Draft 2018 Photovoltaic (PV) Forecast

Distributed Generation Forecast Working Group

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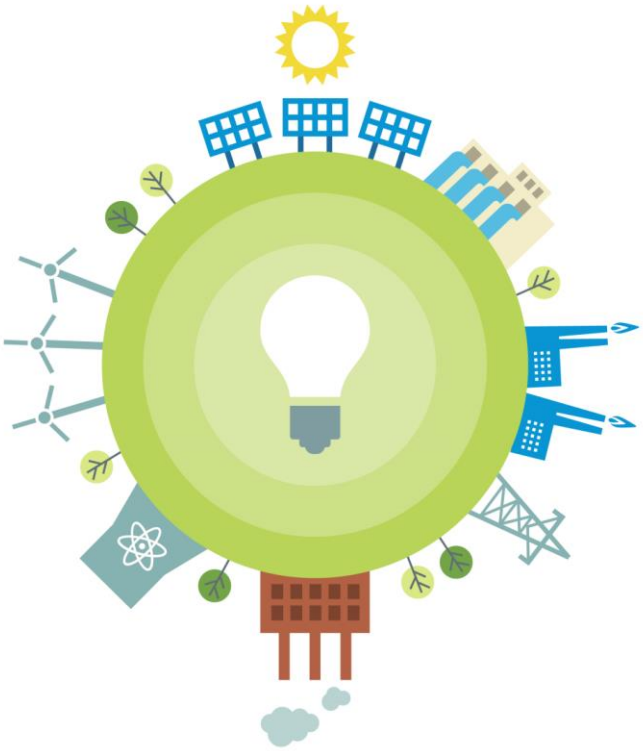
Presentation Outline

- Introduction and Background
- 2017 PV Growth: Forecast vs. Reported
- Forecast Assumptions and Inputs
- Draft 2018 PV Forecast - Nameplate
- Next Steps for the 2018 Capacity, Energy, Loads, and Transmission forecast (CELT)



INTRODUCTION AND BACKGROUND

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)

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

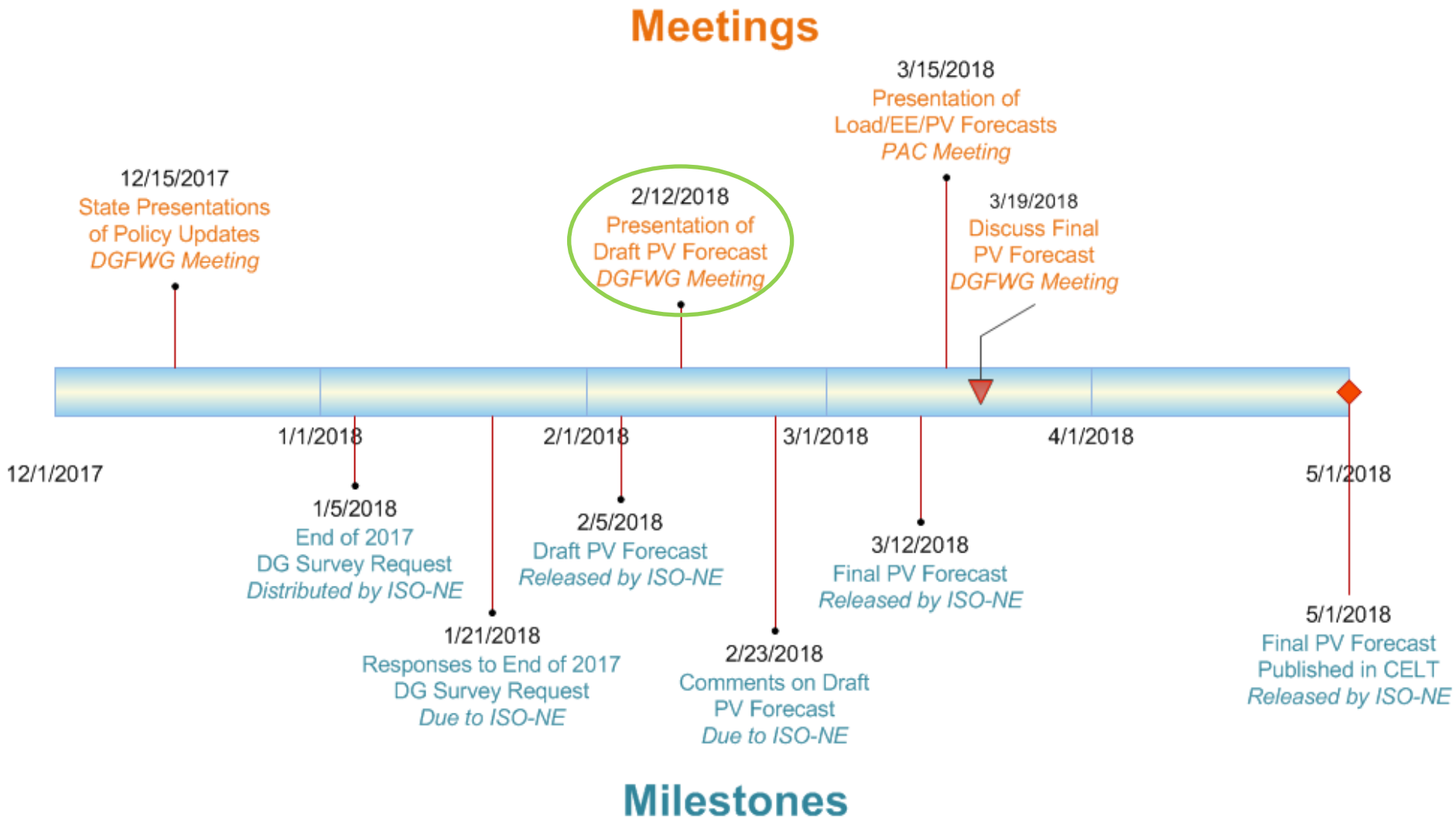
The 2018 gross load forecast reflects loads without PV load reductions

**Existing BTM PV decreases the historical loads seen by the ISO, which are an input to the gross load forecast*

Background: PV Forecast Focuses on DG

- The focus of the DGFWG is distributed generation 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."
- Therefore, the forecast does not consider policy drivers supporting larger-scale projects (i.e., those >5 MW)
  - E.g., projects planned as part of the three-state Clean Energy RFP
- Large projects are generally accounted for as part of ISO's interconnection process and participate in wholesale markets

2018 PV Forecast Schedule



The PV Forecast Incorporates State Policies and Is Based on Historical Data

- The forecast reflects and incorporates existing PV installations and state policies
- The potential expansion of existing state policies or the development of future state policy programs beyond known existing policies is not explicitly considered
- The PV forecast process is informed by ISO analysis and by input from state regulators and other stakeholders through the DGFWG
- The forecast is meant to be a reasonable projection of the anticipated growth of out-of-market, distributed PV resources to be used in ISO's System Planning studies, consistent with our role to ensure prudent planning assumptions for the bulk power system

Forecast Focuses on State Policies in All Six New England States

- A policy-based forecasting approach has been chosen to reflect the observation that trends in distributed PV development are in large part the result of policy programs developed and implemented by the New England states
  - Impact of federal policies are also important
- The ISO makes no judgment regarding state policies, but rather utilizes the state goals as a means of informing the forecast
- In an attempt to control related ratepayer costs, states often factor anticipated changes in PV market conditions directly into policy design, which are therefore implicit to ISO's policy considerations in the development of the forecast

Many Factors Influence the Future Commercialization Potential of PV

Policy Drivers

- Feed-in-tariffs (FITs)/Long-term procurement
- State Renewable Portfolio Standards (RPS) programs
- Net energy metering (NEM) and retail rate structure
- Federal investment tax credit (ITC) and federal depreciation
- Federal trade policy

Other Drivers

- Role of private investment in PV development
- Future equipment and installation costs
- Future wholesale and retail electricity costs
- Interconnection costs and issues

Summary: Draft CELT 2018 PV Forecast

- The 2018 forecast reflects:
  - PV development trends in the region
  - Discussions with stakeholders and data exchange with the New England states and Distribution Owners
- According to data provided by Distribution Owners, approximately 473 MW of PV development occurred in 2017, totaling about 2,391 MW installed across the region
  - Values include FCM, EOR, and BTM PV projects < 5 MW_{ac} in nameplate capacity
- Approximately 3,359 MW of PV development is projected from 2018 through 2027 for a total of 5,750 MW in 2027
  - Values include FCM, EOR, and BTM PV projects < 5 MW_{ac} in nameplate capacity
- Overall, the draft 2018 PV forecast projects steadier PV growth over the entire forecast horizon and is less front-loaded than previous forecasts

2017 PV GROWTH: FORECAST VS. REPORTED

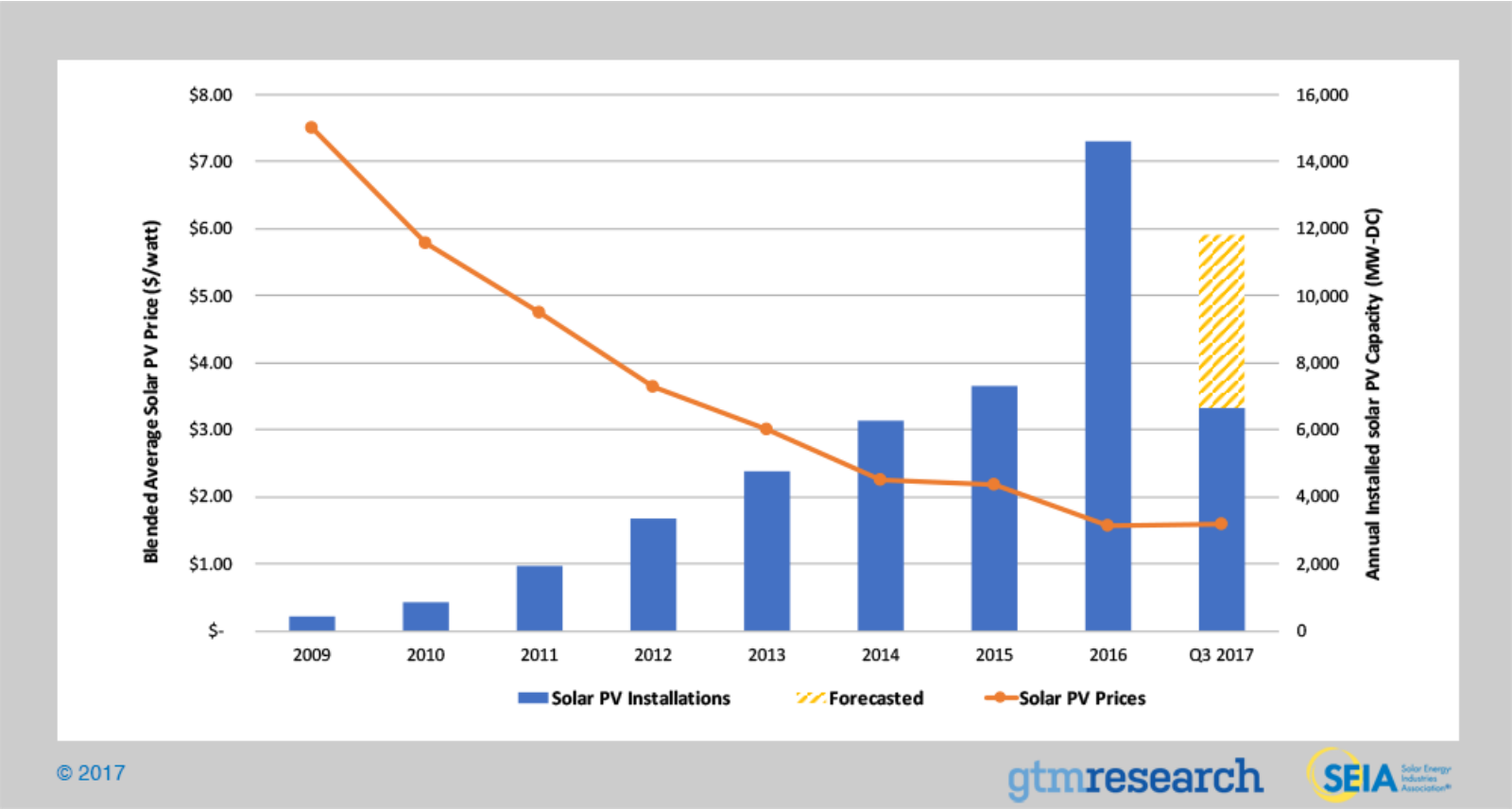
2017 PV Nameplate Growth

- Comparison of the state-by-state 2017 PV growth and the reported growth for 2017 reported by utilities is tabulated below
  - Values include FCM, EOR, and BTM PV projects < 5 MW_{ac} in nameplate capacity
- Regionally, 2017 growth reported by utilities totaled 472.6 MW, which is 25.4 MW lower than the forecast growth
  - Results vary significantly by state

State	2017 Reported Growth	2017 Forecast Growth	Difference
CT	84.1	132.8	-48.7
MA	277.5	273.9	3.6
ME	11.3	6.8	4.5
NH	15.4	18.1	-2.7
RI	25.4	41.3	-15.9
VT	58.9	25.0	33.9
Region	472.6	497.9	-25.4

FORECAST ASSUMPTIONS AND INPUTS

U.S. Installed Cost Reductions Are Leveling Off



Source: https://www.seia.org/sites/default/files/inline-images/growth-falling-prices_q42017.png

Federal Investment Tax Credit

- The federal residential and business Investment Tax Credit (ITC) is a key driver of PV development in New England
- There are no changes to the ITC since the 2017 forecast

Residential ITC

Maximum Allowable Residential ITC	
Year	Credit
2016	30%
2017	30%
2018	30%
2019	30%
2020	26%
2021	22%
Future Years	0%

Business ITC

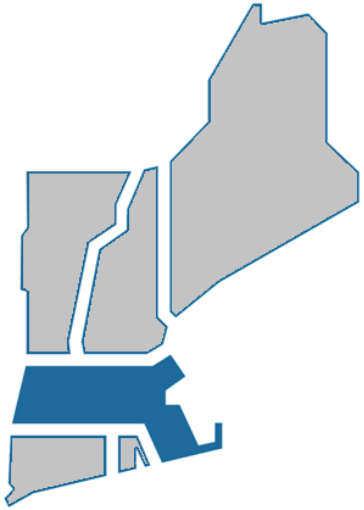
ITC by Date of Construction Start	
Year construction starts	Credit
2016	30%
2017	30%
2018	30%
2019	30%
2020	26%
2021	22%
2022	10%
Future Years	10%

Sources: http://programs.dsireusa.org/system/program/detail/658 **and** http://programs.dsireusa.org/system/program/detail/1235

Other Federal Policies Impacting PV Development

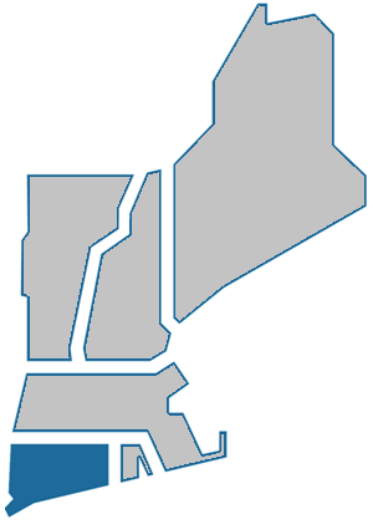
- Anticipated impacts of final federal tax bill are mixed and uncertain, with major features including:
  - Maintain current phase-down schedule for ITC
  - Lower corporate tax rate could decrease tax "appetite" of investors, potentially limiting their ability to monetize the ITC, while also increasing the value of operating projects due to increased after-tax revenue
  - New base erosion anti-abuse tax (BEAT) could reduce amount of tax equity used for investment in many PV projects
- U.S. tariff on imported PV cells and modules
  - Modules represent roughly 10-25% of total installed PV costs
  - Tariff is 30% in year 1, stepping down to 15% by the fourth year
  - Annually allows 2.5 GW of unassembled imported solar cells tariff-free
  - Effect will offset some of the decreasing trend in installed PV costs in past years
- The overall result of these federal policy changes, when considered in tandem with the approaching ITC phase-down and continued decreases in state policy support, is increased near-term uncertainty in the region's PV outlook

Massachusetts Forecast Methodology and Assumptions



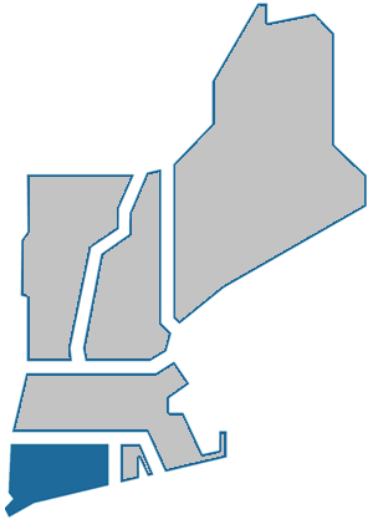
- MA DPU's 12/15/17 DGFWG presentation serves as primary source for MA policy information
- Solar Carve-Out Renewable Energy Certificate (SREC) program
  - A total of 2,100 MW_{DC} developed as part of SREC-I/SREC-II programs
  - Convert: 2,100 MW_{DC} = 1,743 MW_{AC} (83% AC-to-DC ratio assumed)
  - MA Distribution Owners reported 1,602.3 MW_{AC} installed by 12/31/17
    - Of this total, approximately 1,575 MW are SREC-I/SREC-II projects
  - Assume remaining SREC I/II capacity (~168 MW_{AC}) is installed in 2018
- Solar Massachusetts Renewable Target (SMART) Program
  - Sets forth a post-SREC 1,600 MW_{AC} program goal
  - Program achieved over the period 2018-2024 (7 years)
    - Assume 80 MW installed in 2018;
    - Assume remaining 1,520 MW divided evenly over 6 years from 2019-2024
- The annual growth in 2022 is carried forward at constant rate throughout the remaining years of the forecast period and post-policy discount factors are applied

Connecticut Forecast Methodology and Assumptions



- CT DEEP's 12/15/17 DGFWG presentation serves as primary source for CT policy information
- LREC/ZREC program assumptions
  - Seventh LREC/ZREC solicitation is now funded
  - Assume the total PV procured in LREC/ZREC is 470.4 MW
    - Assume Year 7 Solicitation yields additional 77 MW
  - According to utility data, approximately 140 MW of LREC/ZREC projects are in-service
  - Assume remaining 330.4 MW of capacity comes into services evenly over the next 5 years, 2018-2022
    - The period before LREC/ZREC projects are all completed was extended due to consistently slow LREC/ZREC development over past few years
  - The annual growth in 2022 is carried forward at constant rate throughout the remaining years of the forecast period and post-policy discount factors are applied

Connecticut Forecast Methodology and Assumptions *continued*



- CEFIA/Green Bank Residential Solar Incentive Program (RSIP) and Solar Home Renewable Energy Credit (SHREC) program
  - Total 300 MW goal by 2022, but CT DEEP anticipates goal met by 2021
  - Recent CT budget sweeps will not impact program
  - Based on Distribution Owner data, approximately 185 MW installed as of 12/31/17 ; with 115 MW remaining
    - 28.75 MW/year from 2018-2021
  - Post-2021: Forecast inputs kept at 28.75 MW/year and post-policy discount factors are applied
- DEEP Small Scale Procurement (< 5MW) associated with Public Act 15-107
  - Total of 5 MW expected to go into service in 2020
- Shared Clean Energy Facility (SCEF) Pilot Program
  - Assumed a total of two SCEF projects with nameplate capacities of 3.62 MW and 1.6 MW go into service in 2018 and 2019, respectively

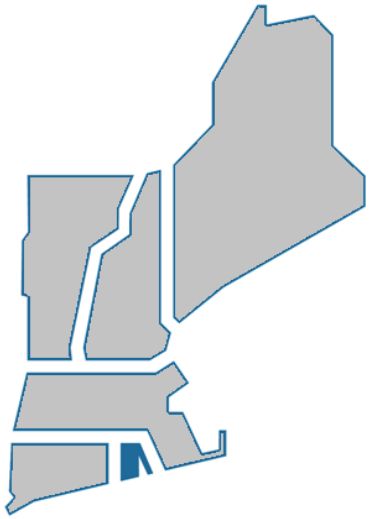
Vermont Forecast Methodology and Assumptions

- VT DPS' 12/15/17 DGFWG presentation serves as the primary source for VT policy information
- DG carve-out of the Renewable Energy Standard (RES)
  - Assume 85% of eligible resources will be PV and a total of 25 MW/year will develop
- Standard Offer Program
  - Will promote a total of 110 MW of PV (of the 127.5 MW total goal)
  - All forward-looking renewable energy certificates (RECs) from Standard Offer projects will be sold to utilities and count towards RES DG carve-out
- Net metering
  - All forward-looking renewable energy certificates (RECs) from net metered projects will be sold to utilities and count towards RES DG carve-out

New Hampshire Forecast Methodology and Assumptions

- NH PUC's 12/15/17 DGFWG presentation serves as the primary source for NH policy information
- NH Distribution Owners reported a total of 15.37 MW of PV growth in 2017
- Assume the new Net Energy Metering Tariff (NEM 2.0), effective September 1, 2017, continues to support the 2017 rate of growth throughout the forecast horizon

Rhode Island Forecast Methodology and Assumptions



- RI OER's 12/17/17 DGFWG presentation serves as the primary source for RI policy information
- DG Standards Contracts program
  - A total of 30 MW of 40 MW program goal will be PV
  - Estimated 18 MW installed by 12/31/16, and 12 MW remaining assumed to be installed at 6 MW/year from 2017-2018
- Newly extended Renewable Energy Growth Program (REGP)
  - Assume REGP supports 36 MW_{DC}/year of PV throughout forecast horizon
    - Convert: 36 MW_{DC} = 29.88 MW_{AC} (83% AC-to-DC ratio assumed)
- Renewable Energy Development Fund & Net Metering
  - Assumed to yield 8 MW/year over the forecast horizon

Maine Forecast Methodology and Assumptions

- ME PUC's 12/17/17 DGFWG presentation serves as the primary source for ME policy information
- ME Distribution Owners reported a total of 11.32 MW of PV growth in 2017
- Assume the new Net Energy Billing Rule (effective April 1, 2018), with gradually reduced rates of compensation, continues to support the 2017 rate of growth throughout the forecast horizon

Discount Factors

- Discount factors are:
  - Developed and incorporated into the forecast to ensure a degree of uncertainty in future PV commercialization is considered
  - Developed for two types of future PV inputs to the forecast, and all discount factors are applied equally in all states
  - Applied to the forecast inputs (see slide 26) to determine total nameplate capacity for each state and forecast year

Policy-Based *PV that results from state policy*	**Post-Policy** *PV that may be installed after existing state policies end*
Discounted by values that increase over the forecast horizon up to a maximum value of 15%	**Discounted by 35-50% due to the high degree of uncertainty associated with possible future expansion of state policies and/or future market conditions required to support PV commercialization in the absence of policy expansion**

Discount Factors Used in Draft 2018 PV Forecast

Policy-Based

Forecast	Final 2017	Draft 2018
2018	0%	10%
2019	0%	10%
2020	10%	10%
2021	15%	15%
2022	15%	15%
2023	15%	15%
2024	15%	15%
2025	15%	15%
2026	15%	15%
2027	--	15%

Post-Policy

Forecast	Final 2017	Draft 2018
2018	36.7%	35.0%
2019	38.3%	36.7%
2020	40.0%	38.3%
2021	41.7%	40.0%
2022	43.3%	41.7%
2023	45.0%	43.3%
2024	46.7%	45.0%
2025	48.3%	46.7%
2026	50.0%	48.3%
2027	--	50.0%

Draft 2018 Forecast Inputs

Pre-Discounted Nameplate Values

States	Pre-Discount Annual Total MW (AC nameplate rating)											Totals
	Thru 2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	
CT	365.6	98.5	96.4	99.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8	**1,324.2**
MA	1602.3	244.4	253.3	253.3	253.3	253.3	253.3	253.3	256.0	256.0	256.0	**4,134.6**
ME	33.5	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	**146.7**
NH	69.7	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	**223.4**
RI	62.2	38.3	38.3	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	**417.9**
VT	257.2	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	**507.2**
Pre-Discount Annual Policy-Based MWs	**2390.5**	**432.8**	**439.8**	**439.7**	**434.7**	**406.0**	**339.9**	**339.9**	**86.6**	**86.6**	**86.6**	**5,483.1**
Pre-Discount Annual Post-Policy MWs	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**28.8**	**94.8**	**94.8**	**350.8**	**350.8**	**350.8**	**1,270.9**
Pre-Discount Annual Total (MW)	**2390.5**	**432.8**	**439.8**	**439.7**	**434.7**	**434.7**	**434.7**	**434.7**	**437.4**	**437.4**	**437.4**	**6,754.0**
Pre-Discount Cumulative Total (MW)	**2390.5**	**2,823.3**	**3,263.1**	**3,702.9**	**4,137.6**	**4,572.3**	**5,007.1**	**5,441.8**	**5,879.2**	**6,316.6**	**6,754.0**	**6,754.0**

Notes:

(1) The above values **<u>are not the forecast</u>**, but rather pre-discounted inputs to the forecast (see slides 13-25 for details)

(2) Yellow highlighted cells indicate that values contain post-policy MWs

(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 2018 SOLAR PV FORECAST

Nameplate MW

Final 2017 PV Forecast

Nameplate Capacity, MW_{ac}

States	Annual Total MW (AC nameplate rating)											Totals
	Thru 2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	
CT	281.5	132.8	132.8	132.8	58.9	44.7	43.5	42.2	40.9	39.6	38.4	**988.2**
MA	1324.8	273.9	260.2	164.4	160.0	155.6	151.1	146.7	71.1	68.9	66.7	**2,843.3**
ME	22.1	6.8	6.8	6.8	6.2	5.8	5.8	5.8	5.8	5.8	5.8	**83.7**
NH	54.3	18.1	12.0	7.4	7.2	7.0	6.8	6.6	6.4	6.2	6.0	**138.2**
RI	36.8	41.3	41.3	35.3	31.8	15.2	11.3	11.1	10.8	10.6	10.4	**255.9**
VT	198.4	25.0	25.0	25.0	22.5	21.3	21.3	21.3	21.3	21.3	21.3	**423.4**
Regional - Annual (MW)	**1918.0**	**497.9**	**478.2**	**371.8**	**286.6**	**249.6**	**239.8**	**233.6**	**156.3**	**152.4**	**148.5**	**4,732.7**
Regional - Cumulative (MW)	**1918.0**	**2415.9**	**2894.1**	**3265.9**	**3552.5**	**3802.1**	**4041.9**	**4275.5**	**4431.8**	**4584.2**	**4732.7**	**4,732.7**

Notes:

(1) Forecast values include FCM Resources, non-FCM Energy Only Generators, and behind-the-meter PV resources

(2) The forecast reflects discount factors described on slides 24-25

(3) All values represent end-of-year installed capacities

(4) Forecast does not include forward-looking PV projects > 5MW in nameplate capacity

Draft 2018 PV Forecast

Nameplate Capacity, MW_{ac}

States	Annual Total MW (AC nameplate rating)											Totals
	Thru 2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	
CT	365.6	88.6	86.8	89.8	80.6	72.9	53.7	52.2	50.6	49.0	47.4	**1,037.3**
MA	1602.3	222.9	228.0	228.0	215.3	215.3	215.3	215.3	135.1	130.9	126.7	**3,535.1**
ME	33.5	10.2	10.2	10.2	9.6	9.6	9.6	9.6	9.6	9.6	9.6	**131.4**
NH	69.7	13.8	13.8	13.8	13.1	13.1	13.1	13.1	13.1	13.1	13.1	**202.7**
RI	62.2	34.5	34.5	31.4	29.6	29.6	29.6	29.6	29.6	29.6	29.6	**370.2**
VT	257.2	22.5	22.5	22.5	21.3	21.3	21.3	21.3	21.3	21.3	21.3	**473.5**
Regional - Annual (MW)	**2390.5**	**392.5**	**395.8**	**395.8**	**369.5**	**361.9**	**342.7**	**341.1**	**259.3**	**253.5**	**247.7**	**5,750.2**
Regional - Cumulative (MW)	**2390.5**	**2783.0**	**3178.8**	**3574.6**	**3944.1**	**4306.0**	**4648.7**	**4989.7**	**5249.0**	**5502.5**	**5750.2**	**5,750.2**

Notes:

(1) Forecast values include FCM Resources, non-FCM Energy Only Generators, and behind-the-meter PV resources

(2) The forecast reflects discount factors described on slides 24-25

(3) All values represent end-of-year installed capacities

(4) Forecast does not include forward-looking PV projects > 5MW in nameplate capacity

NEXT STEPS FOR FINAL CELT 2018

Next Steps for CELT 2018

Incorporation of PV Panel Degradation

- Associated forecasts of energy and the estimated summer peak load reductions will include a 0.5%/year degradation rate to account for expectations regarding a solar panel's declining conversion efficiency over the longer term
  - The ISO first raised this modeling issue at the January 24, 2014 DGFWG meeting (refer to slide 10)
- Long-term panel degradation is often caused by:
  - Degradation of silicon or solder joints
  - Problems with the encapsulant that cause delamination, increased opacity, or water ingress
- Based on research by the National Renewable Energy Laboratory (NREL), the median rate of degradation is 0.5%/year
  - More information available here: https://www.nrel.gov/pv/lifetime.html
- Accounting for this degradation becomes more important as the region's PV panels age
- ISO will use the composite age of the forecasted PV fleet to develop an appropriate degradation rate

Next Steps for CELT 2018

- Once the 2018 nameplate PV forecast is finalized, ISO will:
  - Break down the forecast by market participation category
    - For reference, approximately 67% of PV was behind-the-meter at the end of 2016
  - Create the PV energy forecast
  - Develop the estimated summer peak load reductions
- ISO will reconstitute PV into the historical loads used to develop the long-term gross load forecast
  - Overall accounting in the net load forecast will be the same
  - As in prior forecasts, three PV categories will be used for CELT 2018:
    1. PV as a capacity resource in the FCM
    2. EOR
    3. BTM PV
- ISO will use the same approach as previous forecasts to estimate the geographic distribution of the PV forecast
  - Assumes future development is in existing areas of PV development

We Want Your Feedback …

- Please share your comments today
- ISO requests written comments on draft 2018 PV forecast by February 23, 2018 @ 5:00 p.m.
- Please submit comments to DGFWGMatters@iso-ne.com

Questions