

Draft 2025 Photovoltaic (PV) Forecast

Distributed Generation Forecast Working Group



Long Vu

LEAD DATA SCIENTIST, SYSTEM PLANNING

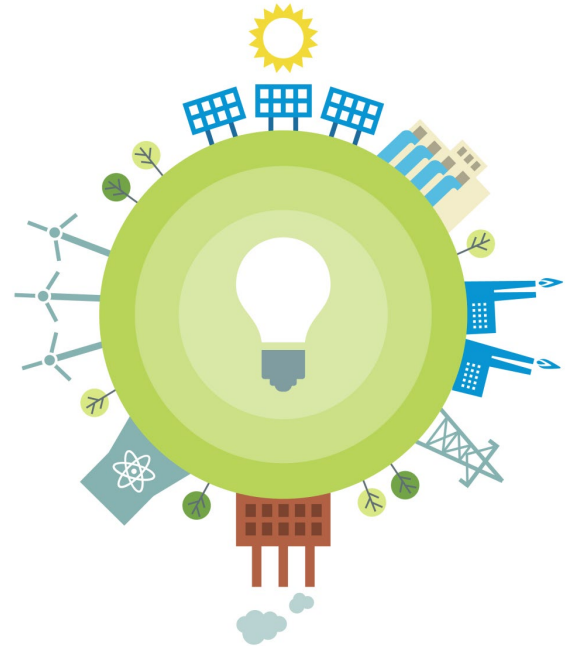


Acronyms

BTM	Behind-the-meter	IOU	Investor-owned utility
CBI	Capacity-based incentive	ITC	Investment tax credit
CELT	Capacity, Energy, Load, and Transmission report	NEB	Net energy billing (ME)
C&I	Commercial and industrial	NM, NEM	Net metering, net energy metering
DER	Distributed energy resource	NREL	National Renewable Energy Laboratory
DG	Distributed generation	NRES	Non-residential Renewable Energy Solutions (CT)
DGFWG	Distributed Generation Forecast Working Group	PP12	ISO-NE Planning Procedure 12
dGEN™	Distributed Generation Market Demand Model	PV	Photovoltaic
EOR	Energy only resources	REF	Renewable Energy Fund (RI)
FCM	Forward Capacity Market	REG	Renewable Energy Growth program (RI)
FITs	Feed-in-tariffs	RRES	Residential Renewable Energy Solutions (CT)
IBI	Investment-based incentive	SCEF	Shared Clean Energy Facility program (CT)
ICR	Installed Capacity Requirement	SMART	Solar Massachusetts Renewable Target

Outline

- Introduction
- 2024 Interconnected DER PV: Forecast vs. Reported
- 2025 Forecast Assumptions and Inputs
- Draft 2025 DER PV Nameplate Forecast
- Next Steps



INTRODUCTION



Introduction

- The majority of state-sponsored distributed PV does not participate in wholesale markets, but reduces the system load observed by ISO
- The long-term PV forecast helps the ISO determine future system load characteristics that are important for the reliable planning and operation of the system
- To properly account for PV in long-term planning, the finalized PV forecast will be categorized as follows:
 1. PV as a capacity resource in the Forward Capacity Market (FCM)
 2. Non-FCM Energy Only Resources (EOR) and Generators
 3. Behind-the-meter PV (BTM PV)

Behind-the-meter PV is reconstituted into historical loads*

The 2025 gross load forecast reflects loads without PV load reductions

**Historical BTM PV reduces historical metered loads; historical loads reconstituted for BTMPV are used to model base load in developing the base load forecast*

PV Forecast Focuses on Distributed Generation

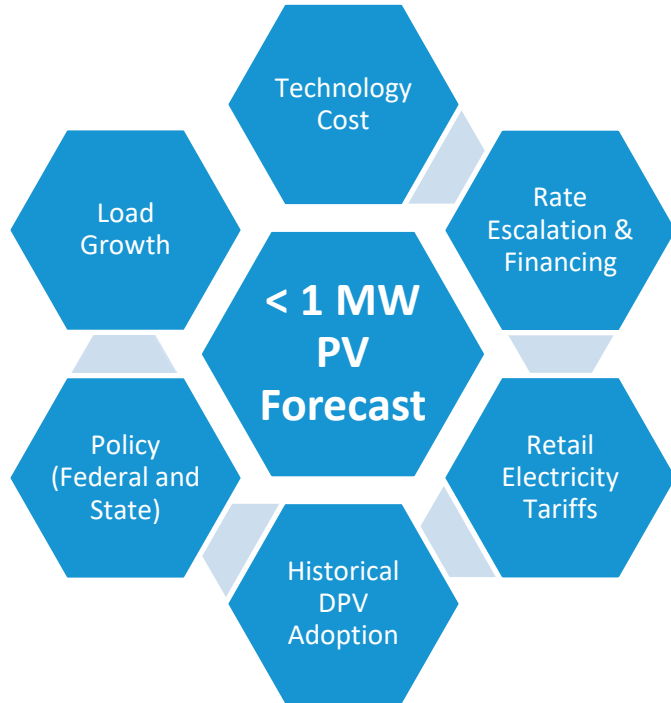
- The focus of the DGFWG is distributed generation (DG) projects:
 - “...defined as those that are typically 5 MW or less in nameplate capacity and are interconnected to the distribution system (typically 69 kV or below) according to state-jurisdictional interconnection standards.”
 - Note that the industry has evolved since the formation of the DGFWG, and today DG is often referred to as a distributed energy resource (DER)
 - Per ISO’s [Planning Procedure 12](#), DER is defined as *any generator or energy storage facility located on the distribution system, any subsystem thereof, or behind a customer meter that is capable of providing energy injection, energy withdrawal, regulation or demand reduction*
 - DER does not include demand response, controllable loads, or other load modifiers
- While DER may include larger-scale DER projects greater than 5 MW in size, the forecast does not consider policy drivers and growth of larger-scale DER projects, since these projects are generally accounted for as part of ISO’s interconnection process and participate in wholesale markets

PV Forecast Methodology

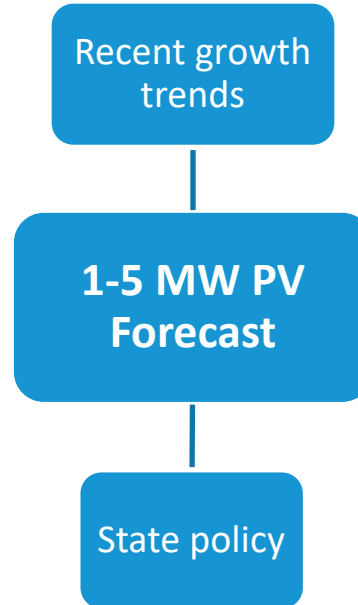
- The PV forecast is a projection of distributed PV resources to be used in ISO-NE System Planning studies, consistent with its role to ensure prudent planning assumptions for the bulk power system
- Beginning with the 2024 PV forecast, the ISO's methodology includes use of the Distributed Generation Market Demand Model (dGen™), an agent-based simulation that was developed and open-sourced by the National Renewable Energy Laboratory (NREL)
 - An overview of the dGen™ model was presented by the NREL team at the [October 2023 DGFWG meeting](#)
- The nameplate PV forecast is developed using the two following additive processes:
 1. For < 1 MW systems: Use residential and commercial dGen™ modeling
 2. For 1-5 MW systems: Use a policy-based approach
- For this year's forecast, the ISO is developing the forecast out through 2050

PV Forecast Inputs

PV Systems < 1 MW



PV Systems 1-5 MW



2024 INTERCONNECTED DER PV

Forecast vs. Reported



2024 DER PV Nameplate Capacity Growth

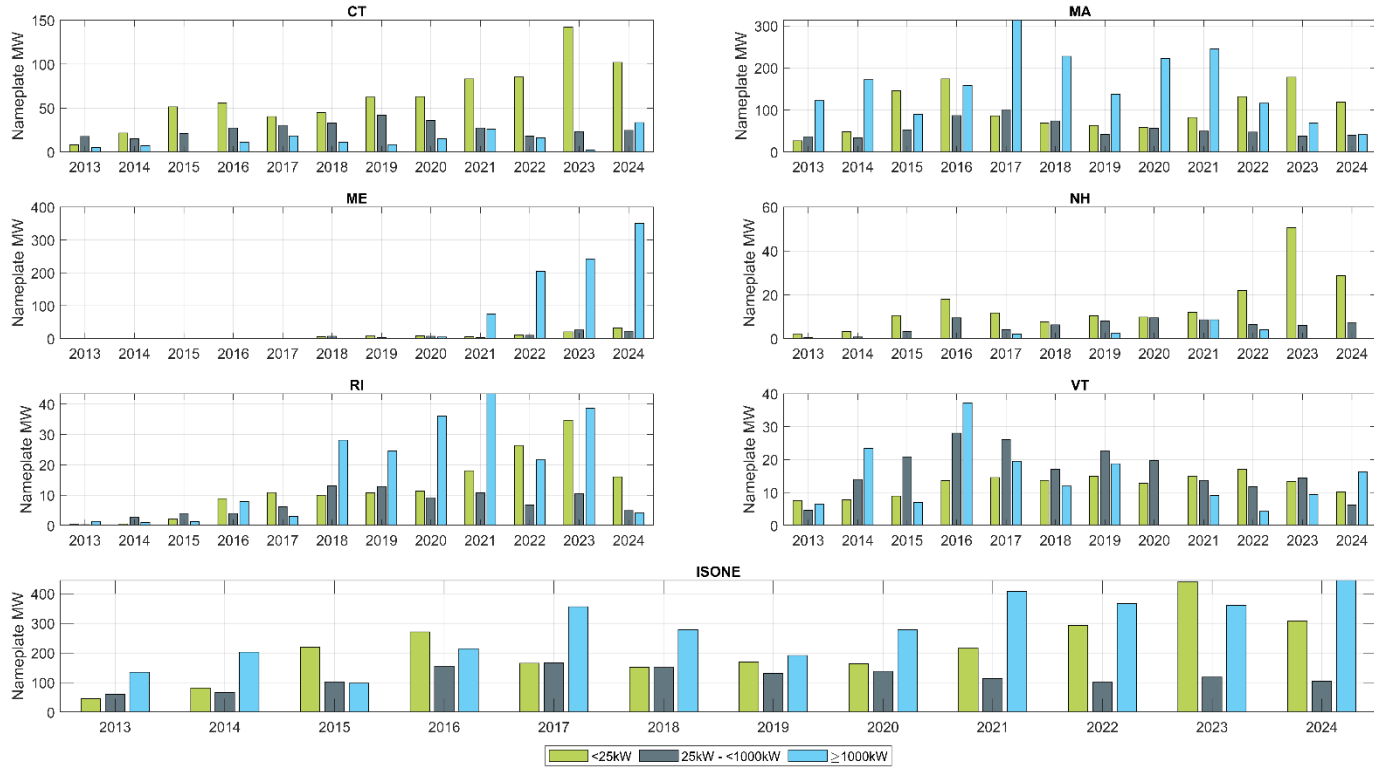
- End of 2024 DER interconnection data reported to ISO is draft
 - On-going data quality checks and improvements as part of ISO's first data collection per [Planning Procedure 12](#)
- A comparison of end-of-2024 and end-of-2023 total reported DER PV capacity is tabulated (top table)
 - Historical amounts of interconnected DER change with each vintage of data reported to ISO
 - The magnitude of changes are typically relatively small
 - Historical end-of-2023 totals reported at the end of 2024 were 159 MW higher than totals reported a year ago
 - Recent ME totals were 104 MW higher than a year ago
 - More significant changes in historical data are likely due to changes in reporting requirements as part of implementation of PP12
- For the annual long-term forecast, ISO is forecasting annual growth in DER PV
- A comparison of 2024 forecast PV growth (CELT 2024) and 2024 growth reported by DER data providers is tabulated (bottom table)
 - Reported growth is based on DER with interconnection dates in 2024
 - Regionally, 2024 reported growth exceeded the CELT 2024 forecast by 53 MW

State	A Total Reported Capacity, MW (End of 2023)	B Total Reported Capacity, MW (End of 2024)	C Total Capacity Change, MW [B - A]
CT	1,091	1,269	178
MA	3,712	3,929	217
ME	588	1,096	508
NH	244	274	30
RI	400	454	54
VT	507	537	30
ISO-NE	6,542	7,558	1,016

State	D 2024 Forecast Growth, MW (CELT 2024)	E 2024 Reported Growth, MW (End of 2024)	F Forecast Error [E - D]
CT	151	160	9
MA	327	200	-127
ME	224	404	180
NH	27	36	9
RI	46	25	-21
VT	29	33	3
ISO-NE	804	857	53

Capacity of Reported Annual DER PV Growth

Small ($\leq 25kW$), Medium ($25- < 1,000kW$), and Large ($\geq 1,000kW$) Projects



Larger-Scale DER PV

Projects >5 MW_{ac}

- Tabulated is a summary of in-service, larger-scale DER PV projects included as part of PP12 data submittals
- These projects are not included in the PV forecast accounting, and are excluded from installed DER PV totals reported herein

State	# Projects Listed	Total Nameplate (MW _{ac})
CT	7	128
MA	-	-
ME	8	88
NH	-	-
RI	30	254
VT	-	-
Total	45	470

DGEN™ PV (< 1MW) FORECAST

Assumptions and Inputs



dGen™ Assumptions

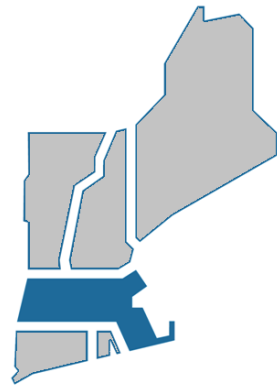
- The ISO [presented](#) the policy modeling assumptions used as inputs to dGen™ at the December 8, 2023 DGFWG
- For 2025 PV forecast, the ISO updated the following inputs to the dGen™ model
 - Historical PV nameplate capacity growth (up to 2022)
 - Tariff rate for each “agent” based on the utility rate from [NREL’s Utility Rate Database \(URDB\)](#)
 - Residential and non-residential incentive rates from the policies driving the PV nameplate capacity growth in the region
 - Calibrate the model parameters based on the most recent observed nameplate capacity growth (2024 data)
- NREL’s [2023 Electricity Annual Technology Baseline \(ATB\)](#) forecast are also used as an input regarding future PV technology costs
 - NREL’s forecast assumes a decline in technology cost at an increasing rate toward the end of the forecast horizon
 - The ISO will use 2024 ATB as an input in the final PV draft forecast

MEGAWATT-SCALE PV FORECAST

Assumptions and Inputs

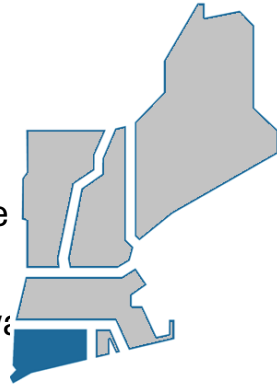


Massachusetts Forecast Assumptions



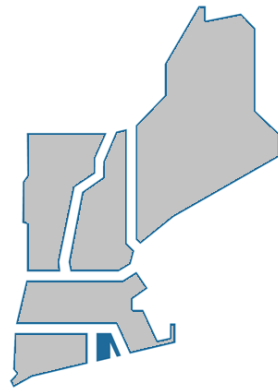
- Policy information is contained in in the MA Department of Public Utilities (MA DPU) [presentation](#) to the DGFWG on December 9, 2024
- PP12 reporting included a total of 1,978 MW_{AC} of MW-scale systems installed through 12/31/2024 with less observable growth from large systems since 2022.
- Within Solar Massachusetts Renewable Target (SMART) Program, approximately 1,021 MW_{AC} of large systems were installed by end of 2024
 - Assume an additional 312 MW_{AC} of large projects will be installed to reach program goal by 2029

Connecticut Forecast Assumptions



- Policy information is contained in the CT Department of Energy & Environmental Protection (DEEP) [presentation](#) to the DGFWG on December 9, 2024
- A total of 435.5 MW_{AC} are operational under the existing Low- & Zero-Emission Renewable Energy Credits (LREC/ZREC) program, and 104.5 MW are assumed to remain.
 - Based on the historical share of large systems, assume 10.8 MW_{AC} to be from large systems
- 8 MW_{AC} are in service under the Shared Clean Energy Facility (SCEF) program, with another 132 MW selected
 - Assume all of the selected MW are large systems, and that another 50 MW_{AC} are expected to be installed under the program's 2025 procurement
 - In addition, Public Act 24-31 extended the SCEF program from 6 years to 8 years
- 56.7 MW_{AC} of MW-scale systems were selected under Non-Residential Energy Solution. An addition of 143 MW_{AC} are expected to be installed throughout the remaining period of the program
- PP12 reporting shows a 3-year average growth rate for MW-scale systems of 17.1 MW_{AC} with 33.4 MW_{AC} installed last year

Rhode Island Forecast Assumptions



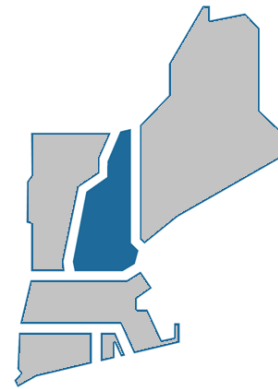
- Policy information is contained in the RI Office of Energy Resources (RI OER) [presentation](#) to the DGFWG on December 9, 2024
- 215.8 MW_{AC} of large system were installed by the end of 2024. An addition of 75 MW_{AC} of large systems are planned from 2024-2026 according to the Renewable Energy Growth (REG) Program Drafted Megawatt Allocation Plan
- Historical data on Renewable Energy Fund (REF) does not include any large systems
- PP12 reporting shows a 3-year average growth rate for MW-scale systems of 21.4 MW_{AC} with 4.1 MW_{AC} installed last year

Vermont Forecast Assumptions



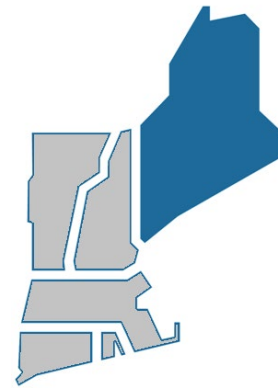
- Policy information is contained in the VT Department of Public Service (VT PSD) [presentation](#) to the DGFVG on December 9, 2024
- 85 MW_{AC} were installed under the Standard Offer program. An addition of 42 MW_{AC} are anticipated, all of which are large systems
- DG carve-out of the Renewable Energy Standard (RES) and its supporting policies (Standard Offer Program, net metering) drive distributed PV growth to match a growing share of VT's annual load energy, with the following assumptions:
 - All forward-looking renewable energy certificates (RECs) from Standard Offer and net metered projects will be sold to utilities and count towards RES DG carve-out
- PP12 reporting shows a 3-year average growth rate for MW-scale systems was 9.9 MW_{AC} with 16.2 MW_{AC} installed last year
- The forecast assumed a near-term increase in the adoption due to the increase in DG RES obligations for utilities in VT. The forecast considered recent DG RES policy changes in VT by increasing the assumed growth of MW-scale systems until 2035
- As part of finalizing VT's 2025 forecast, ISO will revisit MW-scale PV forecast assumptions to include expectations about VT's future load growth based on the ISO's 2025 long-term load forecast

New Hampshire Forecast Assumptions



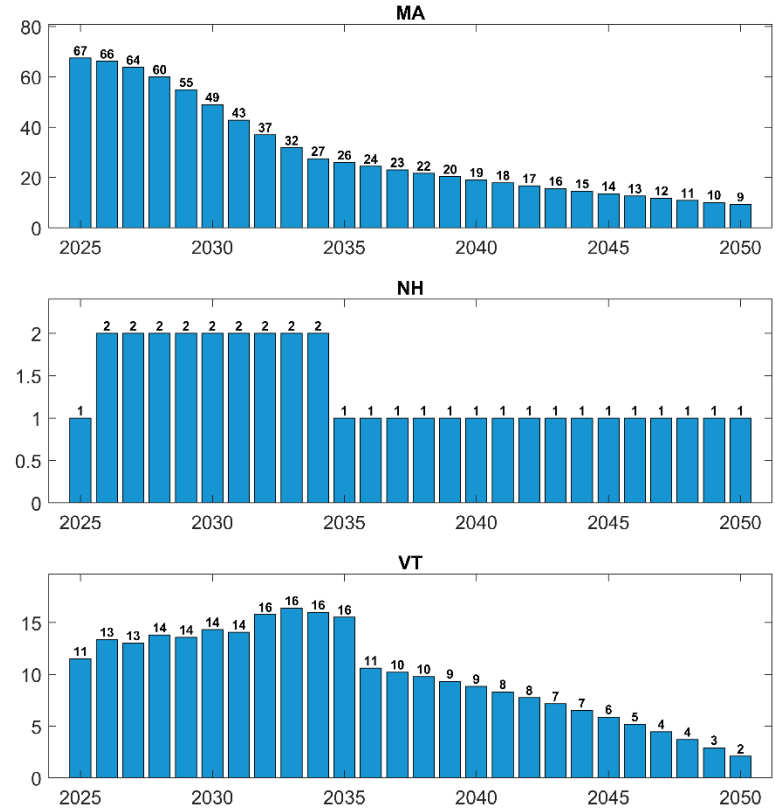
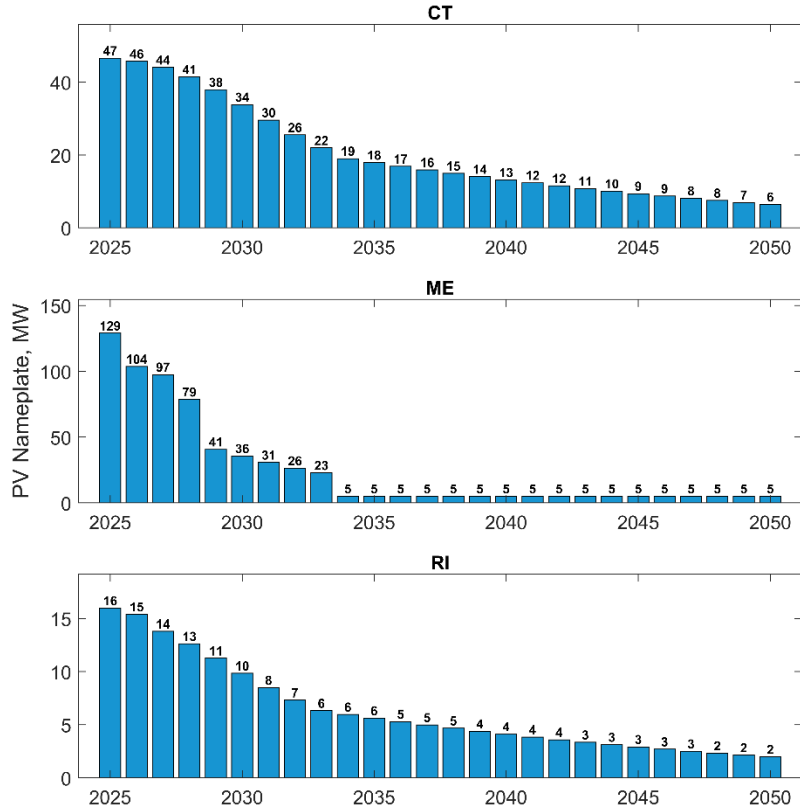
- Policy-based (large system):
 - Policy information is contained in the NH Department of Energy (NH DOE) [presentation](#) to the DGFWG on December 9, 2024
 - Per NH’s net metering tariff, Municipal Hosts are permitted to install projects up to 5 MW
 - PP12 reporting suggests that growth in MW-scale systems in NH has been minimal and sporadic, with zero installed capacity in 2023 and 2024. The forecast assumed no change in policy supporting MW-scale systems

Maine Forecast Assumptions



- Policy information is contained in the ME Governor’s Energy Office (ME GEO) [presentation](#) to the DGFWDG on December 9, 2024
- PP12 reporting indicates a total of 882.1 MW_{AC} of MW-scale systems installed through 12/31/2024, including 350 MW_{AC} in 2024
- Annual state MW forecast inputs tabulated below result from the following state programs:
 - Net Energy Billing (NEB), 2-5 MW projects
 - Assume 750 MW total, all of which came online through 2024
 - NEB Successor, 2-5 MW projects
 - Assume 560 MW total program goal, minus 5% of program capacity assumed to be installed in Maine Public District (i.e., outside of ISO New England) and approximately 130 MW that came online through 2024
 - NEB, < 2MW projects, with an assumed annual growth of 5 MW

Megawatt-scale PV Forecast Inputs



USE OF DISCOUNT FACTORS



Discount Factors

- Discount factors are:
 - Developed and incorporated into the forecast to consider a degree of expected uncertainty
 - All discount factors are applied equally in all states
 - Applied to the forecast inputs (see slides 26-28) to determine total nameplate capacity for each state and forecast year

Policy-Based

PV that results from state policy

Discounts for uncertainty associated with future market and grid conditions (maximum value of 15%)

Discount Factors Used

Policy-Based

Forecast Year	Final 2024 Forecast	Draft 2025 Forecast
2025	5%	2.5%
2026	7.5%	5%
2027	10%	7.5%
2028	12.5%	10%
2029	15%	12.5%
2030	15%	15%
2031	15%	15%
2032	15%	15%
2033	15%	15%
2034 - 2050	N/A	15%

Draft 2025 Forecast Inputs – 10-Year Horizon

Nameplate Capacity, PV Systems < 1 MW

States	Annual Total MW (AC nameplate rating)											Totals
	Thru 2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	
CT	1,116	121	124	136	141	150	155	168	176	168	152	2,607
MA	1,951	221	228	253	263	283	294	317	330	311	281	4,730
ME	214	36	39	52	59	72	79	89	93	90	84	907
NH	257	32	34	42	47	55	58	64	67	67	64	786
RI	238	51	53	64	72	68	58	50	54	52	46	807
VT	363	22	22	25	26	29	31	35	38	35	30	657
ISONE	4,139	482	501	572	607	659	674	723	757	723	657	10,494

Notes:

- (1) The above values **are not forecast values**, but rather pre-discounted inputs to the forecast (see slides 22-23 for details)
- (3) All values include FCM Resources, non-FCM Settlement Only Generators and Generators (per OP-14), and load reducing PV resources
- (4) All values represent end-of-year installed capacities

Draft 2025 Forecast Inputs – 10-Year Horizon

Nameplate Capacity, PV Systems 1-5 MW

States	Annual Total MW (AC nameplate rating)											Totals
	Thru 2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	
CT	153	47	46	44	41	38	34	30	26	22	19	499
MA	1,978	67	66	64	60	55	49	43	37	32	27	2,478
ME	882	129	104	97	79	41	36	31	26	23	5	1,452
NH	17	1	2	2	2	2	2	2	2	2	2	36
RI	216	16	15	14	13	11	10	8	7	6	6	323
VT	173	11	13	13	14	14	14	14	16	16	16	315
ISONE	3,419	271	246	234	208	160	144	128	114	101	75	5,102

Notes:

- (1) The above values **are not forecast values**, but rather pre-discounted inputs to the forecast (see slides 22-23 for details)
- (3) All values include FCM Resources, non-FCM Settlement Only Generators and Generators (per OP-14), and load reducing PV resources
- (4) All values represent end-of-year installed capacities

Draft 2025 Forecast Inputs – 10-Year Horizon

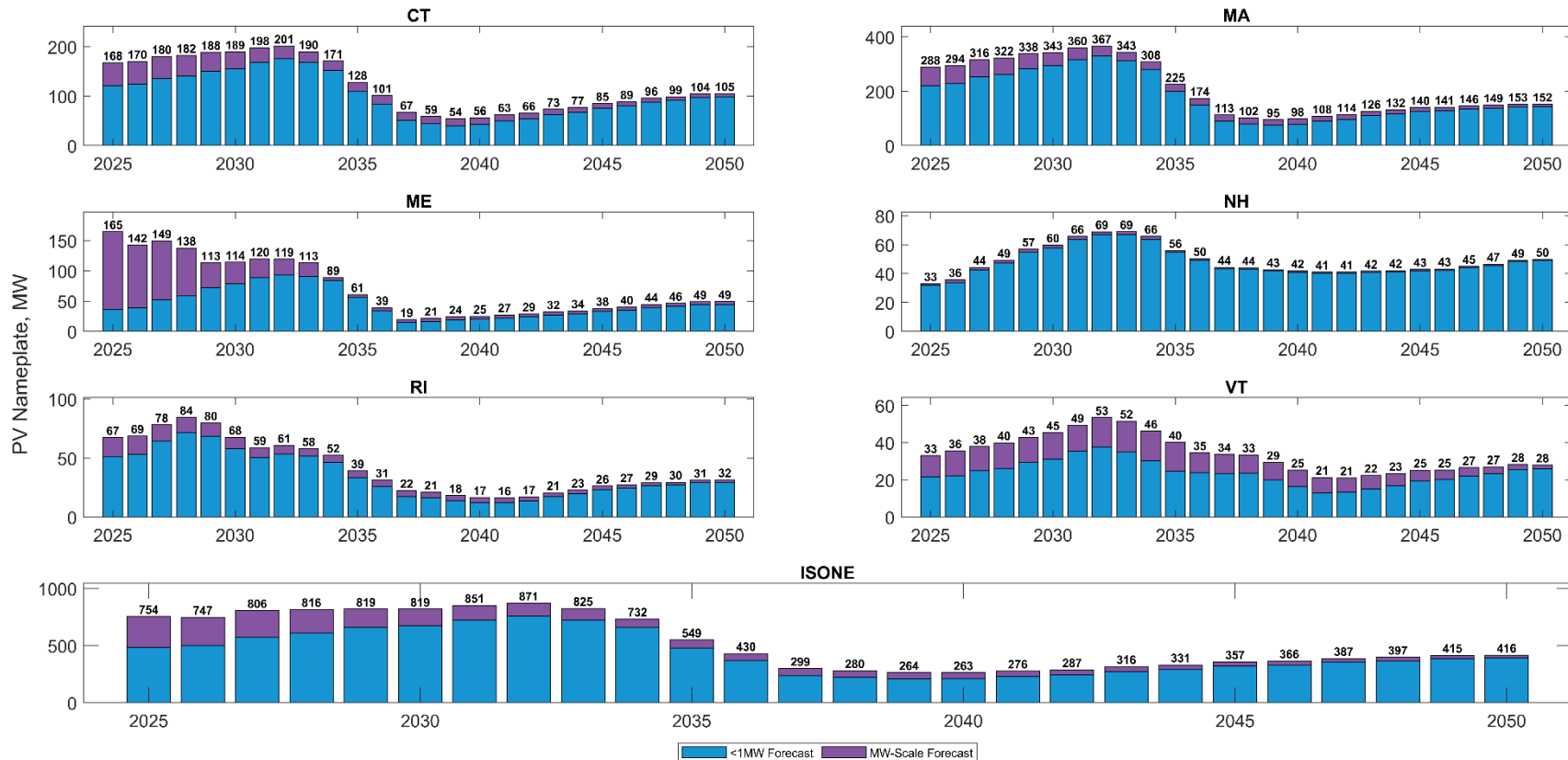
Pre-Discounted Nameplate Values, All PV Systems

States	Annual Total MW (AC nameplate rating)											Totals
	Thru 2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	
CT	1,269	168	170	180	182	188	189	198	201	190	171	3,105
MA	3,929	288	294	316	322	338	343	360	367	343	308	7,208
ME	1,096	165	142	149	138	113	114	120	119	113	89	2,359
NH	274	33	36	44	49	57	60	66	69	69	66	822
RI	454	67	69	78	84	80	68	59	61	58	52	1,130
VT	537	33	36	38	40	43	45	49	53	52	46	972
Pre-Discount Annual Total (MW)	7,558	754	747	806	816	819	819	851	871	825	732	15,597
Pre-Discount Cumulative Total (MW)	7,558	8,312	9,059	9,865	10,681	11,500	12,319	13,169	14,040	14,864	15,597	15,597

Notes:

- (1) The above values **are not the forecast**, but rather pre-discounted inputs to the forecast (see slides 23-24 for details)
- (3) All values include FCM Resources, non-FCM Settlement Only Generators and Generators (per OP-14), and load reducing PV resources
- (4) All values represent end-of-year installed capacities

Draft 2025 Forecast Inputs – Forecast Horizon



DRAFT 2025 PV NAMEPLATE CAPACITY FORECAST

Draft 2025 PV Forecast – 10-Year Horizon

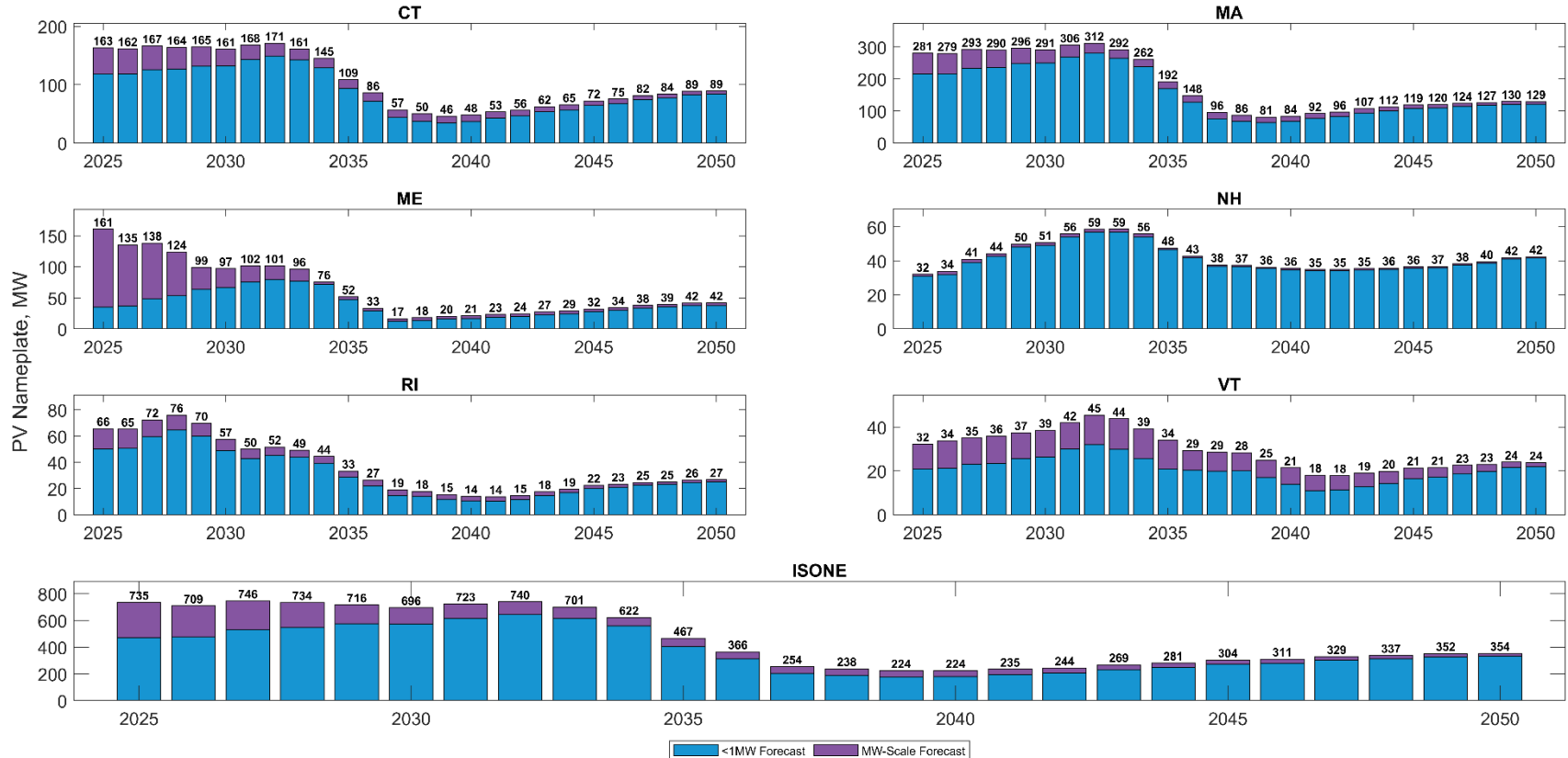
Nameplate Capacity, MW_{ac}

States	Annual Total MW (AC nameplate rating)											Totals
	Thru 2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	
CT	1,269	163	162	167	164	165	161	168	171	161	145	2,895
MA	3,929	281	279	293	290	296	291	306	312	292	262	6,830
ME	1,096	161	135	138	124	99	97	102	101	96	76	2,226
NH	274	32	34	41	44	50	51	56	59	59	56	755
RI	454	66	65	72	76	70	57	50	52	49	44	1,056
VT	537	32	34	35	36	37	39	42	45	44	39	920
Regional - Annual (MW)	7,558	735	709	746	734	716	696	723	740	701	622	14,681
Regional - Cumulative (MW)	7,558	8,293	9,003	9,748	10,483	11,199	11,895	12,618	13,358	14,059	14,681	14,681

Notes:

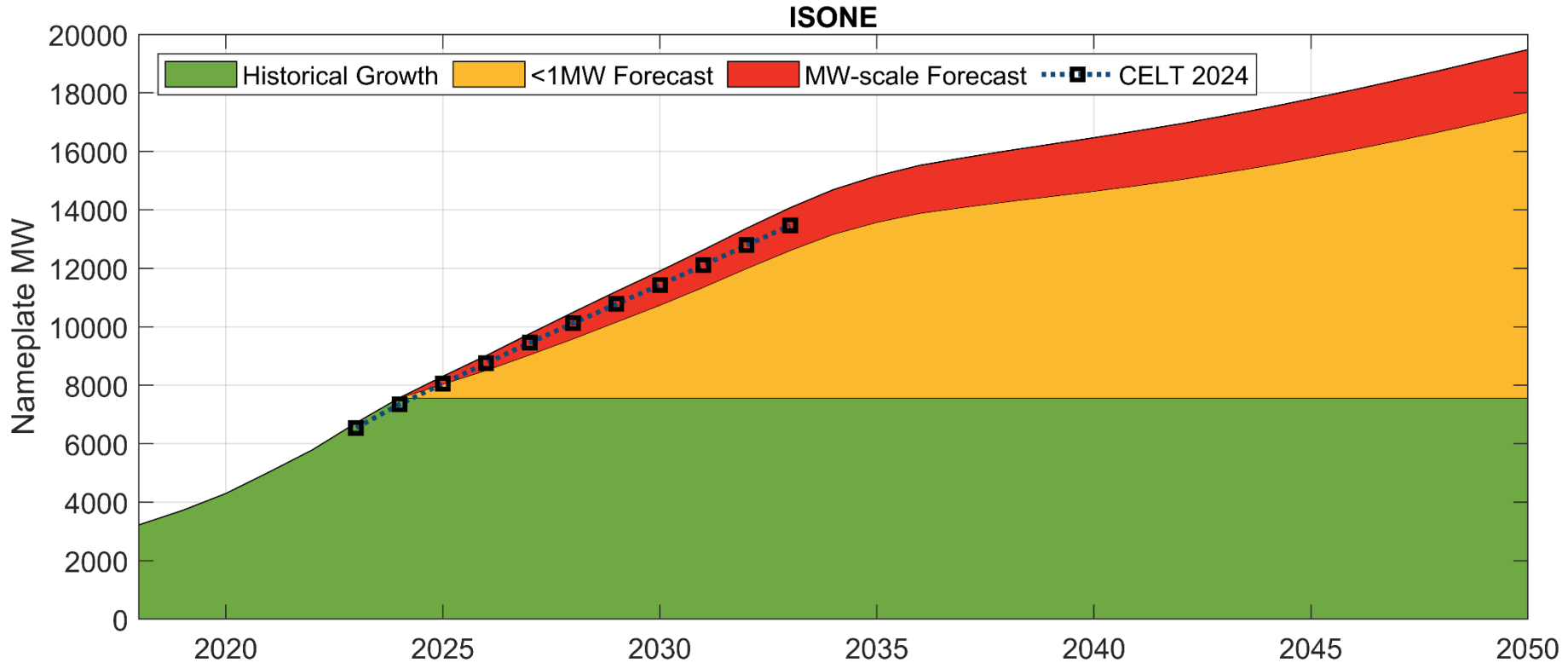
- (1) Forecast values include FCM Resources, non-FCM Energy Only Generators, and behind-the-meter PV resources
- (2) The forecast values are net of the effects of discount factors applied to reflect a degree of uncertainty in the policy-based forecast
- (3) All values represent end-of-year installed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

Draft 2025 PV Forecast – Forecast Horizon



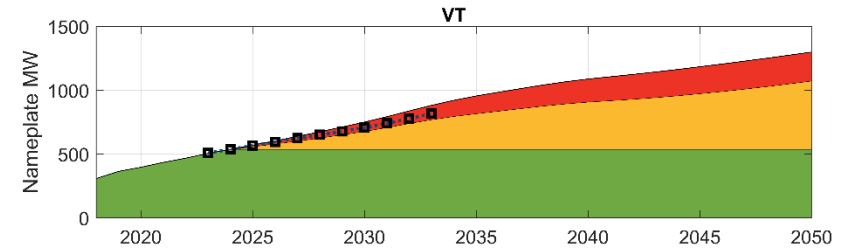
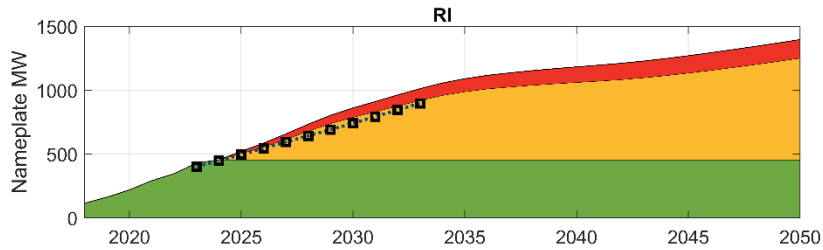
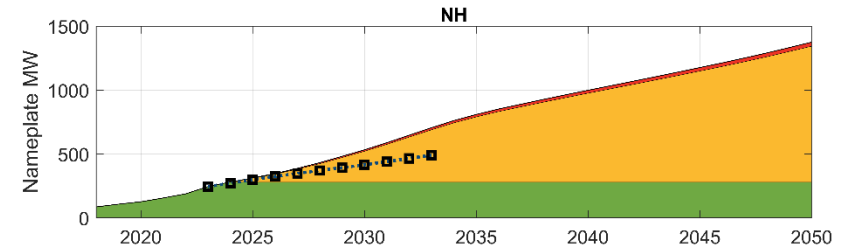
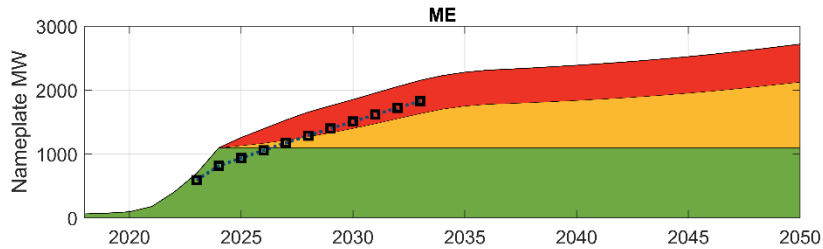
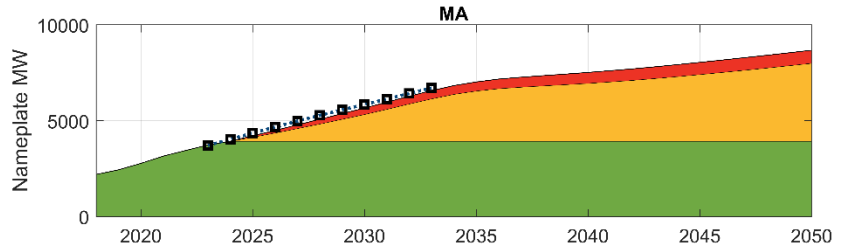
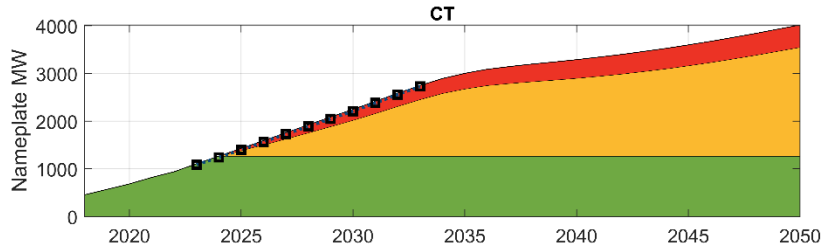
Regional PV Nameplate Capacity Growth – Forecast

Historical vs. Forecast



State PV Nameplate Capacity Growth – 10-Year Horizon

Historical and Forecast

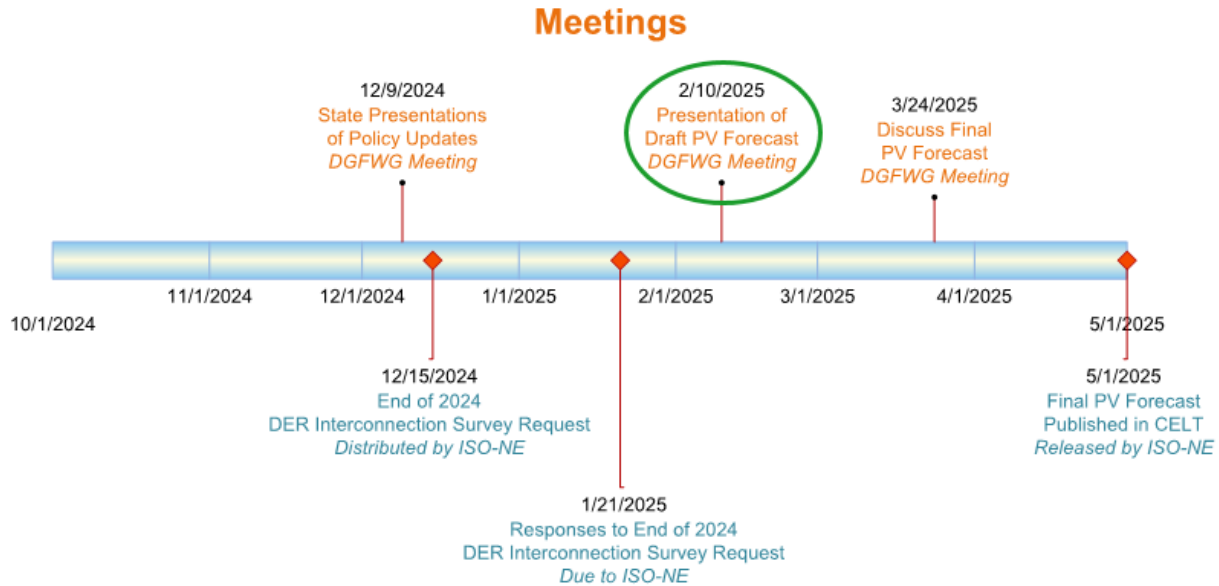


Historical Growth <1MW Forecast MW-scale Forecast CELT 2024

NEXT STEPS



2025 PV Forecast Schedule



Meetings

Milestones



Effective: 2-6-2025
(Schedule subject to change)

Next Steps for CELT 2025

- Other components of the forecast are developed once the nameplate PV forecast is finalized:
 - Breakdown of the forecast by market participation category (i.e., FCM, EOR, and BTM PV)
 - PV energy forecast and estimated peak load reductions
 - As part of the ISO's new hourly load forecast methodology, BTMPV is modeled hourly and peak load reductions due to BTMPV are calculated as the difference between gross and net peak values
 - County-level forecast for the megawatt-scale systems will be developed once the 2025 nameplate PV forecast is finalized
- Section 3 of the ISO's 2025 Report on [Capacity, Energy, Loads, and Transmission](#) (CELT 2025), will include nameplate, energy, and estimated summer peak load reductions
- Additional BTM PV data for states, load zones, and Regional System Plan (RSP) subareas will be available in the annual [Load Forecast Data workbook](#)
- Updates on DER storage items discussed at the December 9 DGFWG [meeting](#)

Send Us Your Feedback



- Stakeholders may provide written comments on the draft 2025 forecast by February 28, 2025 @ 5:00 p.m.
 - Please submit comments to DGFWGMatters@iso-ne.com
- ISO thanks the DGFWG for its input

Questions

