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Draft 2024 Photovoltaic (PV) Forecast

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Distributed Generation Forecast Working Group

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Outline

- Introduction
- 2023 Installed PV: Forecast vs. Reported

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- Forecast Assumptions and Inputs
- Draft 2024 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)

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- 2. Non-FCM Energy Only Resources (EOR) and Generators
- 3. Behind-the-meter PV (BTM PV)

Similar to energy efficiency (EE), behind-the-meter PV is reconstituted into historical loads*

The 2024 gross load forecast reflects loads without PV load reductions

*Existing BTM PV decreases the historical metered loads, which are an input to the gross 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 statejurisdictional 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)
 - DER is defined in this context as a source of electric power that is interconnected to the distribution system
 - DER includes both generators and energy storage technologies
 - DER does <u>not</u> include demand response, controllable loads, or other load modifiers
- Therefore, the forecast does not consider policy drivers supporting larger-scale projects (i.e., those >5 MW)

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• Large 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.
- For 2024 PV forecast, the ISO has updated its methodology to include the Distributed Generation Market Demand Model (dGen[™]), an agent-based simulation that was developed and open-sourced by the National Renewable Energy Laboratory (NREL)
- The ISO now develops the distributed PV nameplate forecast as part of two additive processes:
 - 1. For < 1 MW systems: Use residential and commercial dGen[™] modeling
 - 2. For 1-5 MW systems: Use a policy-based approach
- The ISO used a policy-based forecasting approach to generate forecast for all PV systems in the New England states that are equal or greater than one megawatt, but less than five megawatts.

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2023 INSTALLED PV

Forecast vs. Reported



2023 PV Nameplate Capacity Growth

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- Comparison of the state-bystate 2023 forecast PV growth and the growth for 2023 reported by utilities is tabulated
 - Values include FCM, EOR, and BTM PV projects
- Regionally, 2023 growth reported by utilities totaled 892.4 MW, which is 9.8 MW lower than the forecast growth
 - Results vary by state as tabulated

State	2023 Reported Growth	2023 Forecast Growth	Error
СТ	159.4	171.3	-11.9
MA	322.6	348.3	-25.7
ME	253.7	276.8	-23.1
NH	56.4	25.2	31.2
RI	62.7	52.1	10.6
VT	37.5	28.5	9.0
Region	892.4	902.2	-9.8

Nameplate Capacity of Reported Annual PV Growth

Small (<= 20kW), Medium (20-<1,000kW), and Large (>=1,000kW) Projects



Larger-Scale PV

Projects >5 MW_{ac}

- Tabulated is a summary of inservice, larger-scale (i.e., non-DG)
 PV projects included as part of
 Distribution Owner survey data
 responses
- These projects are not included in the PV forecast accounting, and are excluded from installed PV totals reported herein

State	# Projects Listed	Total Nameplate (MW _{ac})
СТ	5	97.4
MA	-	-
ME	3	34.0
NH	-	-
RI	21	169.9
VT	-	-
Total	29	301.2

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DGENTM PV (< 1MW) FORECAST

Assumptions and Inputs



dGen[™] Assumptions

- The ISO <u>presented</u> the policy modeling assumptions used as inputs to dGen[™] at the December 8, 2023 DGFWG
 The ISO did not change any of the assumptions discussed
- NREL's <u>2023 Electricity Annual Technology Baseline (ATB)</u> 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

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 8, 2023
- MA Distribution Owners reported a total of 1,746 MW_{AC} of large systems (>= 1000 MW) installed through 12/31/2023 with less growth from large systems in 2021 and 2022.
- Within Solar Massachusetts Renewable Target (SMART) Program, 1,013 MW_{AC} of large systems were installed by end of 2023
 - Assume an additional 412 MW_{AC} of large projects will be installed to reach program goal by 2029

Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MW-scale Forecast	94	93	89	84	77	69	60	52	44	38

MA Forecast Inputs



Connecticut Forecast Assumptions

- Policy information is contained in the CT Department of Energy & Environmental Protection (CT ٠ DEEP) presentation to the DGFWG on December 8, 2023
- A total of 411.3 MW_{AC} are operational under the existing Low- & Zero-Emission Renewable ٠ Energy Credits (LREC/ZREC) program, and 123.8 MW are assumed to remain.
 - Based on the historical share of large systems, assume 10.8 MW_{AC} to be from large systems
- 1.5 MW_{AC} are in service under the Shared Clean Energy Facility program, with another 116.8 MW selected ٠
 - Assume all of the selected MW are large systems, and that another 100 MW₄ are expected to be installed under the program's 2024 and 2025 procurement
- 44.1 MW_{AC} of large systems were selected under Non-Residential Energy Solution. An addition of 148 . MW_{AC} are expected to be installed throughout the remaining period of the program
- Most recent historical data shows a 3-year average growth rate for large system was 14.8 MW_{AC} with 2 ٠ MW_{AC} installed last year
- Forecast inputs tabulated below reflect approximately 80% of total nameplate capacity from policies listed above

Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MW-scale Forecast	39	47	50	43	36	32	28	24	21	18

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CT Forecast Inputs

Rhode Island Forecast Assumptions

- Policy information is contained in the RI Office of Energy Resources (RI OER) presentation DGFWG on December 8, 2023
- 178.8 MW_{AC} of large system were installed by the end of 2023. 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
- Most recent historical data shows a 3-year average growth rate for large system was 18.8 MW_{AC} with 15.8 MW_{AC} installed last year

Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MW-scale Forecast	14	16	15	14	13	11	10	8	7	6

RI Forecast Inputs

Vermont Forecast Assumptions

- Policy information is contained in the VT Department of Public Service (VT PSD) presentation to the DGFWG on December 8, 2023
- 81.9 MW_{AC} were installed under the Standard Offer program. An addition of 44.5 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
- Most recent historical data shows a 3-year average growth rate for large system was 8.8 MW_{AC} with 9.3 MW_{AC} installed last year
- The forecast assumed a decline in the adoption of large systems beginning in 2028

Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MW-scale Forecast	10	10	10	10	5	5	4	4	3	3

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VT Forecast Inputs



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 8, 2023
 - Historical PV growth from large systems in has been minimal and sporadic, with zero installed capacity in 2023

NH Forecast Inputs

Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MW-scale Forecast	1	1	1	1	1	1	1	1	1	



Maine Forecast Assumptions

- Policy information is contained in the ME Governor's Energy Office (ME GEO) presentation to the DGFWG on December 5, 2022
- ME Distribution Owners reported a total of 453.8 MW_{AC} of large systems installed through 12/31/2023, including 223.2 MW_{AC} in 2023
- 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, minus 453.8 MW installed through 12/31/2023
 - 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)
 - NEB, < 2MW projects, with an assumed annual growth of 5 MW

ME Forecast Inputs

Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MW-scale Forecast	208	104	101	95	87	77	67	58	50	43

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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 24-26) to determine total nameplate capacity for each state and forecast year





Discount Factors Used

Policy-Based

Forecast Year	Final 2022 Forecast	Draft 2023 Forecast
2024	10%	2.5%
2025	15%	5%
2026	15%	7.5%
2027	15%	10%
2028	15%	12.5%
2029	15%	15%
2030	15%	15%
2031	15%	15%
2032	15%	15%
2033	N/A	15%

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Draft 2024 Forecast Inputs

Nameplate Capacity, PV Systems < 1 MW

States				Annu	al Total MV	V (AC name	eplate ratin	g)				Totals
States	Thru 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	TOLAIS
СТ	972.0	115.9	122.3	128.7	140.3	145.4	156.8	163.1	177.0	184.5	182.0	2,488.0
МА	1,966.0	240.5	245.1	249.8	260.2	266.1	270.3	268.6	282.1	297.3	296.7	4,642.7
ME	134.0	21.5	25.2	28.8	37.5	42.6	53.4	59.2	70.3	75.7	81.2	629.5
NH	227.0	27.0	26.9	26.7	25.7	24.9	24.9	25.8	27.8	28.9	29.1	494.6
RI	221.0	33.6	35.6	37.5	41.0	42.5	46.1	48.1	52.7	55.2	54.0	667.2
VT	347.0	19.9	20.5	21.2	22.9	24.0	27.5	29.9	36.4	40.5	42.6	632.4
ISONE	3,867.0	458.5	475.6	492.7	527.7	545.5	579.0	594.7	646.2	682.0	685.5	9,554.4

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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 2024 Forecast Inputs

Nameplate Capacity, PV Systems 1-5 MW

States				Annua	l Total MW	/ (AC name	eplate ratir	ng)			-	Totolo
States	Thru 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	TOLAIS
СТ	118.0	38.8	46.7	49.6	42.8	35.8	31.9	27.9	24.1	20.7	17.9	454.1
МА	1,746.0	94.4	92.6	89.2	83.9	76.8	68.5	59.9	51.7	44.5	38.5	2,446.0
ME	454.0	207.8	104.3	100.5	94.5	86.5	77.2	67.5	58.2	50.1	43.3	1,344.1
NH	17.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	27.0
RI	179.0	14.0	16.0	15.4	13.8	12.6	11.3	9.8	8.5	7.3	6.3	293.9
VT	160.0	10.2	10.2	10.2	10.2	5.1	4.6	4.1	3.6	3.1	2.5	223.6
ISONE	2,674.0	366.1	270.8	265.9	246.2	217.8	194.4	170.2	147.2	126.7	109.5	4,788.8

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(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 2024 Forecast Inputs

Pre-Discounted Nameplate Values, All PV Systems

Chatra				Annu	al Total M\	V (AC name	eplate ratir	ng)				Tatala
States	Thru 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Totals
СТ	1,090.5	154.7	169.0	178.3	183.0	181.1	188.7	191.0	201.1	205.2	200.0	2,942.7
MA	3,712.0	334.9	337.7	339.0	344.2	342.9	338.8	328.5	333.8	341.7	335.1	7,088.7
ME	588.0	229.3	129.5	129.3	132.1	129.1	130.6	126.6	128.6	125.8	124.5	1,973.5
NH	244.0	28.0	27.9	27.7	26.7	25.9	25.9	26.8	28.8	29.9	30.1	521.6
RI	400.0	47.5	51.5	52.9	54.8	55.1	57.3	57.9	61.1	62.5	60.3	961.1
VT	507.0	30.1	30.7	31.3	33.1	29.1	32.1	34.0	40.0	43.6	45.1	856.1
Pre-Discount Annual Total (MW)	6,541.5	824.5	746.4	758.6	773.9	763.3	773.5	764.9	793.3	808.8	795.1	14,343.7
Pre-Discount Cumulative Total (MW)	6,541.5	7,366.1	8,112.4	8,871.0	9,644.9	10,408.2	11,181.7	11,946.5	12,739.9	13,548.7	14,343.7	14,343.7

Notes:

(1) The above values are not the forecast, 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 2024 PV NAMEPLATE CAPACITY FORECAST



Draft 2024 PV Forecast

Nameplate Capacity, MW_{ac}

States	Annual Total MW (AC nameplate rating)											Tatala
	Thru 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Totals
СТ	1,090.5	150.8	160.6	164.9	164.7	158.5	160.4	162.4	170.9	174.4	170.0	2,728.1
MA	3,712.0	326.5	320.9	313.6	309.7	300.1	288.0	279.2	283.7	290.5	284.9	6,709.1
ME	588.0	223.6	123.0	119.6	118.9	113.0	111.0	107.6	109.3	107.0	105.8	1,826.9
NH	244.0	27.3	26.5	25.6	24.0	22.7	22.0	22.8	24.4	25.4	25.6	490.3
RI	400.0	46.4	49.0	49.0	49.3	48.2	48.7	49.2	52.0	53.1	51.3	896.1
VT	507.0	29.3	29.2	29.0	29.8	25.4	27.3	28.9	34.0	37.1	38.3	815.3
Regional - Annual (MW)	6,541.5	803.9	709.1	701.7	696.5	667.9	657.5	650.2	674.3	687.5	675.8	13,465.8
Regional - Cumulative (MW)	6,541.5	7,345.4	8,054.5	8,756.2	9,452.6	10,120.5	10,778.0	11,428.2	12,102.5	12,790.0	13,465.8	13,465.8

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

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- (3) All values represent end-of-year installed capacities
- (4) Forecast does not include forward-looking PV projects > 5MW in nameplate capacity

Annual PV Nameplate Capacity Growth Breakdown



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Regional PV Nameplate Capacity Growth

Historical vs. Forecast



State PV Nameplate Capacity Growth

Historical and Forecast



NEXT STEPS



2024 PV Forecast Schedule



Next Steps for CELT 2024

- 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 summer peak load reductions (based on methodology documented in <u>this presentation</u>)
- Section 3 of the ISO's 2024 Report on <u>Capacity, Energy, Loads, and Transmission</u> (CELT 2024), 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 <u>Load Forecast Data workbook</u>

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Send Us Your Feedback



- Stakeholders may provide written comments on the draft 2024 forecast by March 1, 2024 @ 5:00 p.m.
 - Please submit comments to <u>DGFWGMatters@iso-ne.com</u>
- ISO thanks the DGFWG for its input

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Questions

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