Draft 2018 CELT ISO-NE Annual Energy and Summer Peak Forecast

Planning Advisory Committee

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SYSTEM PLANNING

Outline

- Introduction and Highlights
- Review of Seasonal Peak Demand and Annual Energy
- Draft 2018 Energy-Efficiency (EE) Forecast
- Draft 2018 Photovoltaic (PV) Forecast
- Draft 2018 Annual Energy and Summer Peak Forecast
- Next Steps

Introduction

Explanation of Gross and Net Load Forecasts

- The ISO annually develops 10-year forecasts of load that are published as part of the Capacity, Energy, Loads, and Transmission (CELT) report; the ISO also publishes additional forecast information as part of the annual forecast process, which is made available at: https://www.iso-ne.com/system-planning/system-forecasting/load-forecast/
- ISO first develops "gross" load forecasts that reflect a forecast of load without reductions from passive demand resources (PDR) and behind-the-meter PV (BTM PV)
  - PDR and BTM PV are reconstituted into historical hourly loads used to estimate gross load forecast models
  - This ensures the proper accounting of PDR and BTM PV, which are both forecast separately
  - Reconstitution also includes load reductions from active demand resources
- In this presentation, PDR will be referred to as energy efficiency (EE)
- "Net" load forecasts are developed by subtracting EE and BTM PV from the gross forecasts
  - Historical net loads include reconstitution of load reductions from active demand resources only
  - Net loads are intended to be representative of energy and loads observed in New England in real-time

Introduction

Categorization of Forecast Changes

- In general, changes reflected in the draft 2018 load forecast relative to the 2017 CELT can be divided into the following three components:
  1. Gross load forecast updates:
     a) Updated macroeconomic forecast from Moody's
     b) Updated historical data used to estimate gross load forecasts
  2. Changes to the EE forecast
  3. Changes to the PV forecast

Draft 2018 CELT Forecast Highlights

- Compared to 2017 CELT forecasts, changes reflected in the draft 2018 CELT include:
  - Macroeconomic outlook forecasts approximately the same economic growth in New England as last year
  - Gross forecasts:
    - Annual energy is approximately 0.3% higher in 2026
    - Summer 50/50 is approximately 2.7% lower in 2026
    - Summer 90/10 is approximately 2.8% lower in 2026
  - BTM PV forecast is approximately 0.6% higher in 2026
  - EE forecast is approximately 16.2% higher in 2026
  - Net forecasts
    - Annual energy forecast is approximately 4.5% lower in 2025
    - Summer 50/50 forecast is approximately 6.0% lower in 2026
    - Summer 90/10 forecast is approximately 5.8% lower in 2026

REVIEW OF SEASONAL PEAK DEMAND AND ANNUAL ENERGY

- *Summer 2017*
- *Winter 2017/2018*
- *2017 Annual Energy*

Summary of 2017 Summer Peak Demand

Net Demand

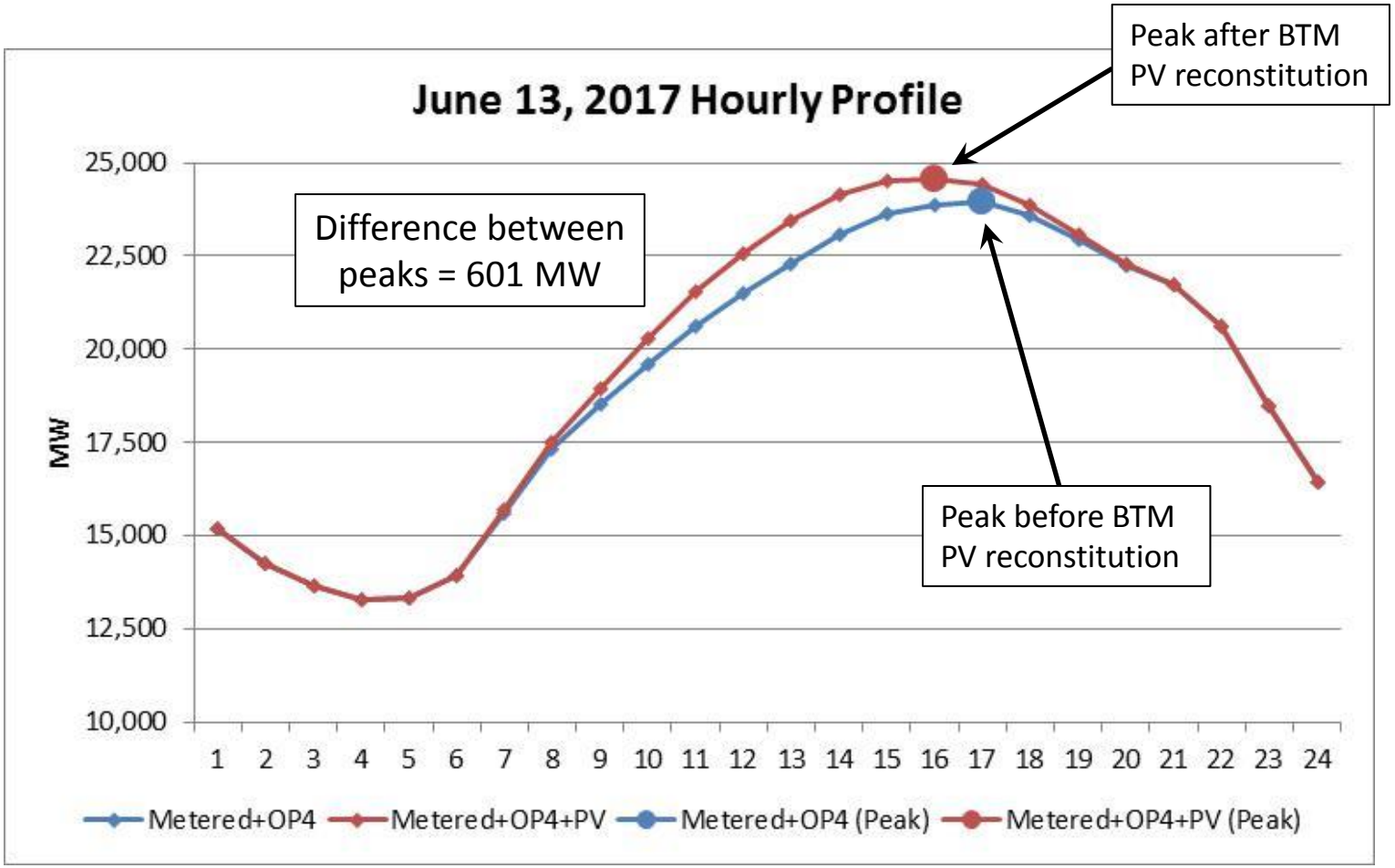
- ISO's long-term summer load forecast uses a 3-day, eight-city weighted temperature-humidity index (WTHI)
- The table below lists the five highest net peak demand days for summer 2017 along with the summer peak demand forecasts published in 2017 CELT
  - The BTM PV values are the MW reduction of the daily peak load determined through reconstitution, as depicted on next slide

Peak Day	Day of Week	Peak Load *	Peak Hour	WTHI	BTM PV
90/10 Forecast	-	28,865	-	82.0	575
50/50 Forecast	-	26,482	-	79.9	575
6/13/2017	Tue	23,968	17	79.3	601
7/19/2017	Wed	23,593	18	77.2	538
7/20/2017	Thr	23,556	17	78.2	720
6/12/2017	Mon	23,346	18	77.4	491
7/21/2017	Fri	22,942	17	77.8	650

* Forecast loads are net of forecasted impacts of EE and BTM PV; actual peak loads are metered and are reconstituted for RTDR when appropriate

Determining BTM PV Peak Load Reduction

2017 New England Summer Peak Day



2017 Summer Peak – Tuesday, June 13, 2017

Observed Load vs. Forecast

- The observed system peak load on June 13th was 2,514 MW lower than the 2017 CELT net 50/50 forecast
  - Observed weather at ISO's eight weather stations was less severe (WTHI=79.3) than the weather assumed for the 50/50 long-term load forecast (WTHI=79.9)
- Using CELT 2017 forecast model coefficients, the difference between forecast and actual can be attributed to two factors:
  1. Peak occurred in June – if the same June peak WTHI value (79.3) were to occur in either July or August, the peak would have been 2,050 MW higher
  2. Peak hour WTHI value less than 50/50 WTHI value - an increase of 0.6 degrees in the WTHI, the difference between the June peak WTHI value and the 50/50 value, would lead to an increase of demand by about 630 MW
- Adding back the adjustments described above to the June 13th peak value results in a adjusted peak of 26,648 MW which is 166 MW (0.6%) higher than the 2017 CELT net 50/50 forecast of 26,482 MW

Weather Normal Energy (GWh)

Comparison of 2017 and 2016

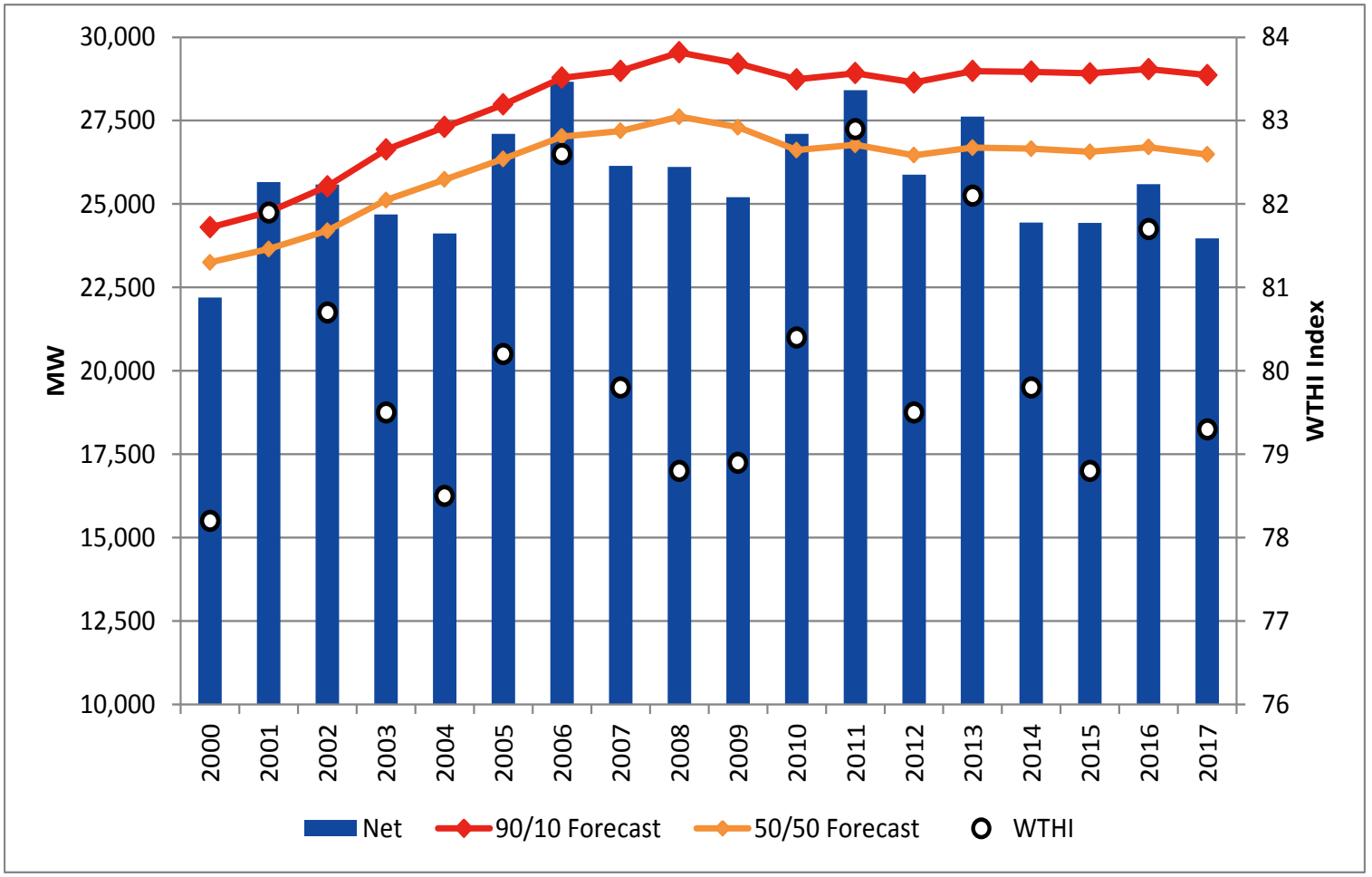
- After adjusting for weather and weekday/weekend effects, energy consumption is down 2.6% compared to weather normal 2016 energy
- After reconstituting for EE, energy consumption is down 0.7% compared to 2016
- The 2017 weather normal energy reconstituted with EE is 137,323 GWh, 1.0% (1,366 GWh) lower than the CELT 2017 forecast of 138,689 GWh

	2016	2017	GWh Change	% Change
Weather Normal Energy	123,953	120,668	-3,265	-2.6
Energy Efficiency	14,379	16,665	2,276	15.8
Weather Normal Energy + EE	138,332	137,323	-1,009	-0.7

Weather Normal 2017 Summer Peak Load

- The 50/50 weather normalized gross peak load for the summer of 2017 is 28,817 MW, 1.1% lower (-329 MW) than the CELT 2017 forecast of 29,146 MW for the summer of 2017
- The 90/10 weather normalized gross peak load for the summer of 2017 is 31,184 MW, 1.1% lower (-345 MW) than the CELT 2017 forecast of 31,529 MW for the summer of 2017
- The ISO New England Control Area actual summer peak load of 23,968 MW, occurred on June 13 at HE 17:00. At the hour of the peak the temperature was 91^{o} F, dew point was 65^{o} F and the WTHI was 79.3^{o} F
  - After reconstitution for active demand resources (14 MW), EE (2,572 MW), and BTM PV (460 MW), the gross peak was 27,014 MW

ISO-NE Net Summer Peaks And Weather (WTHI)



Weather Normal 2017/18 Winter Peak Load

- The 50/50 weather normalized gross peak load for the winter of 2017/18 is 22,910 MW, 0.5% (119 MW) lower than the CELT 2017 forecast of 23,029 MW for the winter of 2017/18
- The ISO New England Control Area actual winter peak load of 20,599 MW, occurred on January 5 (Friday) at HE 1800. At the hour of the peak the temperature was 8º F
  - After reconstitution for active demand resources (6 MW), EE (2,923 MW), and BTM PV (0 MW), the gross peak was 23,528 MW.
- The 2017/18 actual winter peak was higher than the 2016/17 actual winter peak of 19,647 MW, which occurred on December 15, HE 1800 at a temperature of 18º F.

DRAFT 2018 EE FORECAST

Summary of Draft 2018 EE Forecast

- The 2018 Draft EE Forecast results in an increase from the 2017 forecast due to a shift to using Forward Capacity Market (FCM) third Annual Reconfiguration Auction (ARA 3) Qualification values as the starting point for the forecast
- Details of the 2018 forecast and overall forecast methodology are available on the EE Forecast Working Group (EEFWG) webpage:
  - https://www.iso-ne.com/committees/planning/energy-efficiency-forecast/

EE Forecast Model General Assumptions

- Annual EE budgets provided by the Commissions or representatives on their behalf were used in the model and held constant in years after the latest approved budget
- Peak-to-energy ratios were derived from a three-year average of recent performance and held constant through the forecast period
- Production cost baselines were derived from a three-year average of recent performance
- Production costs escalated at a 1.25% graduated rate that begins in the first year of the forecast
- Inflation rate was set at 2.5% per year
- The 2017 CELT energy forecast is used in conjunction with System Benefit Charges (SBC) to forecast SBC dollars

2018 Update to EE Forecast Methodology

Background and Findings

- Beginning in 2014, the EE forecast actuals were represented by FCM Existing Qualified + New Cleared
  - Existing Qualified + New Cleared is a value determined over 3-years prior to the start of the relevant Capacity Commitment Period
- Qualification for ARA 3 is held just a few months prior to the start of the relevant Capacity Commitment Period
- ISO has observed that ARA 3 Qualification diverges from, and is higher than, Existing Qualified + New Cleared, especially in recent years
  - Projects come online early and participate in ARA 3 for earlier Capacity Commitment Periods
  - Terminated projects are removed from ARA 3 Qualification
- ARA 3 Qualification values are the best FCM indicator of what will actually be installed and operating for a given Capacity Commitment Period

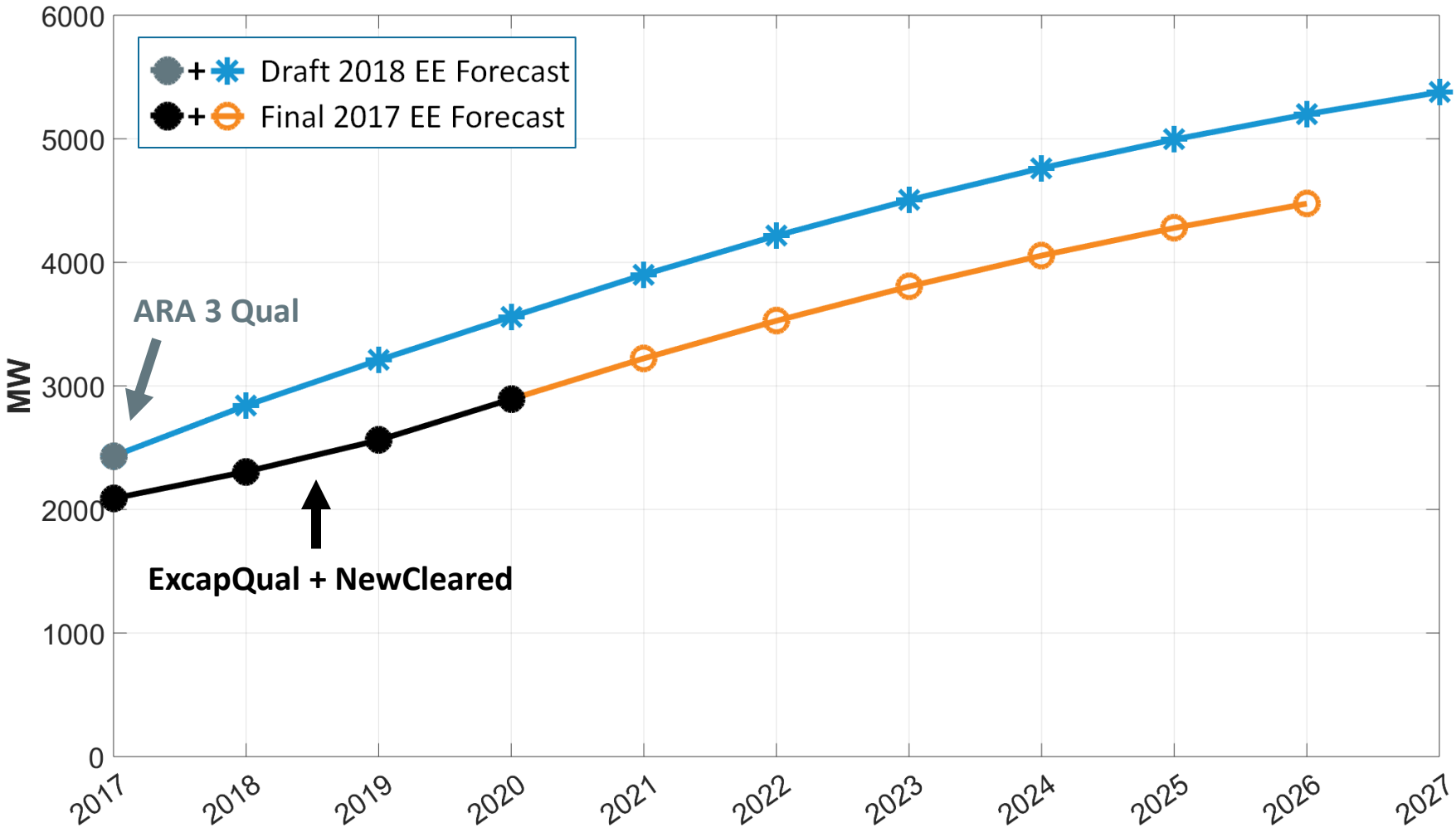
2018 Update to EE Forecast Methodology

Structural Changes

- Replace Existing Qualified + New Cleared with ARA 3 Qualification
  - ARA 3 Qualification is the most up-to-date annual FCM quantity available for any given Capacity Commitment Period
  - ARA 3 Qualification accounts for projects that come online early as well as those that undergo full or partial termination
- Impacts
  - Year 1 of the forecast will be ARA 3 Qualification (fixed)
  - Years 2 through 10 of the forecast will be forecast values
    - Forecast methodology will remain unchanged (budgets, production costs, peak-to-energy ratios)

Summer Peak EE Forecast

New England



Energy and Summer Peak EE Forecast

New England

Energy Savings (GWh)

	New England	MA	CT	ME	RI	VT	NH
2019	2,690	1,733	295	161	267	125	108
2020	2,568	1,631	308	152	257	118	102
2021	2,498	1,517	391	141	240	112	97
2022	2,306	1,395	364	130	222	104	91
2023	2,104	1,269	335	118	203	96	84
2024	1,898	1,140	304	106	184	87	77
2025	1,695	1,014	273	94	164	81	69
2026	1,495	891	242	83	145	72	62
2027	1,303	775	212	72	127	63	54
Total 2019-2027	18,558	11,366	2,724	1,058	1,809	857	745
Average	2,062	1,263	303	118	201	95	83

Demand Savings (MW)

	New England	MA	CT	ME	RI	VT	NH
2019	367	241	42	21	34	14	16
2020	351	226	44	20	32	13	15
2021	342	211	55	19	30	13	14
2022	315	194	52	17	28	12	13
2023	288	176	47	16	25	11	12
2024	259	158	43	14	23	10	11
2025	232	141	39	12	21	9	10
2026	204	124	34	11	18	8	9
2027	178	108	30	10	16	7	8
Total 2019-2027	2,535	1,577	387	139	227	98	107
Average	282	175	43	15	25	11	12

DRAFT 2018 PV FORECAST

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, non-FCM Energy Only Resources, 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
- Additional details of the draft 2018 PV forecast are available at:

https://www.iso-ne.com/static-assets/documents/2018/02/dgfwg_2018feb12_draft2018forecast_final.pdf

PV Panel Degradation Factors

- Associated forecasts of energy and estimated summer peak load reductions from BTM PV 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, and is assumed to be linear over time
  - 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
- The ISO estimated the capacity-weighted composite age of the forecasted PV fleet to develop appropriate degradation factors to use for the forecast

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 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 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:

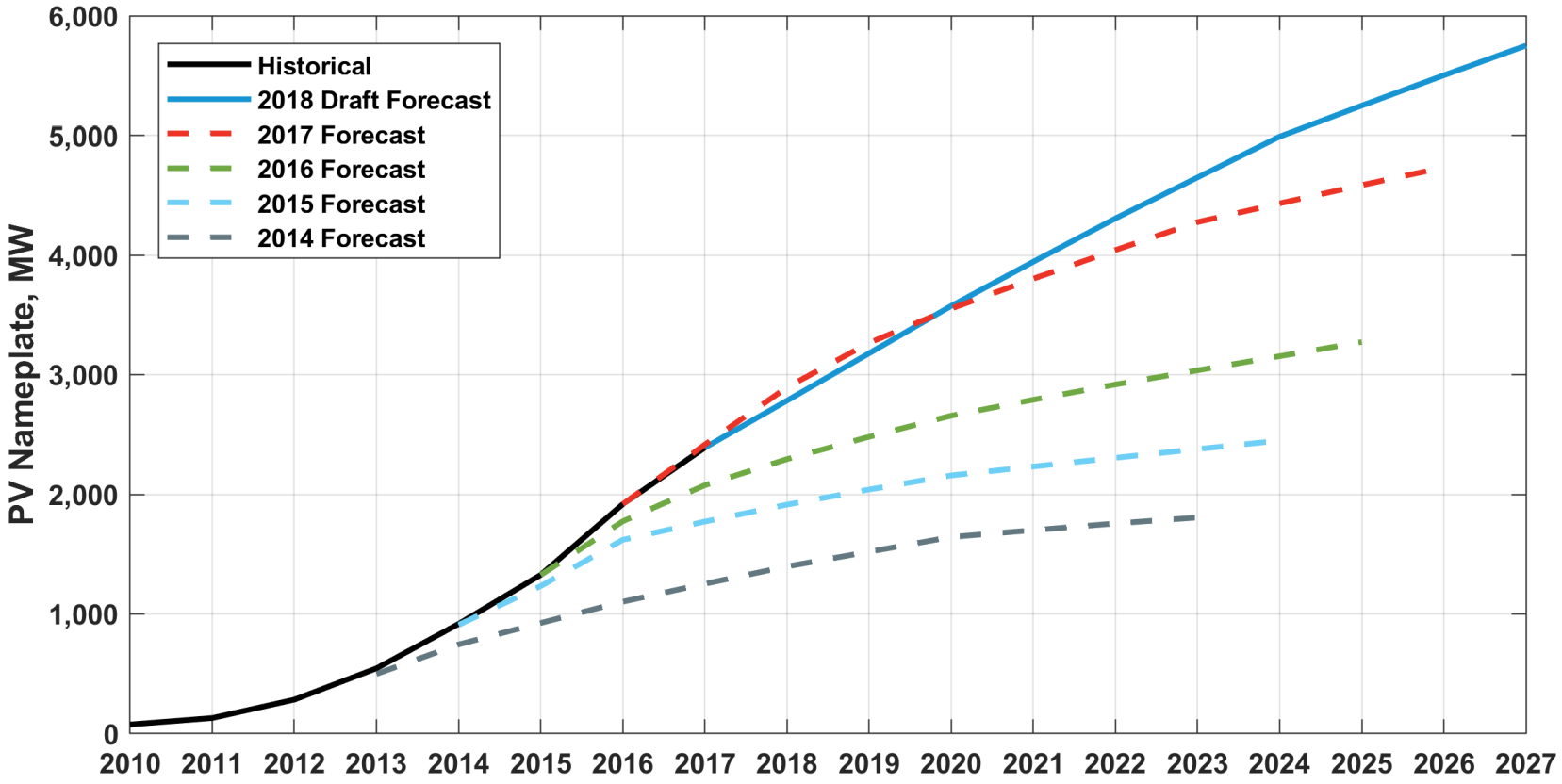
(1) Forecast values include FCM Resources, non-FCM Energy Only Generators, and behind-the-meter PV resources

(2) The forecast 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

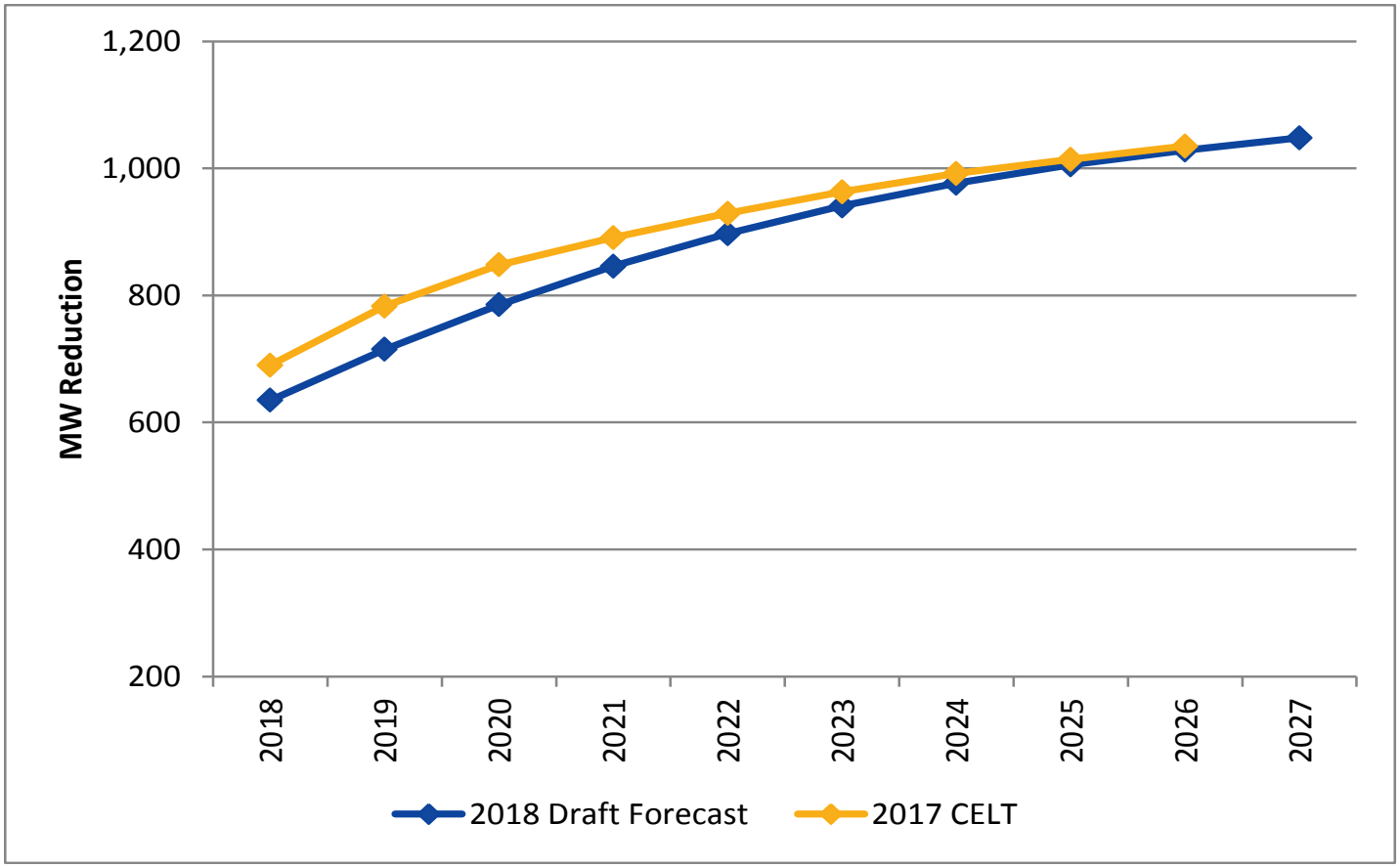
(4) Forecast does not include forward-looking PV projects > 5MW in nameplate capacity

PV Growth: Reported Historical vs. Forecast



Estimated BTM PV Summer Peak Reduction

Comparison of Draft 2018 and Final 2017 Forecasts



DRAFT 2018 ENERGY AND SUMMER PEAK LOAD FORECAST

Draft 2018 Energy and Summer Peak Forecast

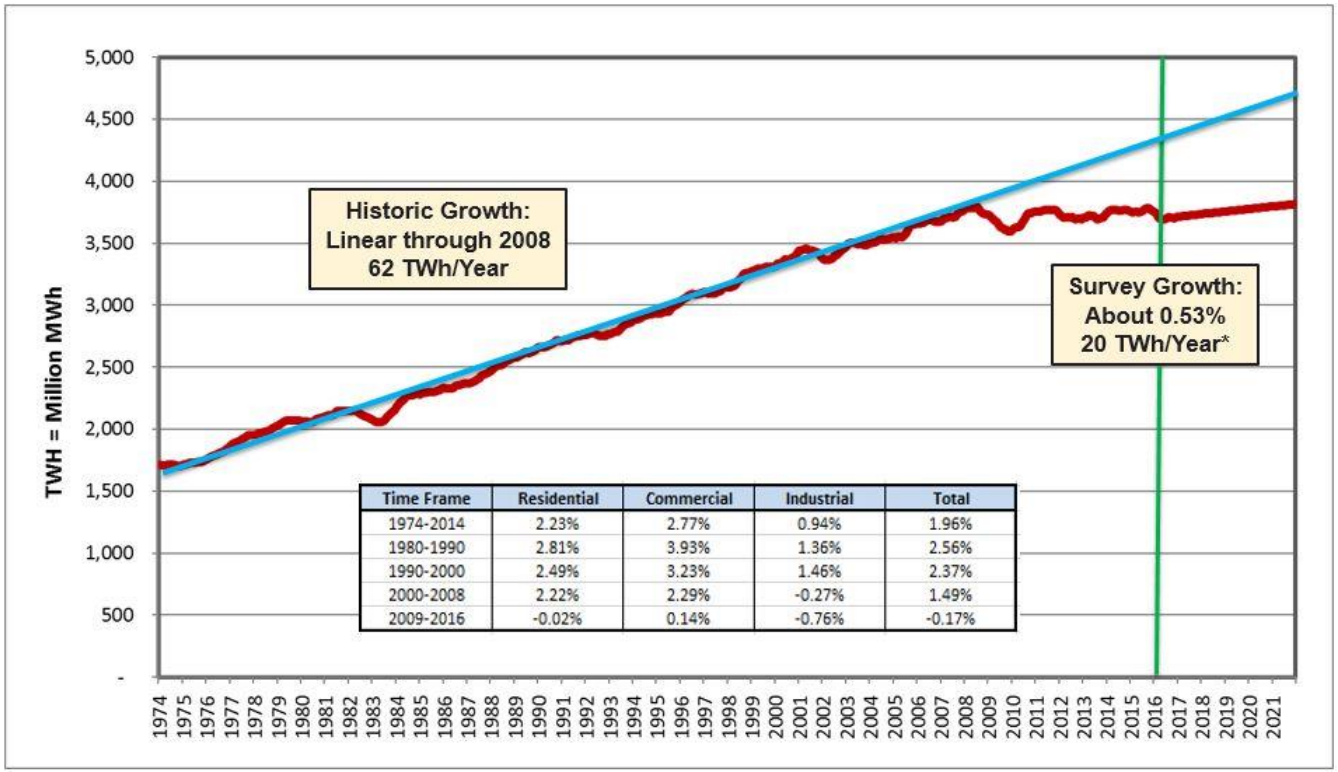
Summary

- The same methodology used to develop the CELT 2017 summer peak demand forecast was used to develop the draft 2018 CELT forecast
  - The input data were refreshed as is done each year
- Energy models use the updated Moody's macroeconomic forecast of October 2017 as an input
- The ISO re-estimated econometric gross forecast models, with the addition of 2017 data, based on actual energy and daily peaks that have been reconstituted with active demand resources, EE, and BTM PV
- The 2018 CELT forecast of energy, summer peak, EE, and BTM PV are all draft
- The 2018 CELT summer peak forecast is lower than the 2017 CELT forecast
- The draft load forecast was presented to the NEPOOL Load Forecast Committee (LFC) on February 7 with no objections

Total U.S. Electricity Sales

Terawatt-Hours (TWh)

- Trends in U.S. electricity consumption since 2009 have been different than long-term historical trends
  - New England has witnessed a similar shift

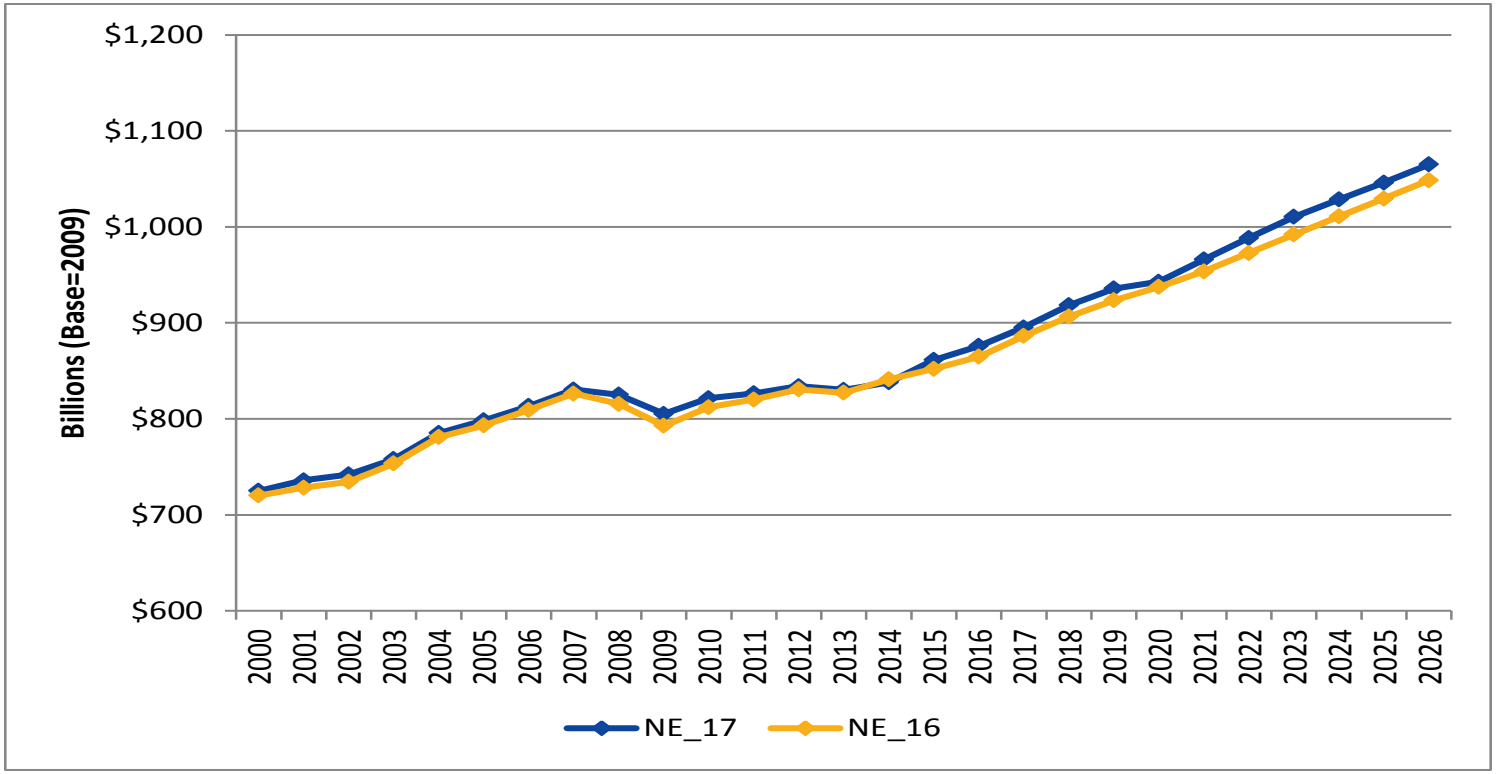


Time Frame	Residential	Commercial	Industrial	Total
1974-2014	2.23%	2.77%	0.94%	1.96%
1980-1990	2.81%	3.93%	1.36%	2.56%
1990-2000	2.49%	3.23%	1.46%	2.37%
2000-2008	2.22%	2.29%	-0.27%	1.49%
2009-2016	-0.02%	0.14%	-0.76%	-0.17%

Source: Itron 2017 Benchmarking Survey

Moody's 2017 and 2016 Economic Forecast

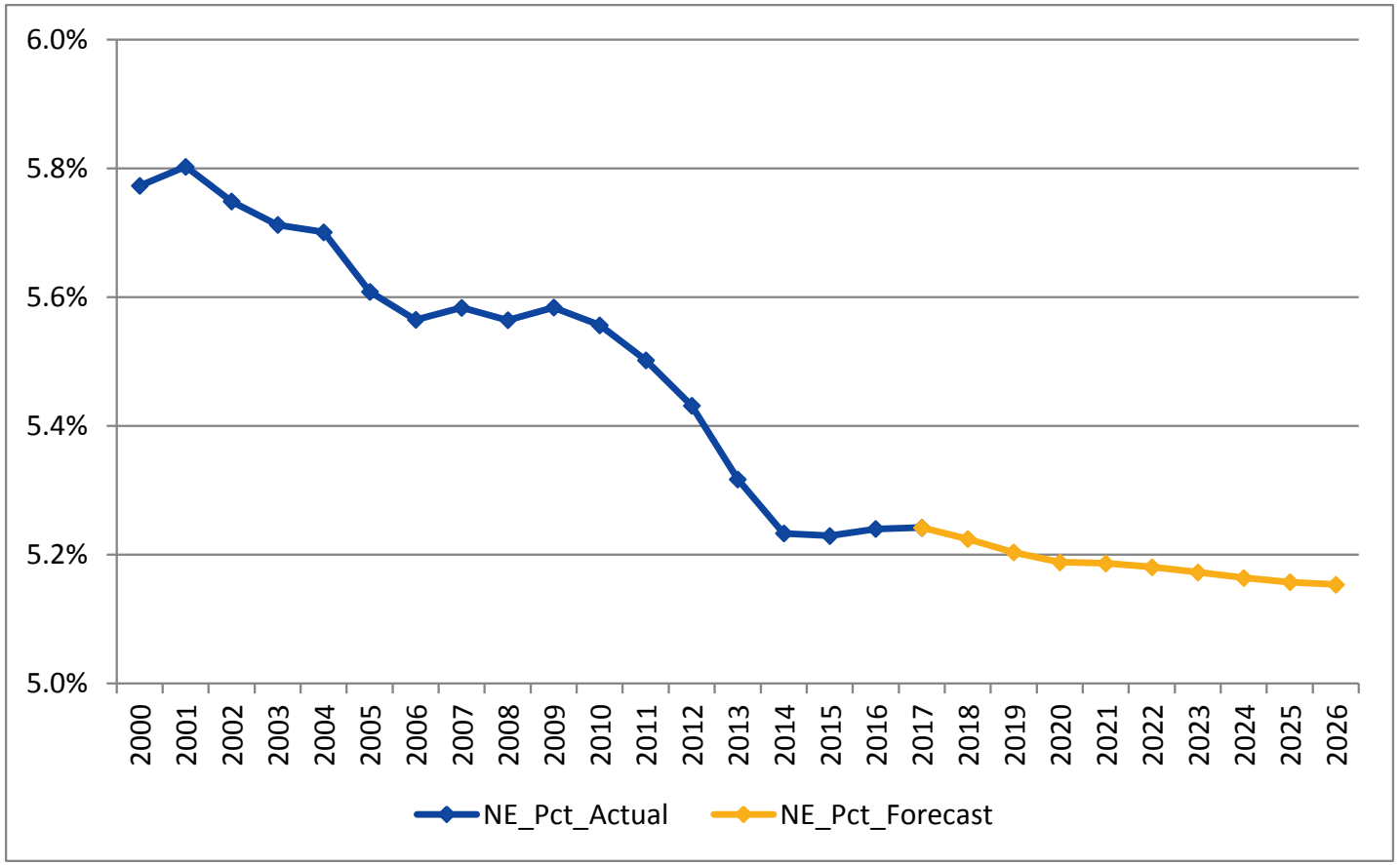
New England Gross State Product



- Compound Annual Growth Rate (CAGR) from 2017 thru 2026 of 1.95% approximately the same as last year's forecast of 1.89%. Historical revisions of GRP increased slightly
- National CAGR, 2.1%, little change from last year's forecast.

Moody's Economic Forecast

New England Percent of U.S. Gross Domestic Product



Gross Energy Forecast

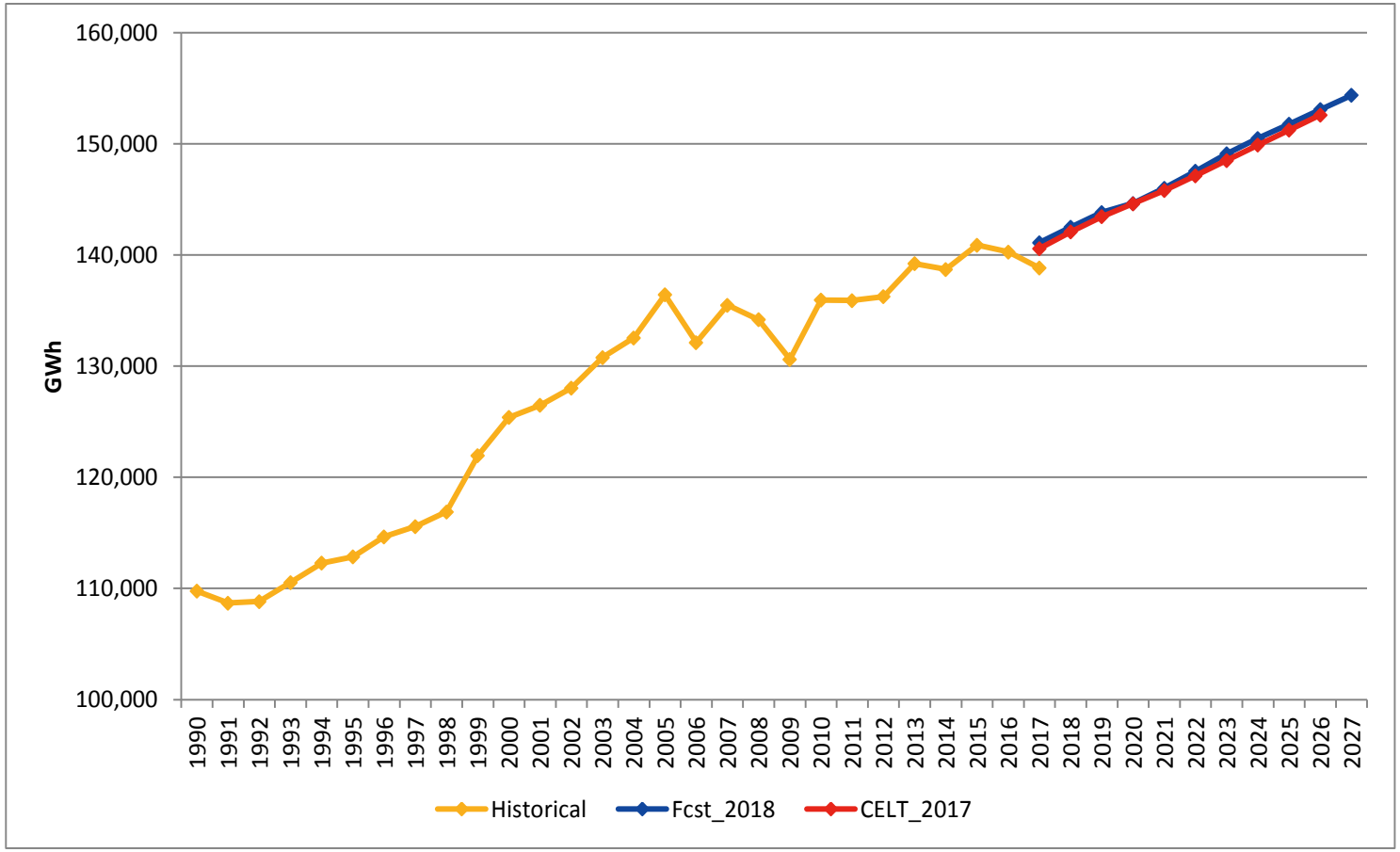
New England

ISO-NE subtracts impacts of Federal Efficiency Standards (EISA07) from the modeled gross energy forecast

	2018 Draft Forecast			2017 CELT
Year	Gross Forecast w/o Standards (GWh)	Incremental Standards (GWh)	Gross Forecast with Standards (GWh)	Gross Forecast with Standards (GWh)
2018	142,522	34	142,488	142,078
2019	143,888	68	143,820	143,447
2020	144,733	99	144,634	144,611
2021	146,150	141	146,009	145,799
2022	147,734	196	147,538	147,127
2023	149,352	252	149,100	148,507
2024	150,781	296	150,485	149,884
2025	152,112	346	151,766	151,233
2026	153,466	394	153,072	152,593
2027	154,804	440	154,364	

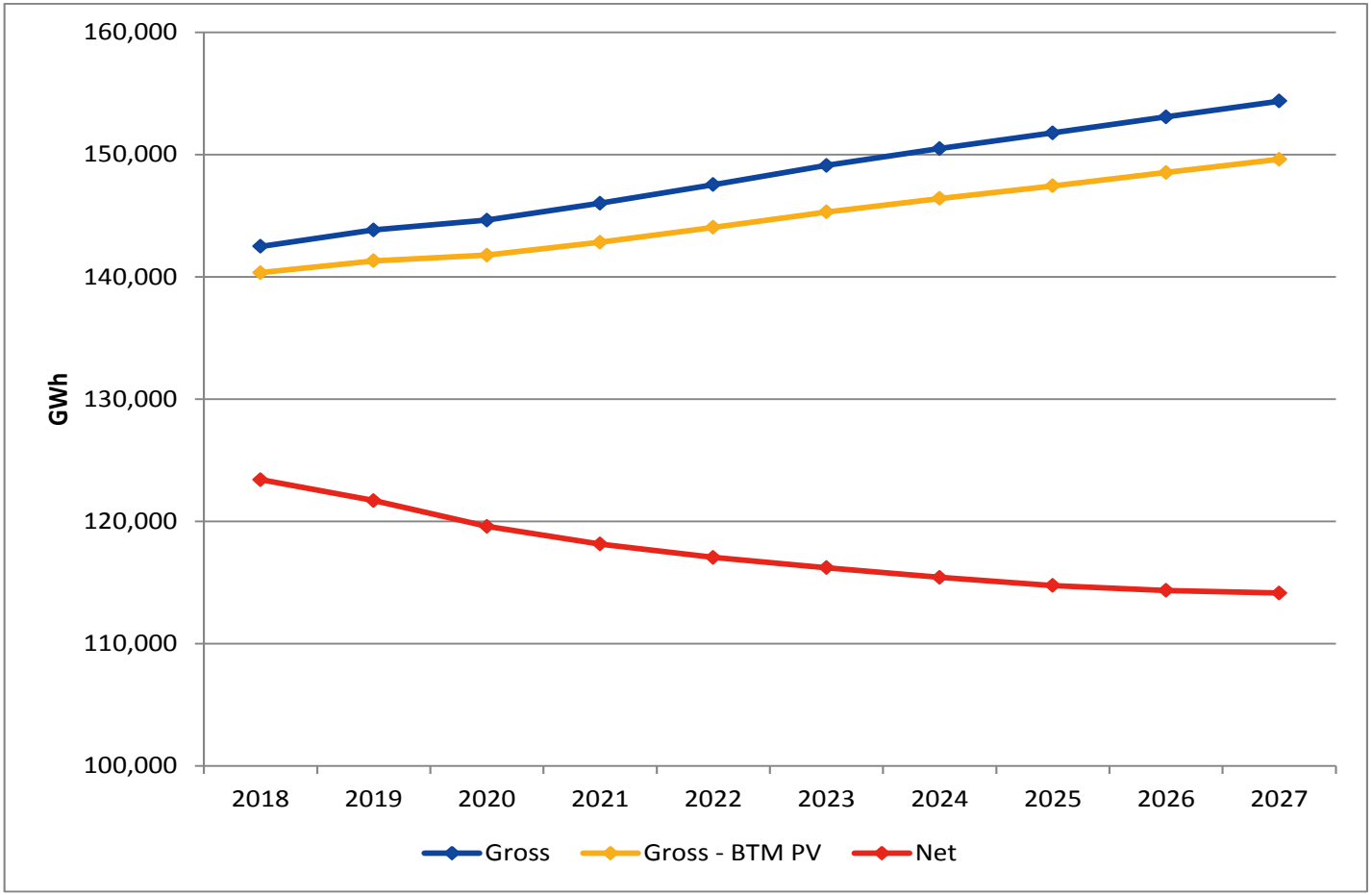
NE Gross Energy History and Forecast

Net Load + Energy Efficiency + BTM PV – Federal Efficiency Standards



2018 (+0.3% ,+410 GWh) 2022 (+0.3% , +411 GWh) 2026 (+0.3%, +479 GWh)

Draft 2018 CELT ISO-NE Energy Forecast

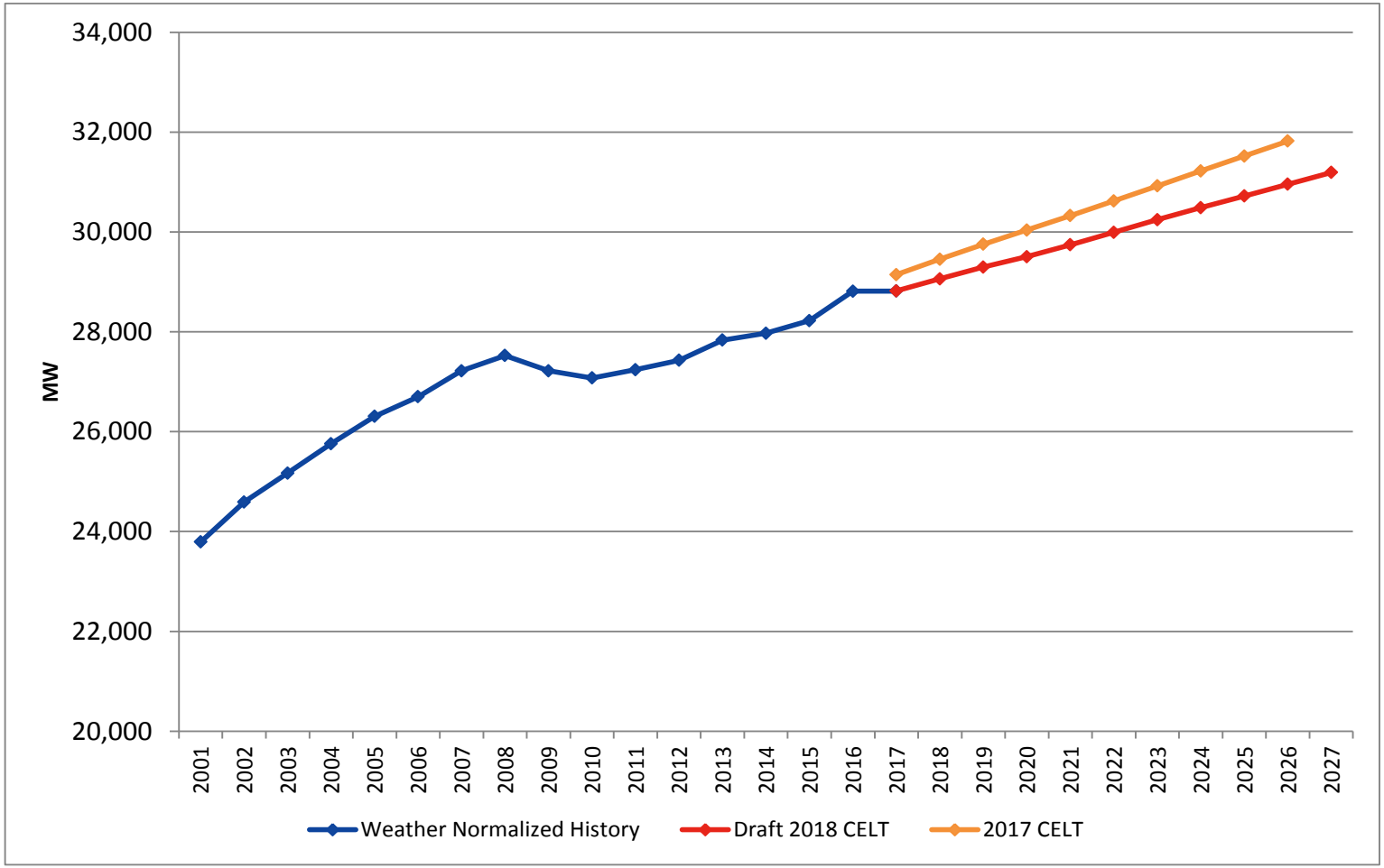


Forecast Comparison Table: Annual Energy

Draft 2018 CELT and 2017 CELT

	Draft 2018 CELT (GWh)				2017 CELT (GWh)				Change (GWh)			
Year	Gross	BTM PV	EE	Net	Gross	BTM PV	EE	Net	Gross	BTM PV	EE	Net
2018	142,488	2,154	16,929	123,405	142,078	2,373	13,279	126,426	410	-219	3,650	-3,021
2019	143,820	2,514	19,618	121,688	143,447	2,800	14,911	125,736	373	-286	4,707	-4,048
2020	144,634	2,865	22,187	119,582	144,611	3,133	17,038	124,440	23	-268	5,149	-4,858
2021	146,009	3,194	24,685	118,130	145,799	3,381	19,441	122,977	210	-187	5,244	-4,847
2022	147,538	3,503	26,991	117,044	147,127	3,609	21,659	121,859	411	-106	5,332	-4,815
2023	149,100	3,799	29,095	116,206	148,507	3,830	23,683	120,994	593	-31	5,412	-4,788
2024	150,485	4,082	30,993	115,410	149,884	4,027	25,508	120,349	601	55	5,485	-4,939
2025	151,766	4,330	32,688	114,748	151,233	4,185	27,137	119,911	533	145	5,551	-5,163
2026	153,072	4,545	34,183	114,344	152,593	4,338	28,575	119,680	479	207	5,608	-5,336
2027	154,364	4,755	35,487	114,122								

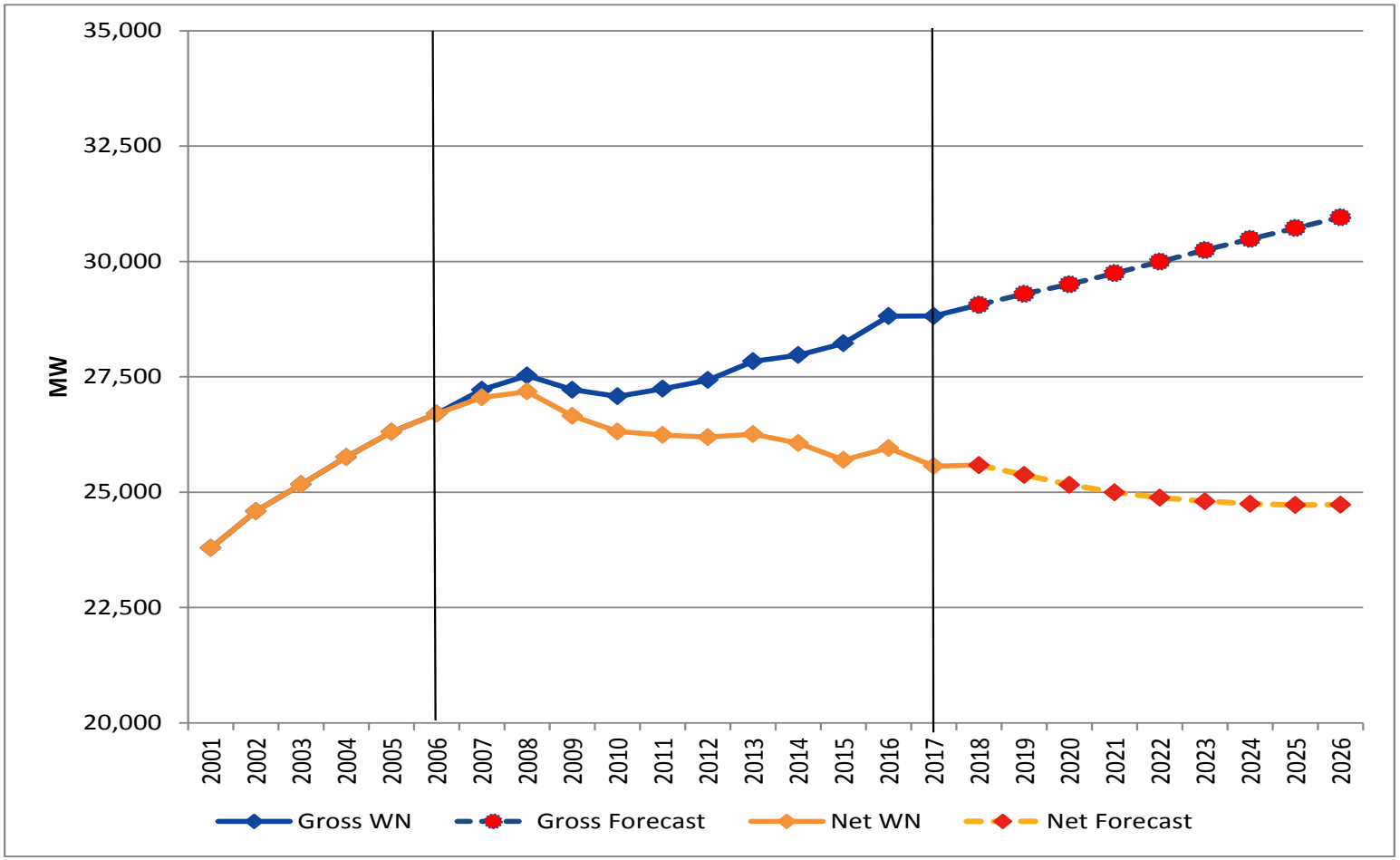
ISO-NE Gross 50/50 Summer Peak Forecast



2018 (-1.3% , -394 MW) 2022 (-2.1% , -629 MW) 2026 (-2.7%, -863 MW)

Draft 2018 CELT ISO-NE 50/50 Summer Peak Forecast

Weather Normal History 2001-2017 and Draft Forecast

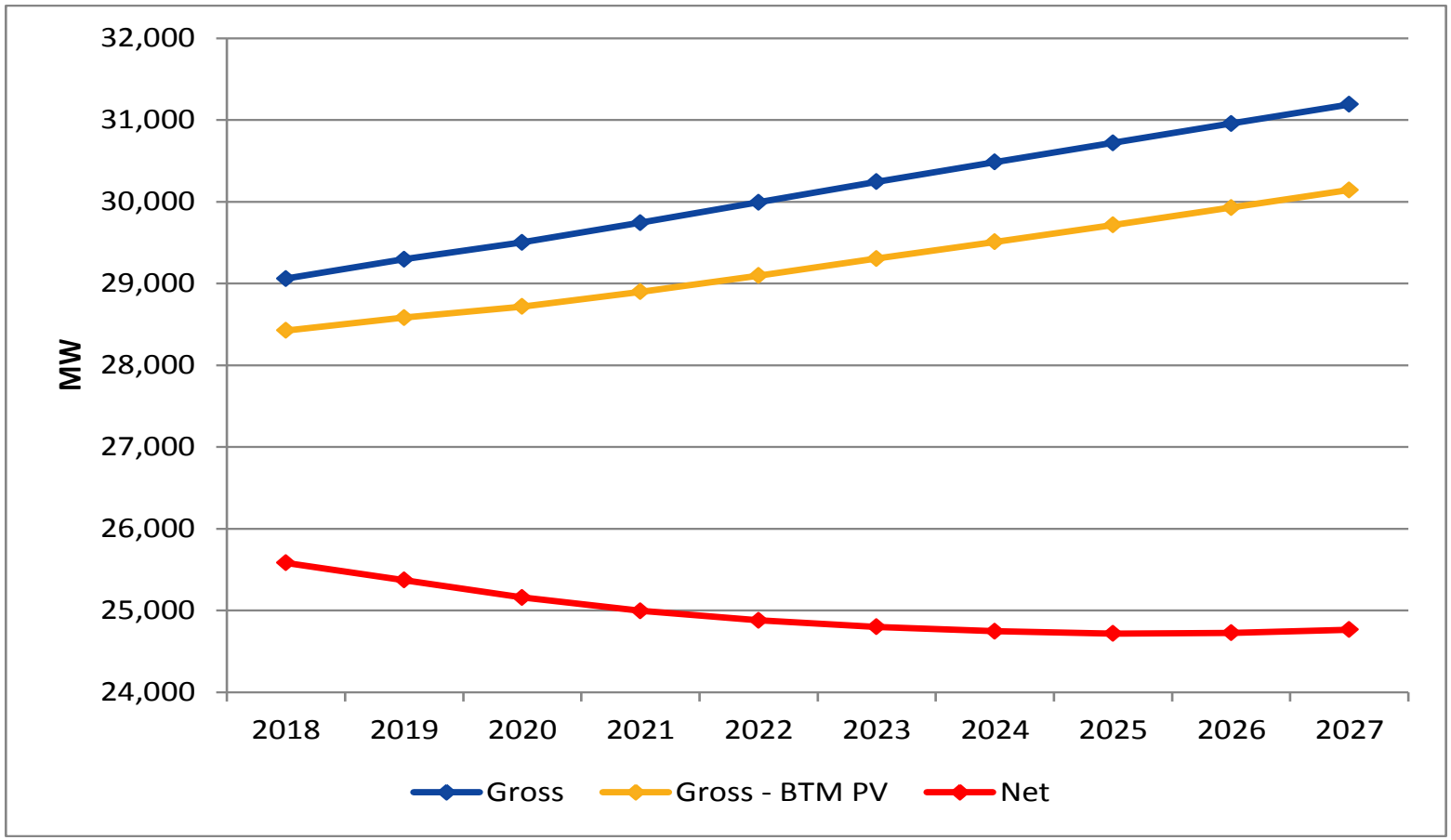


Draft 2018 ISO-NE CELT Forecast

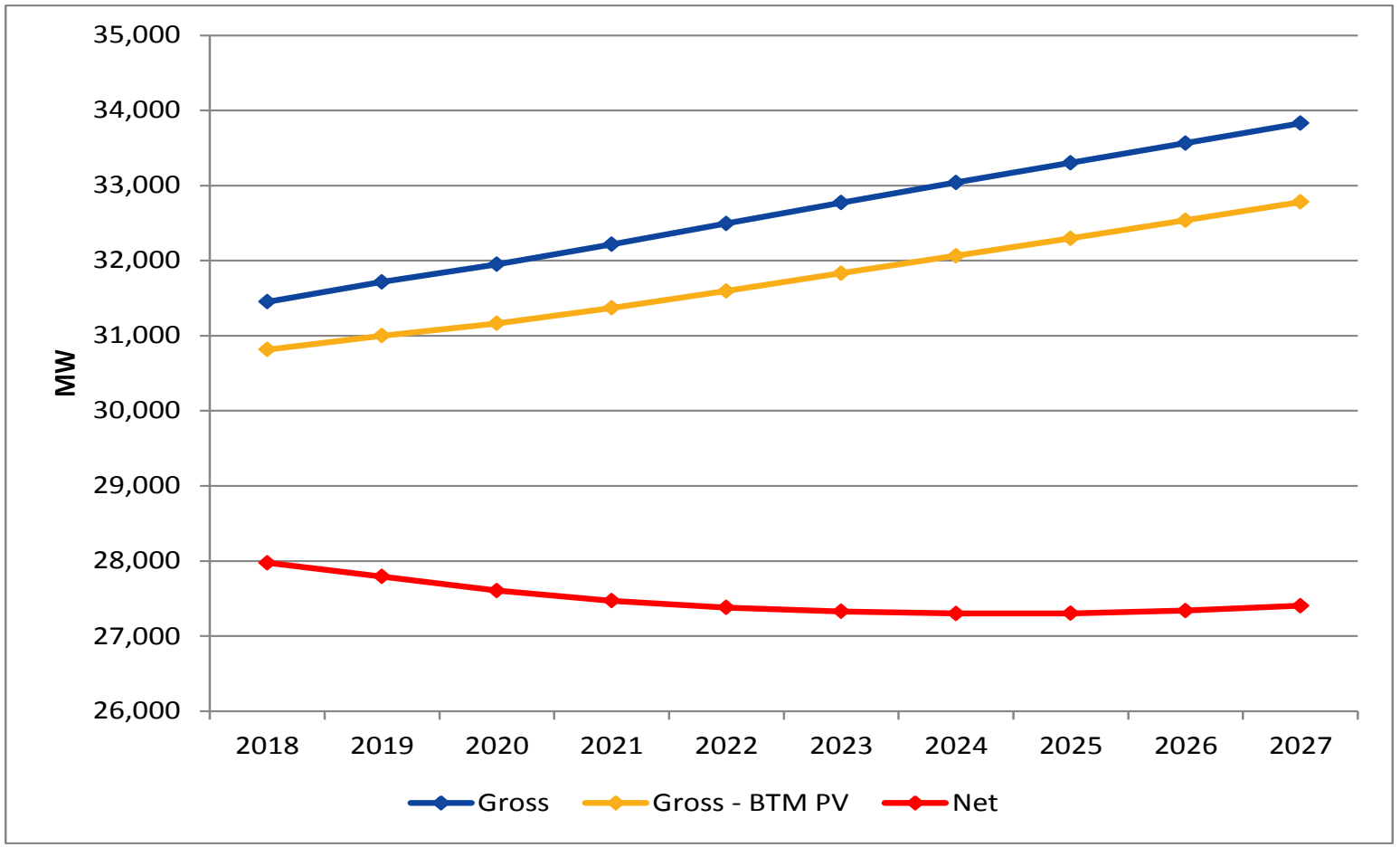
Summer Gross and Net Peak, EE, and BTM PV

Summer Peak (MW)						
Year	Gross 50/50	Gross 90/10	BTM PV	EE	Net 50/50	Net 90/10
2018	29,060	31,451	635	2,841	25,584	27,975
2019	29,298	31,716	715	3,209	25,374	27,792
2020	29,504	31,950	785	3,559	25,160	27,606
2021	29,744	32,217	846	3,901	24,997	27,470
2022	29,994	32,494	897	4,216	24,881	27,381
2023	30,245	32,773	941	4,503	24,801	27,329
2024	30,486	33,041	977	4,763	24,746	27,301
2025	30,721	33,303	1,006	4,995	24,720	27,302
2026	30,957	33,566	1,029	5,199	24,729	27,338
2027	31,192	33,829	1,048	5,377	24,767	27,404
CAGR	0.79%	0.81%			-0.42%	-0.29%

Draft 2018 CELT ISO-NE 50/50 Summer Peak Forecast



Draft 2018 CELT ISONE 90/10 Summer Peak Forecast



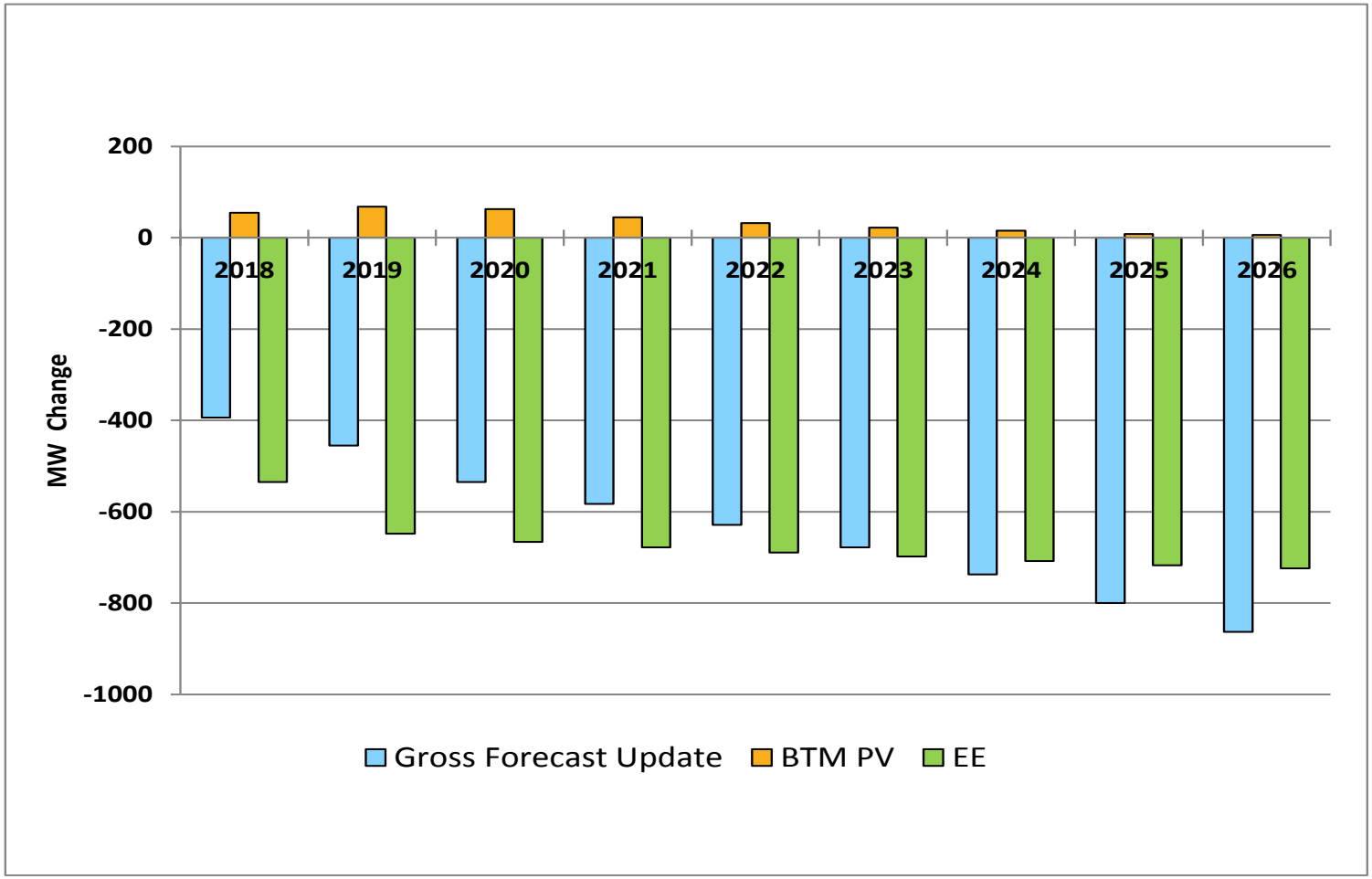
Forecast Comparison Table: Summer Peak

Draft 2018 CELT and 2017 CELT

	Net 50/50 Summer Peak					Net 90/10 Summer Peak			
	Fcst_2018	**2017 CELT**	**Change**	**% Change**		**Fcst_2018**	**2017 CELT**	**Change**	**% Change**
2018	25,584	26,458	-874	-3.3%		27,975	28,877	-902	-3.1%
2019	25,374	26,409	-1,035	-3.9%		27,792	28,865	-1,073	-3.7%
2020	25,160	26,298	-1,138	-4.3%		27,606	28,790	-1,184	-4.1%
2021	24,997	26,213	-1,216	-4.6%		27,470	28,741	-1,271	-4.4%
2022	24,881	26,167	-1,286	-4.9%		27,381	28,732	-1,351	-4.7%
2023	24,801	26,155	-1,354	-5.2%		27,329	28,757	-1,428	-5.0%
2024	24,746	26,176	-1,430	-5.5%		27,301	28,814	-1,513	-5.2%
2025	24,720	26,228	-1,508	-5.7%		27,302	28,903	-1,601	-5.5%
2026	24,729	26,310	-1,581	-6.0%		27,338	29,021	-1,683	-5.8%
2027	24,767					27,404			
CAGR	-0.36%	-0.07%				-0.23%	0.06%		

Forecast Impact on Summer Peak by Component

Change from 2017 CELT



Next Steps

- Finalization of the forecasts will be discussed at upcoming stakeholders meetings:
  - The next DGFWG meeting will be on March 19, 2018
  - The next EEFWG meeting will be on March 26, 2018
  - The next LFC meeting will be on March 28, 2018
- The finalized forecasts will be shared at the April 26, 2017 PAC
- The finalized 2018 CELT forecasts will be published by May 1, 2018 and will include:
  - Final EE forecast
  - Final PV forecast
    - Including BTM PV
  - Final ISO-NE and state forecasts for:
    - Annual energy
    - Seasonal peaks
    - Gross and net of PDR/BTM PV
  - Forecasts at the state, load zone, and subarea levels

Questions