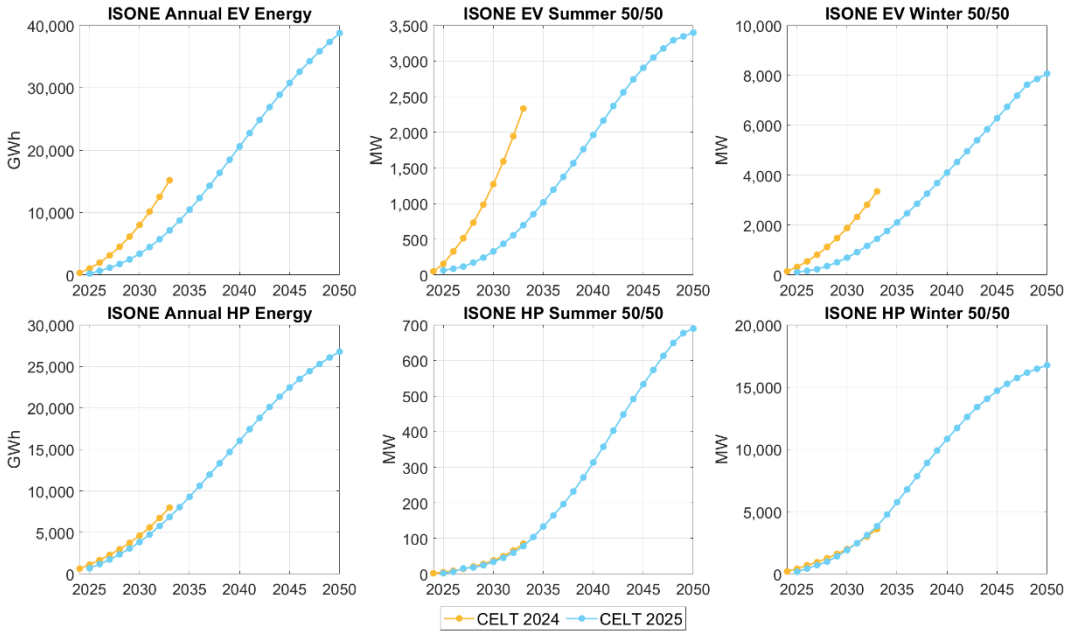
Incremental HP Adoption by State



Final 2025 Electrification Forecasts

- Final 2025 electrification forecasts assume reduced EV and HP adoption relative to 2024 CELT assumptions
- The plot compares the electrification impacts on regional annual energy and 50/50 winter and summer peak demand
  - EV (top) and HP (bottom)
- Aside from changes to adoption assumptions, the hourly forecast reveals:
  - Greater HP impacts on winter peak demand due to morning peaks becoming prevalent by the early 2030s
  - Lower EV impacts on winter and summer demand (per EV adopted)

New England

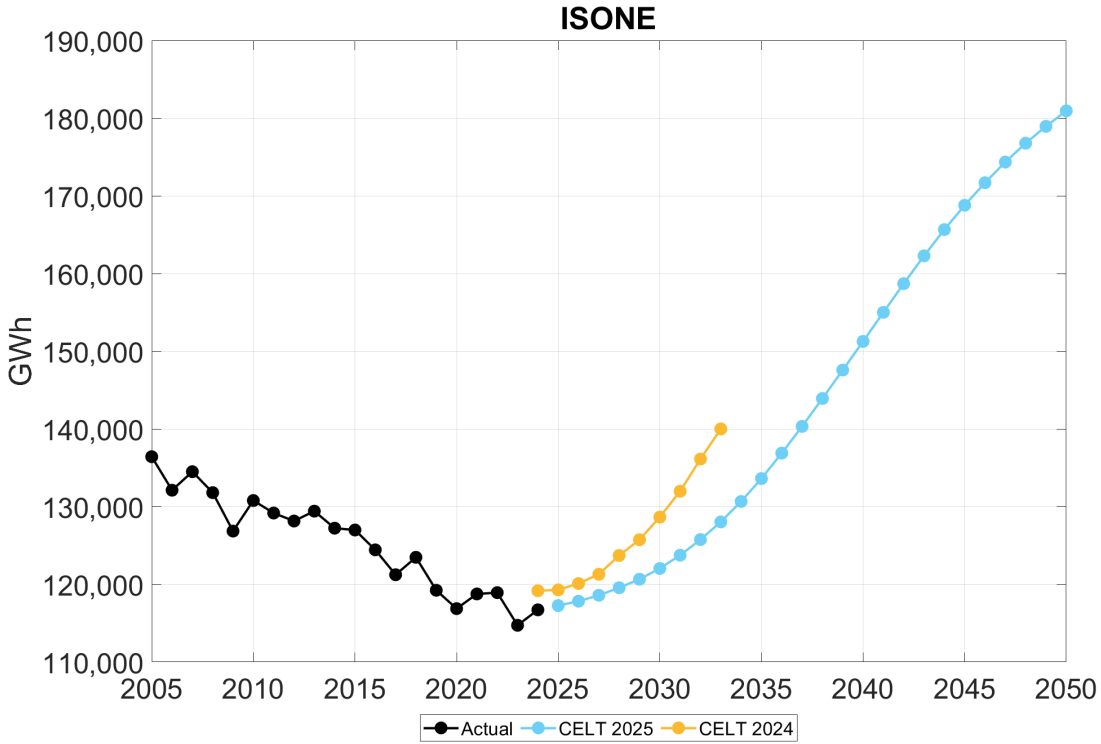


FINAL 2025 ANNUAL ENERGY FORECAST

Annual Net Energy Forecast

New England – Final CELT 2025 Vs. CELT 2024

Year	Net CELT 2024 (GWh)	Net CELT 2025 (GWh)	Change (GWh)	Change (%)
2025	119,285	117,262	-2,023	-1.7%
2026	120,106	117,829	-2,277	-1.9%
2027	121,298	118,591	-2,707	-2.2%
2028	123,720	119,559	-4,161	-3.4%
2029	125,741	120,659	-5,082	-4.0%
2030	128,655	122,044	-6,611	-5.1%
2031	131,983	123,747	-8,236	-6.2%
2032	136,126	125,761	-10,365	-7.6%
2033	140,001	128,034	-11,967	-8.5%
2034		130,665		



Final 2025 Annual Energy Forecasts

New England - Summary

Year	Base (GWh)	Transportation Electrification* (GWh)	Heating Electrification* (GWh)	Gross (GWh)	BTM PV (GWh)	Net (GWh)
2025	122,662	224	692	123,578	-6,316	117,262
2026	122,843	663	1,188	124,693	-6,864	117,829
2027	123,033	1,160	1,743	125,936	-7,346	118,591
2028	123,331	1,761	2,365	127,457	-7,898	119,559
2029	123,619	2,499	3,060	129,178	-8,519	120,659
2030	123,935	3,398	3,846	131,179	-9,136	122,044
2031	124,271	4,472	4,748	133,491	-9,744	123,747
2032	124,626	5,724	5,773	136,123	-10,362	125,761
2033	124,979	7,148	6,867	138,994	-10,961	128,034
2034	125,368	8,735	8,049	142,152	-11,487	130,665

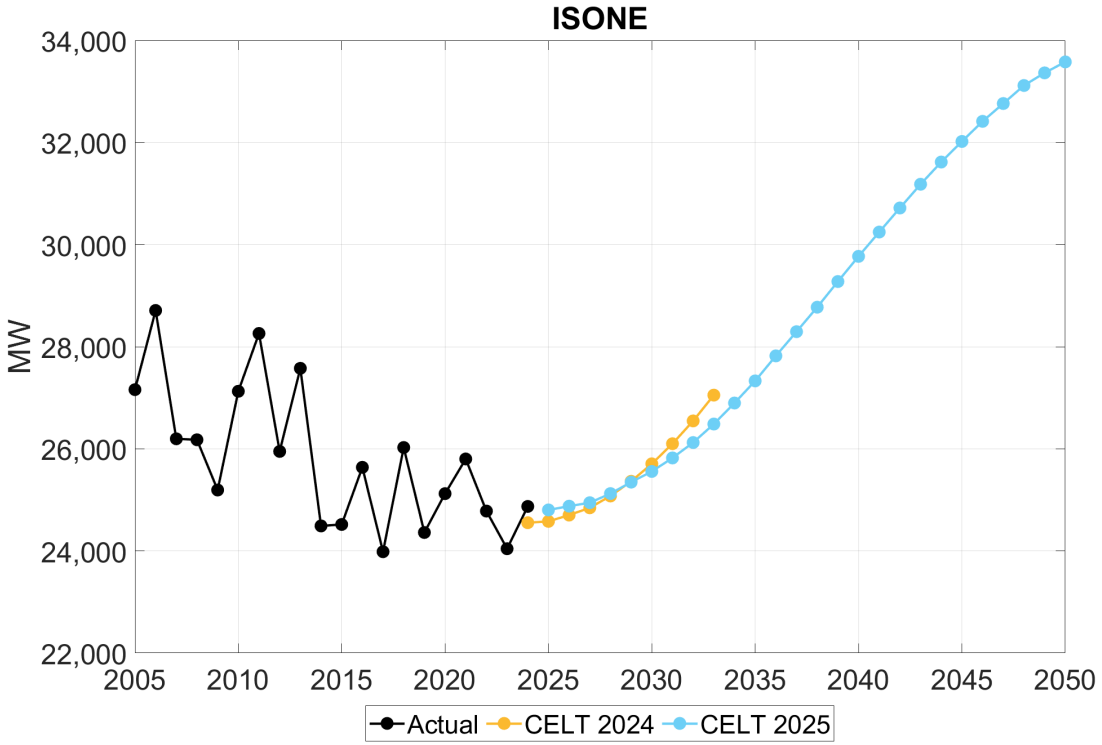
** Electrification forecasts are included in both gross and net peak forecasts.*

FINAL 2025 SUMMER PEAK DEMAND FORECAST

Summer Net 50/50 Peak Forecast

New England – Final CELT 2025 Vs. CELT 2024

Year	Net CELT 2024 (MW)	Net CELT 2025 (MW)	Change (MW)	Change (%)
2025	24,579	24,803	224	0.9%
2026	24,702	24,877	175	0.7%
2027	24,845	24,945	100	0.4%
2028	25,076	25,124	48	0.2%
2029	25,364	25,347	-17	-0.1%
2030	25,706	25,557	-149	-0.6%
2031	26,100	25,821	-279	-1.1%
2032	26,547	26,123	-424	-1.6%
2033	27,052	26,486	-566	-2.1%
2034		26,897		



Final 2025 Summer Peak Forecasts

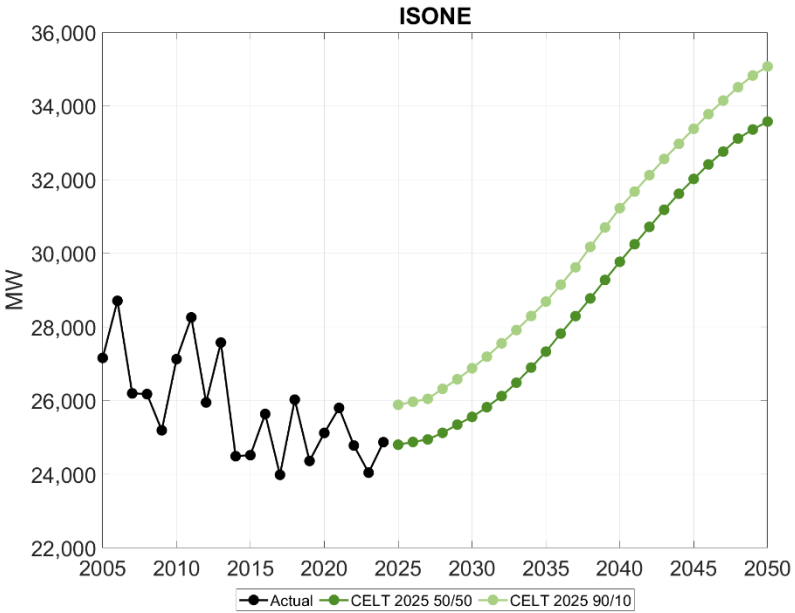
New England 50/50 - Summary

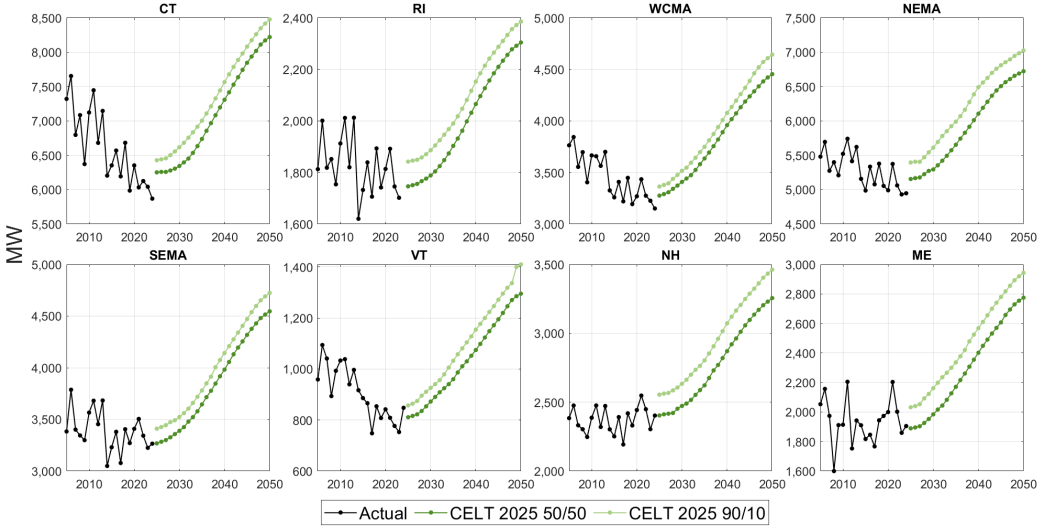
Year	Base (MW)	Transportation Electrification* (MW)	Heating Electrification* (MW)	Gross (MW)	BTM PV (MW)	Net (MW)
2025	26,471	66	2	26,539	-1,736	24,803
2026	26,542	87	6	26,635	-1,759	24,877
2027	26,621	117	16	26,754	-1,809	24,945
2028	26,801	174	18	26,993	-1,869	25,124
2029	26,994	244	25	27,262	-1,915	25,347
2030	27,130	331	34	27,495	-1,938	25,557
2031	27,281	437	45	27,764	-1,942	25,821
2032	27,442	558	60	28,059	-1,936	26,123
2033	27,624	698	78	28,400	-1,915	26,486
2034	27,821	852	104	28,777	-1,879	26,897

** Electrification forecasts are included in both gross and net peak forecasts.*

Final 2025 50/50 and 90/10 Forecasts

Summer Net Peak



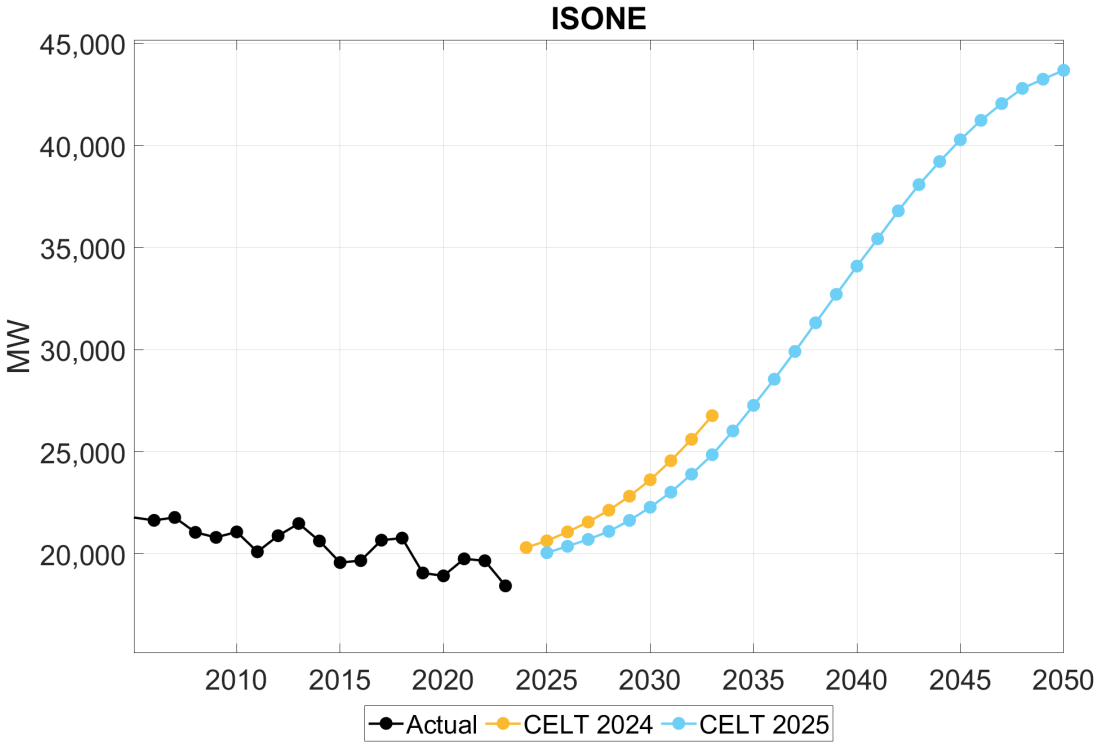


FINAL 2025 WINTER PEAK DEMAND FORECAST

Winter Net 50/50 Peak Forecast

New England – Final CELT 2025 Vs. CELT 2024

Year	Net CELT 2024 (MW)	Net CELT 2025 (MW)	Change (MW)	Change (%)
2025	20,638	20,056	-582	-2.8%
2026	21,075	20,371	-704	-3.3%
2027	21,559	20,707	-852	-4.0%
2028	22,136	21,101	-1,035	-4.7%
2029	22,824	21,638	-1,186	-5.2%
2030	23,628	22,284	-1,344	-5.7%
2031	24,562	23,021	-1,541	-6.3%
2032	25,609	23,902	-1,707	-6.7%
2033	26,768	24,856	-1,912	-7.1%
2034		26,020		



Final 2025 Winter Peak Forecasts

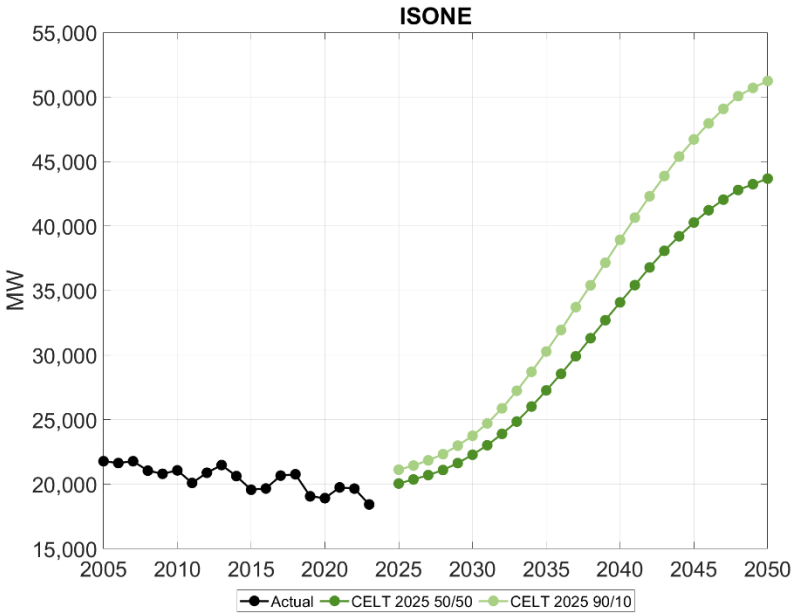
New England 50/50 - Summary

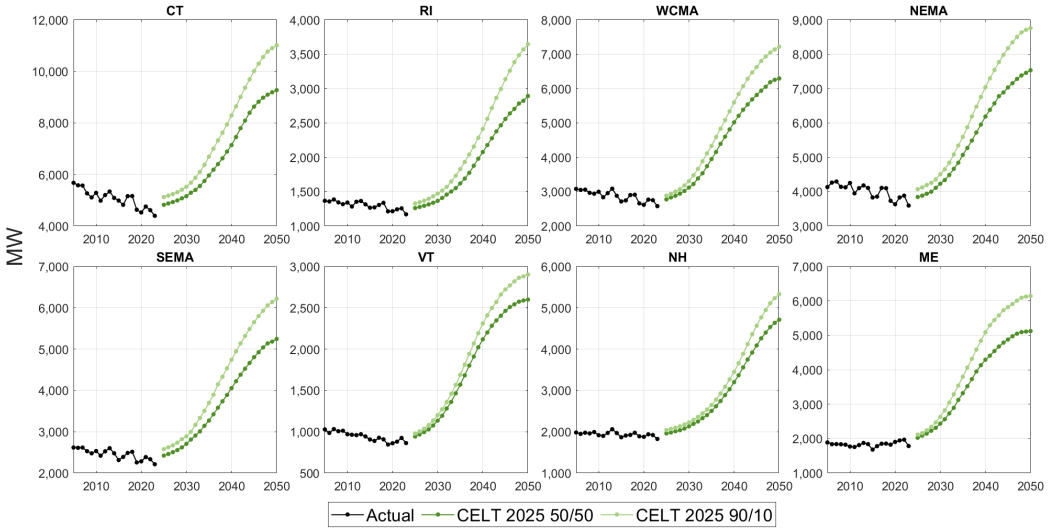
Year	Base (MW)	Transportation Electrification* (MW)	Heating Electrification* (MW)	Gross (MW)	BTM PV (MW)	Net (MW)
2025	19,756	114	186	20,056	0	20,056
2026	19,775	168	435	20,378	-7	20,371
2027	19,795	229	707	20,731	-24	20,707
2028	19,810	356	992	21,159	-58	21,101
2029	19,820	509	1,421	21,751	-113	21,638
2030	19,831	694	1,927	22,452	-168	22,284
2031	19,843	914	2,472	23,229	-208	23,021
2032	19,857	1,166	3,123	24,145	-243	23,902
2033	19,873	1,449	3,837	25,159	-304	24,856
2034	19,892	1,764	4,765	26,422	-402	26,020

** Electrification forecasts are included in both gross and net peak forecasts.*

Final Draft 2025 50/50 and 90/10 Forecasts

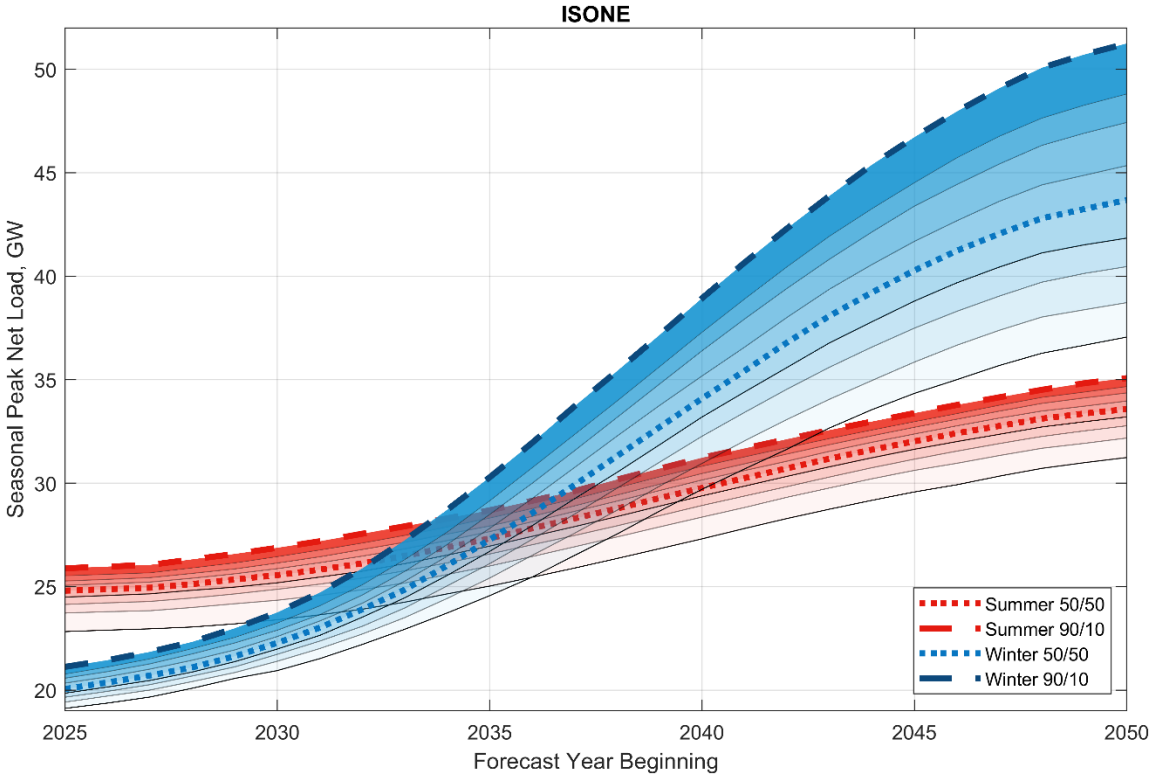
Winter Net Peak





Winter and Summer Peak Convergence

- Plot shows “peak” portion of probabilistic net load forecast distribution for both winter and summer
  - Forecasts include impacts of both heating and transportation electrification
- By 2033, the 90/10 net winter demand forecast exceeds the 50/50 net summer demand forecast
- Beyond 2035, electrification is expected to cause winter peak demand to become the typical, prevailing peak season



GROSS LOAD FORECAST FOR CALCULATING ICR FOR UPCOMING ARAS

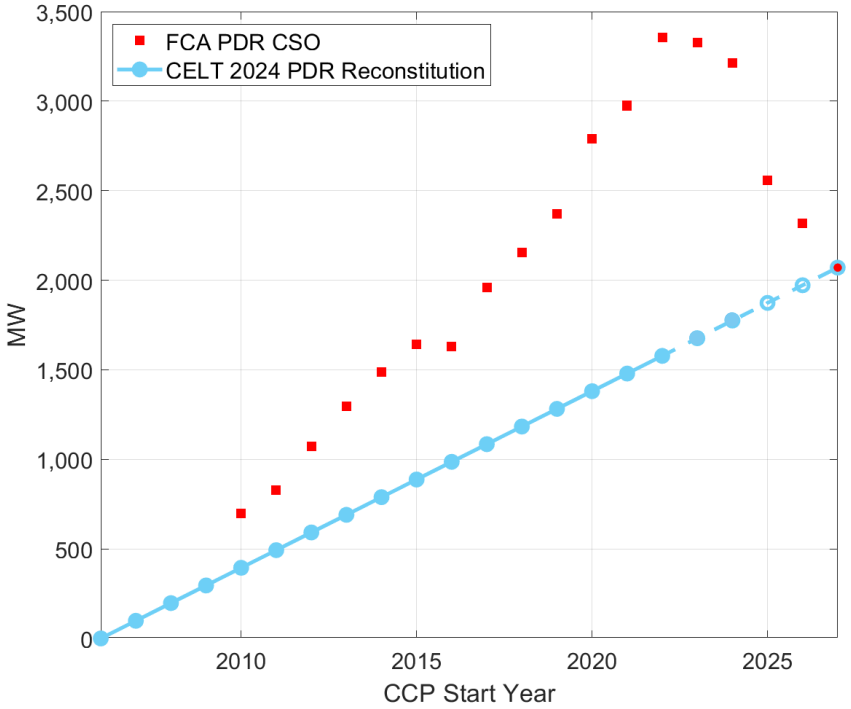
CELT 2025: Pre-Existing Forecast Methodology

- Calculation of ICR for the remaining FCM ARAs will be supported by a gross load forecast based on the pre-existing (pre-CELT 2025) forecast methodology
  - Gross load stems from reconstituting for BTM PV and PDRs
  - Separate models for energy and seasonal peaks
  - Details on the pre-existing forecast methodology can be found in this presentation
- Input data
  - Reconstitution for PDR resources based on FCA 18 CSOs
  - CELT 2025 EV and HP forecasts
  - Load, weather, economic data through end of 2024
- Reporting of gross load forecast values generated using the pre-existing methodology will be confined to specific tabs within the CELT Report and Forecast Data Workbook

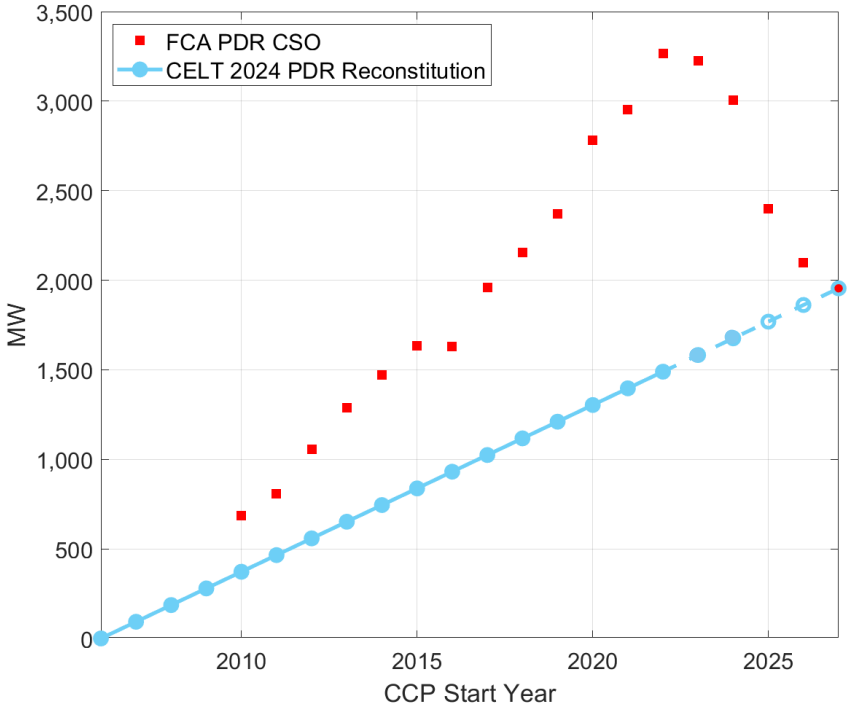
Pre-Existing Methodology

CELT 2025 PDR Reconstitution for New England

Summer (June) PDR CSO

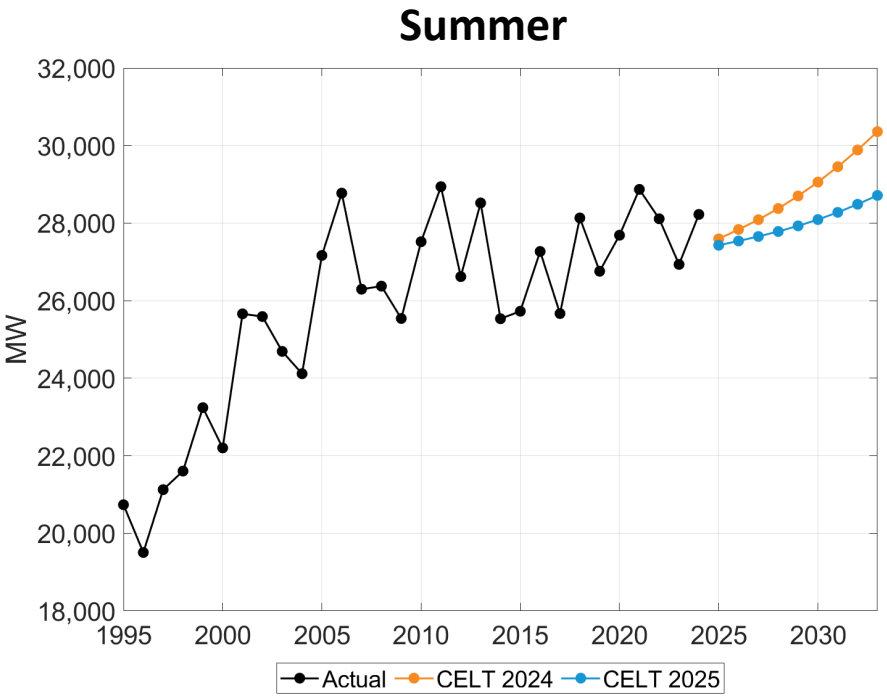


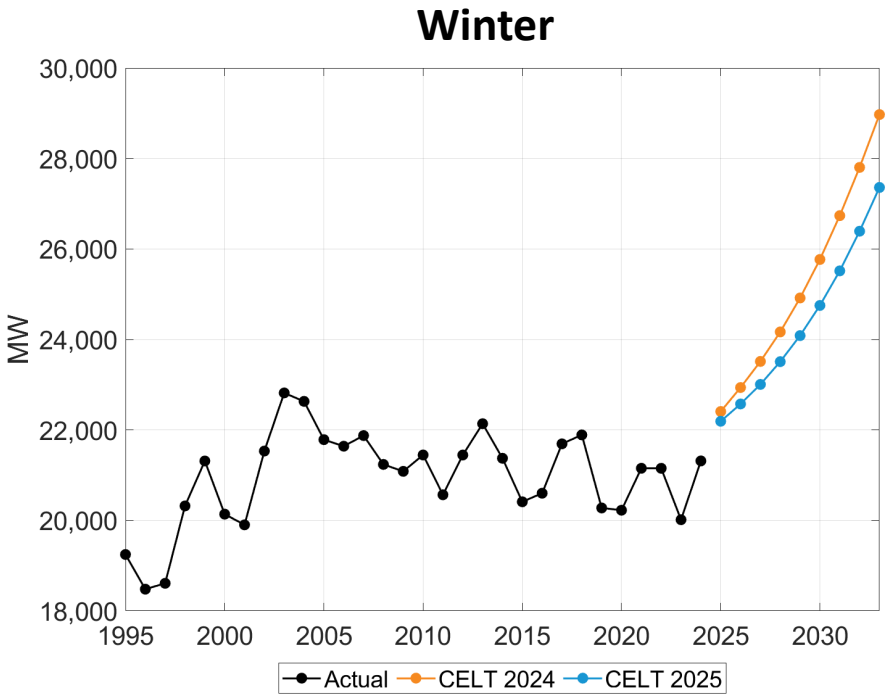
Winter (December) PDR CSO



Pre-Existing Methodology

CELT 2025 50/50 Gross Peak Forecast





Pre-Existing Methodology

CELT 2025 Gross Load Forecast Values for ARAs

- Upcoming ARA events will only use forecast values relevant to the 2026-2027 and 2027-2028 capacity commitment periods (CCPs)

Year (Winter Start Year)	Summer 50/50 Peak (MW)	Summer 90/10 Peak (MW)	Winter 50/50 Peak (MW)	Winter 90/10 Peak (MW)	Annual Energy (GWh)
2026	27,539	29,407	22,574	23,495	134,794
2027	27,655	29,532	23,006	24,031	136,064

LOAD FORECAST REPORTING

Load Forecast Reporting

- Prior to CELT 2025, the long-term load forecast has been published across three workbooks available on the ISO webpage
  - CELT Report
    - Contains a subset of load forecast data, for ISONE as a whole
  - Forecast Data workbook
    - Contains detailed reporting of forecast results over 10-year horizon
  - Forecast Itemization workbook
    - Contains further details on forecast components over 10-year horizon

- For the CELT 2025 forecast, modifications will be made to how the load forecast is reported
  - CELT Report
    - Removal of lines related to the EE forecast
    - Forecast values reported in the CELT report will be largely unchanged
  - Forecast Data workbook
    - Workbook tabs will be consolidated to reflect data-friendly formatting
    - Changes implemented for CELT 2025 are intended to set the stage for expanded and enhanced reporting in the future
    - Will include reporting of forecast results over 20-year horizon
  - Forecast Itemization workbook
    - This product will be retired
    - Data will now be integrated into the Forecast Data workbook

Forecast Data Workbook

Conceptualization of Improvements for CELT 2025

Forecast Data 2024

2024 CELT Forecast Detail: ISONE Control Area, New England States, RSP Sub-areas, and SMD Load Zones

SUMMER PEAK(MW)

	GROSS			GROSS-PV			NET	
ISO-NE	50/50	90/10	PV	50/50	90/10	EE	50/50	90/10
2024	27,424	29,254	1,097	26,327	28,158	1,775	24,553	26,383
2025	27,593	29,434	1,141	26,453	28,293	1,873	24,579	26,419
2026	27,835	29,688	1,161	26,674	28,526	1,972	24,702	26,554
2027	28,088	29,953	1,173	26,916	28,780	2,070	24,845	26,710
2028	28,376	30,254	1,199	27,178	29,055	2,102	25,076	26,954
2029	28,700	30,592	1,218	27,481	29,373	2,117	25,364	27,256
2030	29,058	30,966	1,236	27,823	29,730	2,117	25,706	27,613
2031	29,453	31,377	1,253	28,201	30,124	2,101	26,100	28,023
2032	29,886	31,826	1,269	28,616	30,556	2,069	26,547	28,488
2033	30,359	32,313	1,284	29,075	31,029	2,023	27,052	29,007
CAGR	1.1	1.1	1.8	1.1	1.1	1.5	1.1	1.1
STATES:								
CT	50/50	90/10	PV	50/50	90/10	EE	50/50	90/10
2024	6,964	7,400	217	6,747	7,183	448	6,299	6,735
2025	6,983	7,420	243	6,741	7,177	473	6,268	6,705
2026	7,016	7,453	268	6,748	7,186	498	6,251	6,688

- Formatted columns and rows with spaces, merged cells, and mixed data types
- Multiple sheets are needed to support summer and winter values
- Blocks for each subregion
- Lack of adaptability to future needs
  - Adding granularity or new concepts entails adding blocks of data and new data tabs

NEW Forecast Data 2025

Region	Year	Season	Coincidence	Percentile	Base	EV	HP	Gross	BTMPV	Net
ISONE	2025	summer	CP	50	26471	66	2	26539	1736	24803
ISONE	2025	summer	CP	90	27759	67	2	27828	1942	25886
ISONE	2025	winter	CP	50	19756	114	186	20056	0	20056
ISONE	2025	winter	CP	90	20789	115	221	21125	0	21125
CT	2025	summer	CP	50	6575	15	0	6591	338	6253
CT	2025	summer	CP	90	6784	15	0	6799	370	6429
CT	2025	winter	CP	50	4773	21	29	4824	0	4824
CT	2025	winter	CP	90	5060	25	41	5126	0	5126
ISONE	2026	summer	CP	50	26542	87	6	26635	1759	24877
ISONE	2026	summer	CP	90	27835	92	6	27934	1965	25969
ISONE	2026	winter	CP	50	19775	168	435	20378	7	20371

- Columns contain a single data type
- Meta data columns provide concise identification of desired data elements
- Data can be easily extracted in Excel by applying filters, or can be processed programmatically
- Seamless reporting of large datasets
- Adaptability to future needs
  - Reporting of additional granularity or more forecast years simply adds more rows
  - Reporting of new concepts or meta data attributes entails new columns

Forecast Data Workbook

Replaced Tabs

Tab in Forecast Data 2024	NEW Tab* in Forecast Data 2025
2A Summer (MW)	Seasonal Peaks
2B Winter (MW)	
7 Distrbn	
12 FC	
4 Mnth Peak	Monthly Peaks
2C Energy (GWh)	Energy
6 Mnth NEL	
16 Electrification	Seasonal Peaks / Energy

** Exact naming of tabs in the Forecast Data 2025 workbook will be subject to finalization, and may change.*

Forecast Data Workbook

Discontinued Tabs

Tab in Forecast Data 2024	Description of Existing Tab	NEW Reference Tab* in Forecast Data 2025
10g Gross Diff 10n Net Diff	• Formatted tables of differences between energy values for select load components, for the current and prior forecast vintage	This can more easily and comprehensively be extracted utilizing the new “Energy” tab
14 Summary	• Formatted table of differences between select peak values, for select load components, and percentiles, for the current and prior forecast vintage	This can more easily and comprehensively be extracted utilizing the new “Seasonal Peaks” tab
15 PV EE	• Formatted table of differences between energy and demand values, for the EE and BTM PV forecasts, for current and prior forecast vintages • The EE forecast has been discontinued as of CELT 2025	BTMPV forecast values can be found in the new “Energy”, “Seasonal Peaks”, and “Monthly Peaks” tabs

** Exact naming of tabs in the Forecast Data 2025 workbook will be subject to finalization, and may change.*

Next Steps

- The final CELT 2025 forecast will be published on May 1 2025
  - CELT Report (CELT webpage)
  - Forecast Data workbook (Load Forecast webpage)
  - Slide decks describing the final EV and HP forecasts (Load Forecast webpage)

Questions

Acronyms

ASOS	Automated Surface Observing System	**EIA**	Energy Information Administration
ARA	Annual reconfiguration auction	**EV**	Electric Vehicle
AEO	EIA's Annual Energy Outlook	**GCM**	Global Climate Model
BTMPV	Behind the meter photovoltaic	**FCM**	Forward Capacity Market
CDD	Cooling degree day	**GWH**	Gigawatt hour
CELT	Capacity, Energy, Load, and Transmission	**HDD**	Heating degree day
COP	Coefficient of performance	**HP**	Heat pump
CSO	Capacity Supply Obligation	**ICR**	Installed Capacity Requirement
DER	Distributed energy resource	**IPSL**	Institut Pierre-Simon Laplace (Climate Modelling Center)
DGFWG	Distributed Generation Forecast Working Group	**LFC**	Load Forecast Committee
ECMWF	European Center for Medium-Range Weather Forecasts	**MAPE**	Mean absolute percent error
EE	Energy Efficiency	**MW**	Megawatt
EEFWG	Energy Efficiency Forecast Working Group	**PDR**	Passive Demand Resource
EPRI	Electric Power Research Institute	**SAE**	Statistically-adjusted end-use
ERA5	ECMWF Reanalysis Version 5	**SSP**	Shared Socioeconomic Pathway