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VIA ELECTRONIC MAIL

November 14, 2018

TO: Energy & Technology Committee
Environment Committee

FROM: Melanie A. Bachman, Executive Director MAB

RE: **DOCKET NO. F-2017/2018** - Connecticut Siting Council Review of the Ten-Year Forecast of Connecticut Electric Loads and Resources

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The Connecticut Siting Council (Council) hereby announces the issuance of the *2017/18 Connecticut Siting Council Review of the Ten Year Forecast of Connecticut Electric Loads and Resources*. Pursuant to Connecticut General Statutes §16-50r, this report assesses the status of electric loads and resources in the state over a ten-year forecast period.

This public report is available on our website at www.ct.gov/csc under the "Publications" link:

MAB/MP/laf

c: Council Members

DOCKET NO. F-2017/2018 – Connecticut Siting Council Review of the Ten-Year Forecast of Connecticut Electric Loads and Resources

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Report

November 8, 2018

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INTRODUCTION

Since 1972, the Connecticut General Assembly has mandated the Connecticut Siting Council (Council) to review the forecasts of our state's electricity needs and resources. Specifically, since the passage of Public Act (PA) 01-144 in 2001, the requirement is to review a ten-year forecast of loads and resources. Under Connecticut General Statutes (CGS) §16-50r(a), each entity engaged in electric transmission services, electric distribution services or generating electric power with a capacity of one megawatt or greater shall file annually with the Council a forecast of loads and resources (or an update of the previous year's forecast report) on or before March 1 of such year.

Such reports shall include, as applicable: (1) A tabulation of estimated peak loads, resources and margins for each year; (2) data on energy use and peak loads for the five preceding calendar years; (3) a list of existing generating facilities in service; (4) a list of scheduled generating facilities for which property has been acquired, for which certificates have been issued and for which certificate applications have been filed; (5) a list of planned generating units at plant locations for which property has been acquired, or at plant locations not yet acquired, that will be needed to provide estimated additional electrical requirements, and the location of such facilities; (6) a list of planned transmission lines on which proposed route reviews are being undertaken or for which certificate applications have already been filed; (7) a description of the steps taken to upgrade existing facilities and to eliminate overhead transmission and distribution lines in accordance with the regulations and standards described in section 16-50t; and (8) for each private power producer having a facility generating more than one megawatt and from whom the person furnishing the report has purchased electricity during the preceding calendar year, a statement including the name, location, size and type of generating facility, the fuel consumed by the facility and the by-product of the consumption. On and after March 1, 2012, each such report from a person engaged in electric transmission services or electric distribution services, as defined in section 16-1, shall identify any potential reliability concerns during the forecast period and such person shall provide such information to the Commissioner of Energy and Environmental Protection.

Also per CGS §16-50r(a), the Council shall hold a public hearing on such filed forecast reports annually, and at least one session of such hearing shall be held after six-thirty p.m. Upon reviewing such forecast reports, the Council may issue its own report assessing the overall status of loads and resources in the state. If the Council issues such a report, it shall be made available to the public and shall be furnished to each member of the joint standing committee of the General Assembly having cognizance of matters relating to energy and technology, any other member of the General Assembly making a written request to the council for the report and such other state and municipal bodies as the council may designate.

The Council is in receipt of March 2017 and March 2018 utility forecast reports, with March 2018 being the most up to date at this time. The Council held public comment sessions in New Britain at 6:30 p.m. on May 9, 2017 and September 19, 2018. No comments were received at either public comment session.

Given the importance not only for our State, but for our region, the electric network must be highly reliable. Daily operations of the grid, including both power flows and transactions within the wholesale market for electricity, are managed by the Independent System Operator for New England. ISO New England Inc. (ISO-NE) is a private, not-for-profit corporation, governed by an independent board of directors and overseen by the Federal Energy Regulatory Commission (FERC). Reliability standards set or approved by FERC are carried out through ISO-NE by its member companies. This centralized regional authority for management helps to ensure that the system functions reliably and efficiently. ISO-NE also directs annual forward planning for both electric transmission and generation needs in our region. Members choose to participate in this regional planning process in one of the following sectors: generators, suppliers, alternative resources (including renewable resources), transmission owners, publicly-owned utilities, and end users. Nonetheless, since each state regulates the power facilities in-state only, and affects future electric reliability by establishing energy policies for in-state businesses and citizens, the prudent state must carefully review forecasts of anticipated electric supply and demand within its own borders.

Pursuant to PA 11-80 and PA 13-298, the Department of Energy and Environmental Protection (DEEP) is mandated to create an Integrated Resource Plan (IRP). Its most important features, to be discussed below in more detail, are its coordinated approach to procuring electricity and its emphasis on energy reliability and efficiency. Furthermore, in accordance with PA 11-80 and PA 13-298, DEEP is also mandated to create a Comprehensive Energy Strategy (CES). The CES, while taking into account the findings of the IRP, lays out a coordinated approach to address our collective energy, economic, and environmental challenges while aiming towards a cheaper, cleaner, and more reliable energy future.

In contrast to the IRP, which establishes policy, and the CES, which not only addresses policy and strategy but covers multiple types of energy, the Council's report is limited strictly to forecasting and focuses on electricity, as required by statute.

ELECTRIC DEMAND

Load and Load Forecasting

Load forecasting by the Connecticut utilities is broken down by each distribution company's service area. This includes the two largest distribution companies, The Connecticut Light and Power Company d/b/a Eversource Energy (Eversource) and The United Illuminating Company (UI), as well as municipal electric distribution companies, the Connecticut Municipal Electric Energy Cooperative (CMEEC) and Wallingford Electric Division (WED)[1]. UI serves 17 municipalities in the greater New Haven area near the coast from Fairfield to North Branford and north to Hamden. The Connecticut Municipal Electric Energy Cooperative (CMEEC) collectively serves the majority of the municipal utilities in Connecticut, namely, the City of Norwalk's Third Taxing District Electrical Department; Groton Utilities; Jewett City Department of Public Utilities; Norwich Public Utilities; and South Norwalk Electric & Water. Bozrah Power & Light Company (Bozrah) and the

Mohegan Tribal Utility Authority (MTUA) are also full-requirement wholesale customers of CMEEC[2]. Wallingford Electric Division (WED) serves the Town of Wallingford (and a portion of North Branford) as a municipal utility. The largest transmission/distribution company by size and service area is Eversource, which serves all of the remaining municipalities in Connecticut. Collectively, at any given time, the sum of Eversource, UI, CMEEC[3], and WED loads is approximately equal to the Connecticut load. The Council is mandated by statute to review these utility forecasts for the Connecticut load.

The principal term for describing electric load is "demand," which can be thought of as the rate at which electrical energy is consumed. (This is not to be confused with "energy", which is the total work done over a given period of time by the electricity.) The most familiar unit of load or demand is a "Watt." On a household scale, a kilowatt (kW) is used, a unit of 1,000 Watts. However, since utility companies serve loads on a much larger scale, forecasts typically use the unit of a megawatt (MW), or one million watts[4]. Very large utility-level loads can sometimes be expressed in gigawatts (GW). One GW is equal to one billion watts or 1,000 MW.

Loads increase with any increase in the number of electrical devices being used at the same time. Demand also depends on the size of the electrical loads or how much work is being performed by those devices. Generally, the higher the electrical loads, the more the stress on the electrical infrastructure. Higher loads result in more generators having to run, and run at higher output levels. Transmission lines must carry more current to transformers located at the various substations. The transformers in turn must carry more electrical load, and supply it to the distribution feeders, which must carry more current (to for example pole or ground-mounted transformers) to supply the end users. In order to maintain reliability and predict when infrastructure must be added, upgraded, and replaced to serve customers adequately, utilities must have a meaningful and reasonably accurate estimate or projection of future loads. The process of calculating future loads is called "load forecasting."

In addition to producing its regional forecast, ISO-NE prepares individual forecasts for each of the New England states, including Connecticut. The Council acknowledges the importance of this forecast by reviewing it in parallel with the sum of the Eversource, UI, CMEEC, and WED forecasts.

ISO-NE forecasts also include projections for ten years based on their planning horizon, similar to ten-year forecasts from Connecticut utilities. In a ten-year forecast, peak loads are predicted for the calendar year that the forecast report is issued and for nine additional years into the future. Thus, a 2018 ten-year forecast does not predict peak loads through 2028, but rather 2027. The 2017 and 2018 utility and ISO-NE forecast reports are considered in the Council's forecast report, as they are the most up-to-date available at this time.

Peak Load Forecasting

Load forecasting focuses primarily on peak load, that is, the highest hourly load experienced during the year. Peak load is more important than typical or average load because the peak represents a clearly-defined worst-case stress on the electric system. Connecticut experiences its peak load during a hot, humid summer day. This is because air conditioning generally creates one of the largest components of demand for power.

While winter months in Connecticut do have periods of significant loads, winter peaks are generally lower than summer peaks because much of the energy for heating is supplied directly by fossil fuels consumed on the customer's premises, not by electricity[5]. While natural gas, propane, or oil heating systems do typically require electricity for blowers/fans, control systems, pumps, etc., this electrical load is generally smaller than the load from air conditioning, which runs entirely on electricity[6]. Conversely, areas such as the Canadian province of Québec, where electric heating is common in winter and there is less demand for air conditioning in summer, can experience peak loads in the winter.

While a detailed discussion of peak loads would have to include additional factors such as customer usage, demographics, conservation efforts, economic conditions, and others, the most important factor is weather—specifically the temperature and humidity. Higher temperatures result in more frequent use of air conditioning, and the units work harder, consuming more electricity. Also, higher humidity can exacerbate the situation, as it can make the temperature feel hotter than it actually is (raising what is sometimes called the "heat index") and further encourage air conditioning use.

The duration of a "heat wave" is another factor. While some customers may tolerate an unusually warm day or two with little or no air conditioning use, extended periods of hot weather can lead to those customers (who initially may be reluctant to run air conditioning) to turn on their air conditioning units. Thus, daily peak loads can sometimes rise during a heat wave even if the daily high temperatures remain more or less uniform.

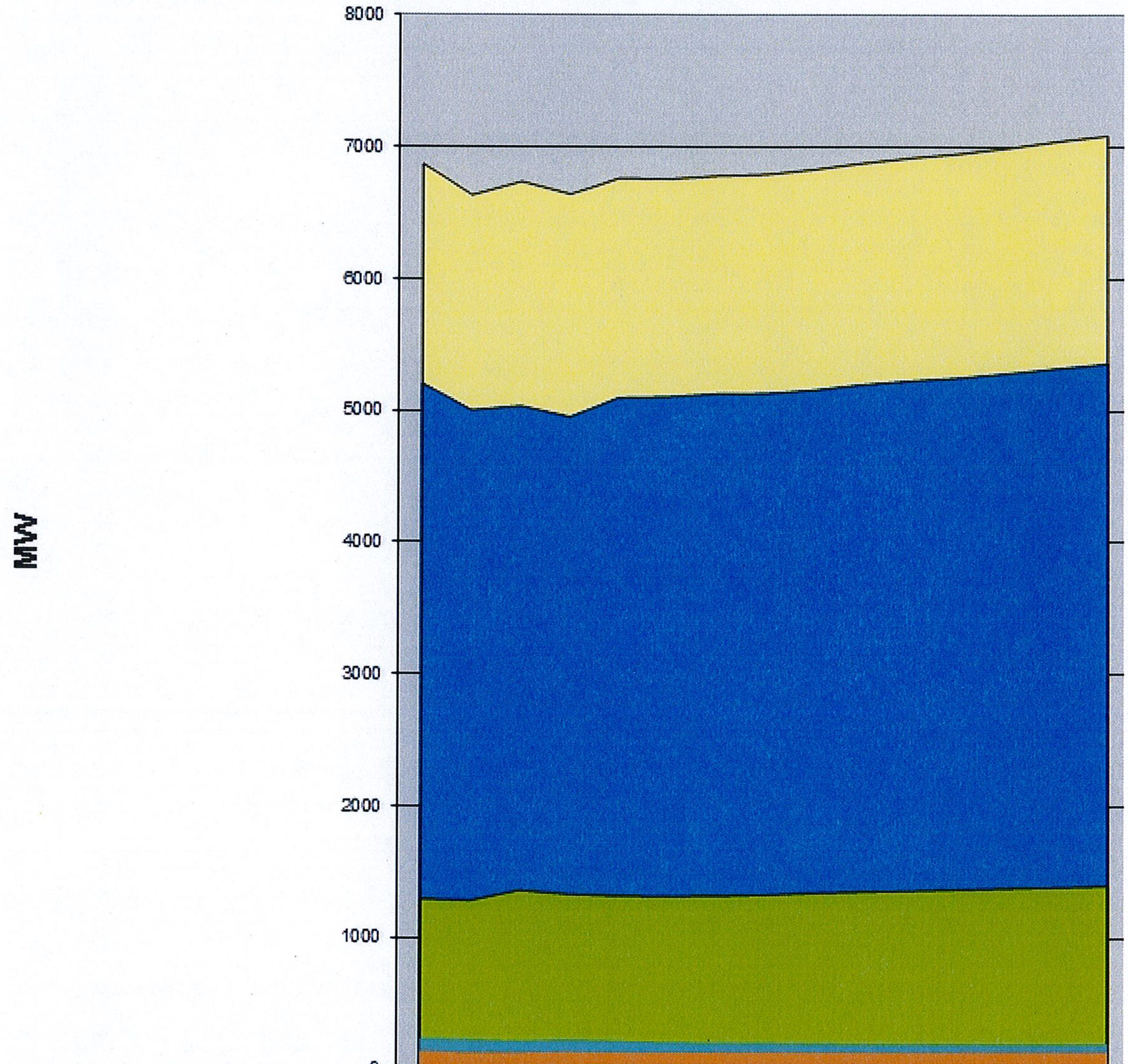
In order to account for weather effects as accurately as possible (for financial planning purposes, not infrastructure planning), the Connecticut transmission/distribution companies provide a forecast based on "normal weather", or assumed temperatures consistent with approximately the past 30 years of meteorological data. This is also referred to as the "50/50" forecast, which means that, in a given year, the probability of the projected peak load being exceeded is 50 percent, while the probability that the actual peak load would be less than predicted is also 50 percent. Another way of considering this 50/50 forecast would be to say that it would be exceeded, on average, once every two years[7].

Normal Weather (50/50) Peak Load Forecast

In its normal weather (50/50) forecast, Eversource predicted a peak load of 5,104 MW for its service area during 2018. This load is expected to grow during the forecast period at a compound annual growth rate (CAGR) of 0.54 percent, reaching 5,357 MW in 2027. UI predicted, in its normal weather (50/50) forecast, a peak load of 1,316 MW for its service area during 2018. This load is expected to grow during the forecast period at a CAGR of 0.65 percent, reaching 1,395 MW in 2027. CMEEC predicted, in its normal weather (50/50) forecast, a peak load of 210 MW for its service area during 2018. This load is expected to decline during the forecast period to 201 MW in 2027. This results in a CAGR of -0.49 percent. Finally, WED predicted a peak load of 129 MW for its service area during 2018.

This load is expected to grow at a CAGR of 0.67 percent, reaching 137 MW in 2027. All the state utilities' 50/50 summer peak loads are depicted in Figure 1a.

Figure 1a: Utility Adjusted Historical & 50/50 Peak Load Forecast in MW



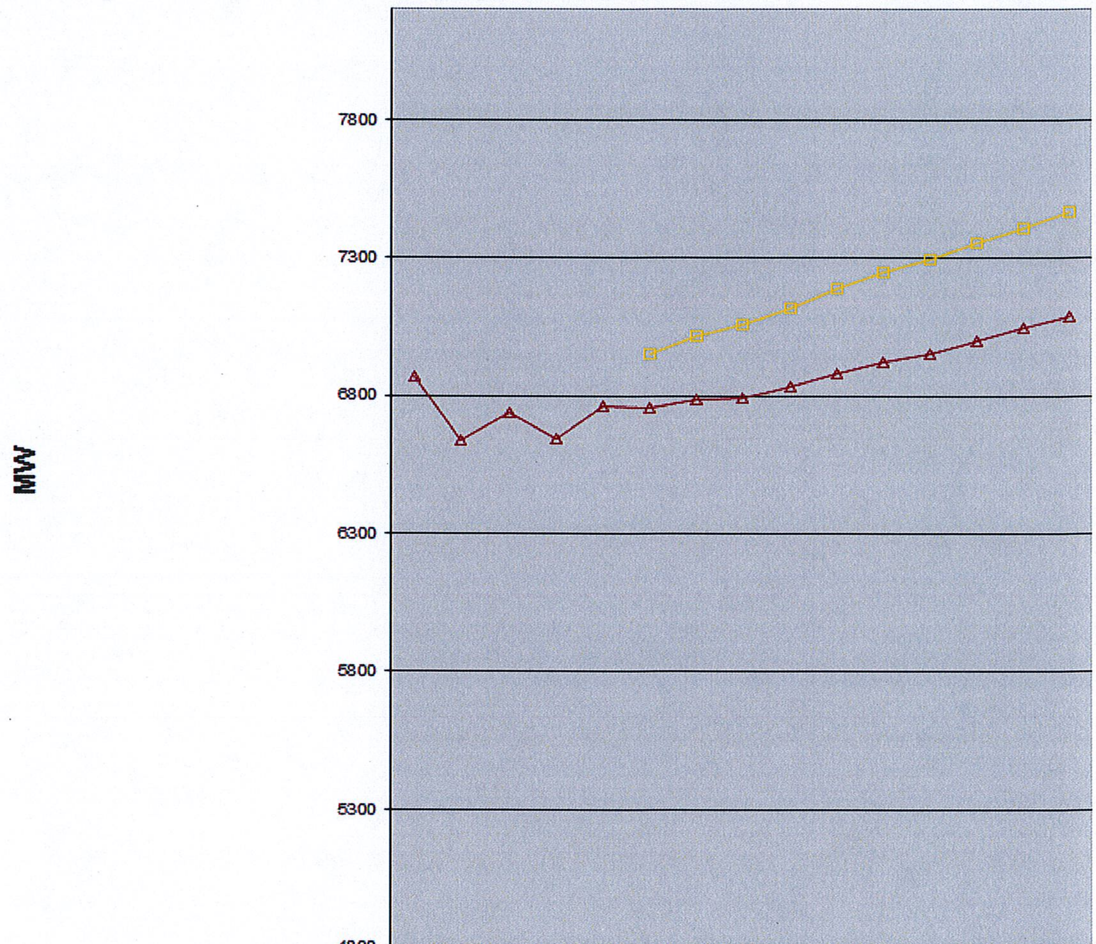
Years	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
CT Utilities Historical & 50/50 Forecast Peak w/C&LM & DG	6869	6636	6738	6644	6765	6759	6784	6795	6833	6881	6921	6954	6998	7046	7090
Eversource Historical & 50/50 Forecast Peak	5202	5002	5034	4953	5098	5104	5128	5132	5158	5198	5228	5251	5285	5323	5357
UI Historical & 50/50 Forecast Peak	1292	1280	1358	1329	1318	1316	1318	1327	1341	1350	1359	1368	1377	1386	1395
CMEEC Historical & 50/50 Forecast Peak	238	231	220	231	222	210	208	206	203	201	201	201	201	201	201
WED Historical & 50/50 Forecast Peak	137	123	126	131	127	129	130	130	131	132	133	134	135	136	137

Megawatts

The sum of the utilities' forecasts resulted in a projected statewide peak load of 6,759 MW during 2018. This load is expected to grow at a CAGR of 0.53 percent and reach 7,090 MW by year 2027. This is very close to Eversource's CAGR because Eversource has the largest service area in Connecticut, and its customers are the dominant source of load in the State.

However, the Council cautions that the sum of individual utilities' forecasts can only approximate the total Connecticut peak load. Because temperatures and customer usage patterns vary across the State, the individual utilities do not necessarily experience their peaks on the same hour and/or same day. Indeed, adding the four utilities' forecasts may slightly overstate the peak load in the State (i.e. be a conservative analysis), but the error is generally considered small.

Figure 1b: 50/50 Forecasts in MW



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
CT Utilities Historical & 50/50 Forecast Peak w/o C&LM & DG						6953	7020	7060	7120	7191	7251	7298	7353	7411	7465
CT Utilities Historical & 50/50 Forecast Peak w/C&LM & DG	6869	6636	6738	6644	6765	6759	6784	6795	6834	6881	6921	6954	6998	7046	7090

Megawatts

Hot Weather (90/10) Peak Forecast

The more significant forecast to be discussed in this review is the 90/10 forecast produced by ISO-NE. It is separate from the normal weather (50/50) forecasts offered by ISO-NE and the Connecticut utilities. However, it is the one used by both ISO-NE and by the

Connecticut utilities for utility infrastructure planning, including both transmission and generation.

A 90/10 forecast is a plausible worst-case hot weather scenario. It means there is only a 10 percent chance that the projected peak load would be exceeded in a given year, while the odds are 90 percent that it would not be exceeded in a given year. Put another way, the forecast would be exceeded, on average, only once every ten years. While this projection is quite conservative, it is reasonable for facility planning because of the potentially severe disruptive consequences of inadequate facilities: brownouts, blackouts, damage to equipment, and other failures.

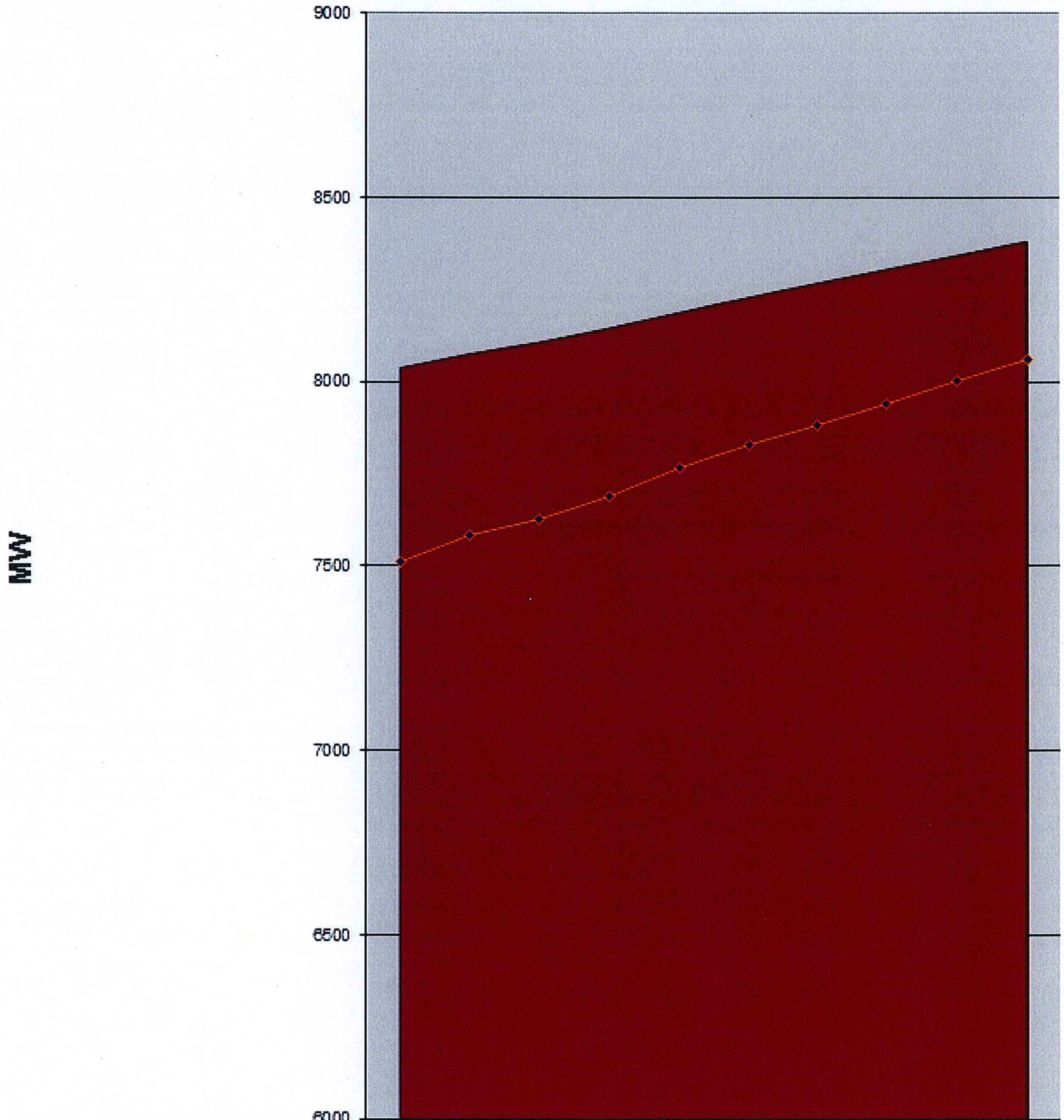
Utility planners must be conservative in estimating risk because they cannot afford the alternative. Just as bank planners should ensure the health of the financial system by maintaining sufficient collateral to meet worst-case liquidity risks, so load forecasters must ensure the reliability of the electric system by maintaining adequate facilities to meet peak loads in worst-case weather conditions or unanticipated equipment failures. While over-forecasting can have economic penalties due to excessive and/or unnecessary expenditures on infrastructure, the consequences of under-forecasting can be much more serious. Accordingly, the Council will base its analysis in this review on the ISO-NE 90/10 forecast.

Specifically, the ISO-NE 90/10 forecast has a projected (worst-case) gross peak load for Connecticut of 8,037 MW in 2018. This extreme weather load is expected to grow at a CAGR of 0.47 percent and reach 8,381 MW by 2027.

The Connecticut utilities also have extreme weather forecasts, which are approximately the same as 90/10 forecasts. For the extreme weather forecasts, it is also necessary to adjust for conservation and load management (C&LM) and distributed generation (DG) (including solar) to roughly compare the utility projections to ISO-NE's projections. Specifically, the sum of the utilities' extreme weather forecasts[8] adjusted by removing the effects of C&LM and DG is 7,512 MW for 2018. This would grow at a CAGR of 0.79 percent to reach 8,063 MW in 2027.

These adjusted utility extreme weather forecasts only differ from the ISO-NE 90/10 forecast by an annual average of 417 MW, or about 5.09 percent, which is reasonable agreement. Nevertheless, the Council will defer to the ISO-NE 90/10 forecast because of its use for infrastructure planning. See Figure 1c for the extreme weather forecasts.

Figure 1c: Extreme Weather and 90/10 Forecasts in MW



	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27
ISO-NE 90/10 CT Forecast Peak	8037	8076	8107	8146	8188	8229	8268	8305	8343	8381
CT Utilities Extreme w/o C&LM & DG	7512	7583	7626	7692	7768	7832	7884	7943	8005	8063

Megawatts

Past Accuracy of Peak Load Forecasts

In March 2007, the Council received ten-year forecast reports from the Connecticut electric utilities. These reports projected annual peak loads for 2007 through 2016. The Council has compared the 2007 forecast projections from Eversource, UI, and CMEEC to the weather-normalized historical peak loads provided by the utilities for 2007 through 2016 in order to determine the percent errors for each utility service area and the state for each of those years.

WED was not included in this analysis because it has not been a separate utility from CMEEC[9] for the full ten year-period; thus, it would not be an appropriate comparison. See Table 1 for this comparison.

Note that, since the comparison involves ten years' worth of data with a different percent error per year, the percent errors were averaged over ten years to determine the average accuracy of these forecasts. The average percent error was based on the magnitudes or absolute values of the errors. Otherwise, when a sum is taken to compute the average, a positive error one year (or forecast that was too high) would cancel out a negative error another year (or forecast that was too low) and distort the results by making the average error much lower (i.e. closer to zero). For example, if a ten-year forecast is 5 percent too high for the first half of the forecast period and 5 percent too low for the second half of the forecast period, then these errors would cancel out when an average is taken, and the average error over 10 years would be zero. That would be misleading. However, if the magnitudes of the errors were used, the average error would be plus or minus 5 percent. Accordingly, in this report, the Council has taken the average of the error magnitudes.

Also, to prevent distorted results in the comparison, it is very important to use weather-normalized past (historical) data, not actual historical data. (This only works for 50/50 forecasts because the 50/50 forecast is based on "normal" weather.) The reason this is done is to remove the effects of weather. Otherwise, an accurate forecast could appear to be more "wrong" simply because of an unusual (and unforeseen) weather pattern in a given year. On the other hand, a less accurate forecast could appear to be more "right" by fortunate coincidence if a warmer or cooler than normal weather pattern happened to compensate for a forecast that was too high or low, respectively.

Table 1

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Avg. % Error
CT Utilities Weather Normalized Historical Loads	6982	6988	6666	6687	6954	6762	6886	6547	6643	6525	
CT Utilities 2007 Forecast Loads*	7036	6745	6791	7246	7511	7441	7275	6498	6681	6857	
Eversource Weather Normalized Historical Loads	5209	5184	4935	4994	5279	5039	5202	5002	5034	4953	
Eversource 2007 50/50 Forecast	5258	4923	4934	5362	5610	5532	5358	4727	4903	5070	
UI Weather Normalized Historical Loads	1381	1403	1351	1315	1284	1336	1292	1280	1358	1329	
UI 2007 50/50 Forecast	1384	1421	1443	1463	1475	1480	1485	1490	1495	1501	
CMEEC Weather Normalized Historical Loads	392	401	380	378	391	387	392	265	251	243	
CMEEC 2007 50/50 Forecast	394	401	414	421	426	429	432	281	283	286	
% Error for State 50/50 Forecast	0.77	-3.48	1.88	8.36	8.01	10.04	5.65	-0.75	0.57	5.09	4.46
% Error for Eversource 50/50 Forecast	0.94	-5.03	-0.02	7.37	6.27	9.78	3.00	-5.50	-2.60	2.36	4.29
% Error for UI 50/50 Forecast	0.22	1.28	6.81	11.25	14.88	10.78	14.94	16.41	10.09	12.94	9.96
% Error for CMEEC 50/50 Forecast	0.5	0.0	8.9	11.4	9.0	10.9	10.2	6.0	12.7	17.7	8.73

As noted in Table 1, Eversource's average percent error for the ten-year (2007 through 2016) forecast period is 4.29 percent. UI's average percent error is 9.96 percent. CMEEC's is 8.73 percent. This results in a weighted average state-wide forecast error of 4.46 percent. (As already noted, the state-wide average is weighted more towards Eversource because they serve the largest load.) Overall, a statewide average forecast accuracy (for the 2007 forecast reports) for 50/50 forecasts to approximately plus or minus 4.5 percent is quite reasonable.

The utilities continue to refine their forecasts, so future forecast accuracy is expected to improve in the long term.

ELECTRIC SUPPLY

Electric supply is conservatively calculated using the generator's CGS 16-50r(a) forecast filings and the ISO-NE Seasonal Claimed Capability Report (SCC Report). The SCC Report includes all generation as seen and/or dispatched by ISO-NE. While other smaller DG at the distribution level can serve to reduce loads, those under 1 MW would not be required to file with the Council, and such loads could be included in the distribution utilities' net load predictions or conservatively excluded.

While peak loads occur during the summer, the electric system is further challenged by the fact that generation capability is at its lowest during the summer[10]. This is largely due to lower thermodynamic efficiencies of many plants when the outside temperatures are higher. Accordingly, generators report two different power outputs to ISO-NE. They are referred to as Summer and Winter Seasonal Claimed Capabilities, respectively. (See Appendix A.) For instance, Connecticut's October 2018 ISO-NE generation output is 9,175 MW in the summer and 9,806 MW during the winter.

Electric Transmission

Electric transmission is used to efficiently move bulk power long distances. To provide balanced power, alternating current (AC) transmission uses three phases that work together as one to serve loads. The potential difference between any two of the phases is called the "line to line voltage" or simply "line voltage." All else being equal, a transmission line with a higher line voltage is a higher capacity line. Higher voltages also reduce losses because, generally, less current would be required to serve a given load, and losses are a function of the current. Under CGS §16-50i, the Council has jurisdiction over an electrical transmission line facility with a design capacity (or line voltage) of at least 69,000 Volts or 69 kilovolts (kV). The Council also has jurisdiction over substation and switching station facilities of 69-kV and up.

Electric transmission is needed for electric reliability in order to serve substation facilities, which in turn, serve local distribution loads (and end users). Electric transmission can also allow electricity that may be produced by lower cost generators to reach more distant load centers. Finally, to the extent the electric transmission crosses the border into another state (i.e. via an interstate tie line), transmission can promote import or export capacity. Import capacity is a resource to Connecticut (like generation) and is discussed in the next section.

The Council has no interstate transmission projects pending its review at this time. More recently, transmission-related projects that have been reviewed and approved by the Council were related to line upgrades (e.g. conductor and structure upgrades) to meet various current National Electrical Safety Code, North American Electric Reliability Corporation, Northeast Power Coordinating Council, and/or ISO-NE standards. Appendix B contains a list of Planned/Proposed Transmission Projects submitted by the utilities in accordance with CGS

§16-50r(a). In such appendix, "Concept" means that the utility has a conceptual but not necessarily final design for such project. "Proposed" means that the utility is seeking Council review and approval of such project. "Planned' means the project has already received approval, and construction is either underway or will be commencing in the near future.

Connecticut's utilities also continue to upgrade, replace and install substation facilities to continue to reliably serve local distribution loads and to ensure the reliability of the transmission system as transmission lines connect to and/or pass through substations as well. Such projects are identified in Appendix C.

Import Capacity

The ability to import electricity plays a significant role in Connecticut's electric supply. It is essential for maximizing reliability and for allowing economic interchange of electricity. In 2018, the 2014 Connecticut Integrated Resource Plan estimated a Connecticut import capacity of 2,950 MW for 2018 based on the projected status of transmission upgrades and completion of the Interstate Reliability Project. While other upgrades may further raise this number, the Council has conservatively utilized a flat 2,950 MW for the remainder of the forecast period (i.e. through 2027) in Table 2.

Demand/Supply Balance

Table 2 contains a tabulation of generation capacity versus peak loads. The ISO-NE 90/10 forecast is applied in this table. Note that peak load here is combined with a reserve requirement. This is an emergency requirement in case a large generating unit trips off-line; thus, reserves must be available to compensate rapidly for that loss of capacity. The largest reserve requirement is 1,220 MW, which is approximately the current summer output of the State's largest generating unit, Millstone 3.

"Installed capacity derate" takes into account a possible number of power plants off-line for maintenance purposes. Existing generation listed in Table 2 is based on the 9,175 MW of total existing generation in Connecticut listed in Appendix A[11]. Appendix A data is from ISO-NE's October 2018 Seasonal Claimed Capability report. Appendix A includes the new CPV Towantic combined cycle natural-gas fueled power plant with a summer rating of roughly 758 MW. The CPV Towantic plant commenced commercial operation on June 1, 2018[12].

Bridgeport Harbor #3 (BHU#3), Connecticut's only remaining active coal-fired generating facility, (with a summer capacity of 383 MW) is slated to retire by July 1, 2021 as part of a Community Environmental Benefit Agreement associated with the approved 485 MW natural gas-fired combined-cycle Bridgeport Harbor #5 (BHU#5) project. BHU#5 is currently under construction and is expected to commence commercial operation by June 1, 2019[13]. As such, the retirement of BHU#3 and the new addition of BHU#5 are listed below in Table 2 as (non-small-DG) changes to Connecticut's generation fleet. The Council notes that this will result in a roughly 100 MW net gain for generation capacity in Connecticut.

In general, the retirement of older generating units is difficult to predict because it is the result of many factors such as market conditions, environmental regulations and the generating companies' business plans. According to ISO-NE's 2017 Regional Electricity Outlook, approximately 6,000 MW of existing generation in New England is "at risk for retirement in coming years" and referred to those resources in a table as "hypothetical" retirements in the 2025 through 2030 timeframe. Three of these facilities are located in Connecticut: Middletown Nos. 2-4 (~747 MW); Montville Nos. 5-6 (~486 MW); and New Haven Harbor (~347 MW). All three are listed below in Table 2 (to be conservative) and are based on the most up to date October 2018 summer seasonal claimed capability ratings.

Even taking into account the most conservative prediction, the ISO-NE 90/10 forecast, and a slated retirement of BHU#3, at-risk power plant retirements, the worst-case generating output (the summer output), and the inclusion of BHU#5 and neglecting the load reducing effects of small DG, the Council anticipates that electric resource supply for Connecticut will be adequate to meet demand during the forecast period. (See Table 2.)

Table 2: Connecticut Resources vs. Peak Load - Balance Table

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
90/10 Load	8037	8076	8107	8146	8188	8229	8268	8305	8343	8381
Reserve (Equiv. Millstone 3)	1220	1220	1220	1220	1220	1220	1220	1220	1220	1220
Load + Reserve	9257	9296	9327	9366	9408	9449	9488	9525	9563	9601
Existing Generation	9175	9175	9175	9175	9175	9175	9175	9175	9175	9175
Installed Capacity Derate	716	727	733	737	737	741	744	744	744	744
Available Generation	8459	8448	8442	8438	8438	8434	8431	8431	8431	8431
Normal Import	2950	2950	2950	2950	2950	2950	2950	2950	2950	2950
Energy Efficiency	52	62	72	82	91	100	111	121	131	141
Total Avail. Resources	11461	11460	11464	11470	11479	11484	11492	11502	11512	11522
Surplus/Deficiency	**2204**	**2164**	**2137**	**2104**	**2071**	**2035**	**2004**	**1977**	**1949**	**1921**
Pending Retirements										
Bridgeport Harbor #3				**-383**	**-383**	**-383**	**-383**	**-383**	**-383**	**-383**
At Risk Retirements per 2017 ISO-NE Regional Electricity Outlook										
Middletown Nos. 2-4								**-747**	**-747**	**-747**
Montville Nos. 5-6								**-486**	**-486**	**-486**
New Haven Harbor								**-347**	**-347**	**-347**
New Generation Under Construction (excluding small DG)										
Bridgeport Harbor #5		**485**	**485**	**485**	**485**	**485**	**485**	**485**	**485**	**485**
Surplus/Deficiency	**2204**	**2649**	**2622**	**2206**	**2173**	**2137**	**2106**	**499**	**471**	**443**

RESOURCE PLANNING

State of Connecticut Resource Planning

Connecticut Siting Council

The Connecticut Siting Council (Council), formerly known as the Power Facility Evaluation Council, was established in 1971 to approve or deny site applications for power facilities by balancing the need for adequate and reliable public utility services at the lowest reasonable cost to consumers while protecting the environment and ecology of Connecticut. Generally, most power plants over 1 MW, all fuel cells, substations and switching stations (at or above 69 kV), and transmission projects (at or above 69 kV) are under the jurisdiction of the Council.

Beginning in 2002, the Council's review of the Connecticut utility forecasts of electric loads and resources has changed from a twenty-year horizon to a ten-year horizon. The Council also reviews the life cycle costs of electric transmission lines and issues a report every five years. The Council has recently completed its 2017 review of life-cycle costs of electric transmission lines[14]. The Council also publishes its Best Management Practices for Electric and Magnetic Fields (for electric transmission lines) and updates such report on an annual basis, as necessary[15].

By virtue of its siting authority, the Council accumulates data and maintains records on the physical characteristics, construction costs, adequacy and reliability of power facilities in Connecticut. This material forms the basis for the annual forecast report and the life-cycle report. By extension, it also forms a basis for energy resource planning done by various other state agencies, and for policy decisions. The Council may make recommendations to those other agencies, depending on patterns observed in its data, records, and reports; however, the Council itself is not an energy resource planning agency, nor is it authorized to set policy.

Department of Energy and Environmental Protection (DEEP)

PA 11-80 accomplished a change in energy resource planning and policy-making when it merged the Departments of Environmental Protection and Public Utility Control. The sweeping changes made by PA 11-80 were necessary because, prior to restructuring, energy resource planning had principally been done by the regulated utilities companies themselves, overseen by the Department of Public Utility Control; after restructuring, the control process became fragmented: no single state agency was responsible for planning and policy, while a proliferation of agency departments and public-private committees or boards carried out various pieces of these tasks. PA 11-80 managed to consolidate the various planning and policy functions within state government along much clearer lines of authority.

Integrated Resource Plan (IRP)

CGS 16a-3a requires that DEEP prepare an Integrated Resources Plan (IRP) every two years. Such IRP provides an in-depth assessment of the state's future electric needs and a plan to meet those future needs. Such report considers both the demand side resources (e.g. energy efficiency) as well as traditional supply side resources such as generation and transmission and makes recommendations on how best to meet future electric needs in the state.

On March 17, 2015, DEEP issued the *2014 Integrated Resource Plan for Connecticut* (2014 IRP)[16]. In the "Forecast of Resource Adequacy to Meet Average and Summer Peak Demand" section, the 2014 IRP noted that, "Resources within Connecticut area expected to be sufficient to meet Connecticut's Local Sourcing Requirement as defined by the Transmission Security Analysis criteria through 2024. Within the Connecticut sub-area specifically, no new capacity will be needed beyond existing resources, planned transmission, and energy efficiency will exceed the local requirement beyond the ten-year IRP horizon. Local electric supply should be adequate barring the unexpected loss of approximately 2,000 MW of supply. However, Connecticut reliability and generation prices would be as affected as other states if the entire region as a whole had insufficient supply."

On June 12, 2018, DEEP held a scoping meeting for an upcoming 2018 IRP. Comments on the scope of the IRP were due by July 12, 2018[16].

Comprehensive Energy Strategy (CES)

Section 51 of PA 11-80 requires that DEEP prepare a CES every three years beginning in 2012. DEEP issued the latest version of the CES on February 8, 2018[17].

The CES is intended to be the state's main policy document and master plan. Its purpose is to guide the state's regulatory and legislative decisions concerning energy resources (not just electrical energy) and to provide the foundation for better energy choices at every level. It covers all fuels in all sections. It offers analysis of the state's current energy circumstances and recommendations designed to move Connecticut towards a cheaper, cleaner, and more reliable energy future. Of these energy topics, the most directly applicable to the Council's work are energy efficiency and electric supply.

Regional Resource Planning

ISO New England Inc. (ISO-NE) Regional System Plan

ISO-NE is a not-for-profit corporation responsible for the reliable and economical operation of New England's electric power system. It also administers the region's wholesale electricity markets and manages the comprehensive planning of the regional power system. The planning process includes the preparation of an annual Regional System Plan (RSP) for the New England region, which includes the following:

- Forecasts of annual energy use and peak loads (i.e. the demand for electricity) for a 10-year planning horizon and the need for resources (i.e., capacity);

- Information about the amounts, locations, and characteristics of market responses (e.g., generation or demand resources or elective transmission upgrades) that can meet the defined system needs – system-wide and in specific areas; and

- Descriptions of transmission projects for the region that could meet the identified needs, as summarized in an RSP Project List, which includes information on project status and cost estimates and is updated several times each year.

On November 2, 2017, ISO-NE issued its *2017 Regional System Plan* (2017 RSP)[18]. The executive summary's concluding paragraph offers this perspective: "The ISO continues to work with stakeholders to address the state of the system, regional challenges, and plans for addressing future issues, as the system becomes less predictable; supply resources, less controllable; and system operations, more complex. For all RSP17 analyses, the ISO used a number of assumptions, discussed with the PAC, which are subject to uncertainty as the system evolves over the planning period and the markets are enhanced to account for public policies. Changes in these assumptions could affect the results and conclusions of RSP17 analyses and ultimately influence the development of transmission and generation and demand resources. While each RSP is a snapshot in time, the planning process is continuous and flexible, and the ISO updates the results of planning activities as needed, accounting for the status of ongoing projects, studies, and new initiatives." (PAC -Planning Advisory Committee)

CONCLUSION

This Council has considered Connecticut's electric energy future and finds that even taking into account the most conservative prediction, the ISO-NE 90/10 forecast, and a slated retirement of BHU#3, at-risk power plant retirements, the worst-case generating output (the summer output), and the inclusion of BHU#5 and neglecting the load reducing effects of small DG, the resources (i.e. generation plus import) for Connecticut during 2018-2027 will be adequate to meet demand. Connecticut currently has and is projected to have a sizeable surplus of resources for the forecast period.

Finally, the Council reviewed the accuracy of past forecasting. Specifically, the 2007 Connecticut utilities' 50/50 load forecasts were compared to the weather-normalized historical data. The utilities' forecasts were, on (weighted) average, accurate to plus or minus 4.46 percent, which is reasonable.

<u>End Notes</u>

1. WED was formerly part of CMEEC. WED separated from CMEEC in 2014.

2. However, for the purposes of load forecasting, Bozrah and MTUA may be treated as part of CMEEC's "service area."

3. A very small amount of CMEEC load (and thus Connecticut load) is the result of providing service to Fisher's Island, New York via a connection to a substation in Groton, Connecticut. The peak load is on the order of 2.5 MW and thus considered negligible relative to the Connecticut load.

4. A one MW load, for example, would be the equivalent of simultaneously operating 100,000 compact fluorescent light bulbs of 10 watts each. Put another way, 1 MW could serve between 300 and 1,000 homes, with 500 being a typical number.

5. According to the U.S. Department of Energy, roughly 80 percent of Connecticut homes are heated using fossil fuels such as natural gas, fuel oil, or other petroleum products. See https://www.eia.gov/state/?sid=CT.

6. There are some natural gas-powered air conditioning systems, but they are much less common than electric air conditioning.

7. With a 50 percent probability of being exceeded in a <u>given</u> year, it would be a near certainty (or about 99.9 percent chance) that such forecast peak load would be exceeded <u>at least once</u> in ten years.

8. An extreme weather forecast is not available for WED. The extreme weather data is estimated from the 50/50 forecast data provided by multiplying by the same ratio (per year) as the sum of the other utilities' 90/10 to 50/50 peak loads. The effects of any errors on the statewide extreme weather forecast total would be very small.

9. CMEEC's 2014 forecast data was properly adjusted to account for the separation of Wallingford from CMEEC. This explains why CMEEC's forecast loads suddenly drop from about 432 MW in 2013 to about 281 MW in 2014.

10. Some combustion turbine power plants can partially compensate for this effect by using evaporative coolers or other cooling system to chill the incoming air during summer months. But all else being equal, power outputs are still generally higher during the winter months for traditional generation.

11. In this report, to be conservative, the summer (not winter) power outputs of existing generation will be considered. To also find the winter power outputs, see Appendix A.

12. https://www.ct.gov/csc/lib/csc/pendingproceeds/docket_192b/dmplan/192b-20180516-operationcommencementd&ocond4c.pdf

13. https://www.ct.gov/csc/lib/csc/pending_petitions/2_petitions_1201through1300/pe1218/finaldecision/pe1218-decisionpackage.pdf

14. https://www.ct.gov/csc/lib/csc/publications/2017-life-cycle_finalrpt.pdf

15. https://www.ct.gov/csc/lib/csc/emf_bmp/revisions_updates/754bmpfinal.pdf

16. https://www.ct.gov/deep/cwp/view.asp?a=4405&q=486946&deepNav_GID=2121

17. https://www.ct.gov/deep/lib/deep/energy/ces/2018_comprehensive_energy_strategy.pdf

18. https://www.iso-ne.com/system-planning/system-plans-studies/rsp/

Glossary

50/50 forecast: A projection of peak electric load assuming normal weather conditions. The 50/50 projected peak load has a 50 percent chance of being exceeded in a given year.

90/10 forecast: A projection of peak electric load assuming extreme (hot) weather conditions. The 90/10 forecast has a 10 percent chance of being exceeded in a given year. This forecast is used for transmission facility planning.

AC (Alternating Current): An electric current that reverses (alternates) its direction of flow periodically. In the United States, this occurs 60 times per second (60 cycles or 60 Hz).

Ampere (amp): A unit measure for the flow (current) of electricity. As load increases, so does the amperage at any given voltage.

Baseload generator: A generator that operates nearly 24/7 regardless of the system load: for example, a nuclear unit.

Blackout: A total disruption of the power system, usually involving a substantial or total loss of load and generation over a large geographical area.

Black start capability: The capability of a power plant to start generating electricity by itself without any outside source of power, for instance, during a general blackout.

British thermal unit (BTU): The amount of energy required to heat or cool one pound of water by one degree Fahrenheit.

C&LM (Conservation and load management): Any measures to reduce electric usage and provide savings. See Conservation. See Demand response.

Cable: A fully insulated conductor, usually installed underground.

CAGR (Compound annual growth rate): The percentage by which a quantity (such as load or energy) increases per year over the forecast period, on average, while taking into account compounding effects. It is analogous to a computed compound interest rate on a bank account based on a beginning balance and final balance several years later (assuming no deposits other than interest and no withdrawals). Since it is nine years from the first year of the forecast period to the last, CAGR = (100%*((Final Value/Initial Value)^(1/9)) – 1).

CELT (Capacity, Energy, Load and Transmission Report): An annual ISO-NE report including data and projections for New England's electric system over the next ten years.

CHP (Combined heat and power): Term used interchangeably with cogeneration. See Cogen.

Circuit: A system of conductors (three conductors or three bundles of conductors) through which electrical energy flows between substations. Circuits can be supported above ground by transmission structures or placed underground.

Circuit breaker: A device designed to open and close a circuit manually and also to open the circuit automatically on a predetermined overload of current.

Class I renewable energy source: " electricity derived from solar power, wind power, a fuel cell, geothermal, landfill methane gas, anaerobic digestion or other biogas derived from biological sources, thermal electric direct energy conversion from a certified Class I renewable energy source, ocean thermal power, wave or tidal power, low emission advanced renewable energy conversion technologies, a run-of-the-river hydropower facility that began operation after July 1, 2003, and has a generating capacity of not more than thirty megawatts, provided a facility that applies for certification under this clause after January 1, 2013, shall not be based on a new dam or a dam identified by the commissioner as a candidate for removal, and shall meet applicable state and federal requirements, including applicable site-specific standards for water quality and fish passage, or a biomass facility that uses sustainable biomass fuel and has an average emission rate of equal to or less than .075 pounds of nitrogen oxides per million BTU of heat input for the previous calendar quarter, except that energy derived from a biomass facility with a capacity of less than five hundred kilowatts that began construction before July 1, 2003, may be considered a Class I renewable energy source, or any electrical generation, including distributed generation, generated from a Class I renewable energy source, provided, on and after January 1, 2014, any megawatt hours of electricity from a renewable energy source described under this subparagraph that are claimed or counted by a load-serving entity, province or state toward compliance with renewable portfolio standards or renewable energy policy goals in another province or state, other than the state of Connecticut, shall not be eligible for compliance with the renewable portfolio standards established pursuant to section 16-245a" (Conn. Gen. Stat. § 16-1(a)(20))

Class II renewable energy source: "Energy derived from a trash-to-energy facility, a biomass facility that began operation before July 1, 1998, provided the average emission rate for such facility is equal to or less than 0.2 pounds of nitrogen oxides per million BTU of heat input for the previous calendar quarter, or a run-of-the-river hydropower facility provided such facility has a generating capacity of not more than five megawatts, does not cause an appreciable change in the riverflow, and began operation prior to July 1, 2003." (Conn. Gen. Stat. § 16-1(a)(21))

Class III source: "The electricity output from combined heat and power systems with an operating efficiency level of no less than fifty per cent that are part of customer-side distributed resources developed at commercial and industrial facilities in this state on or after January 1, 2006, a waste heat recovery system installed on or after April 1, 2007, that produces electrical or thermal energy by capturing preexisting waste heat or pressure from industrial or commercial processes, or the electricity savings created in this state from conservation and load management programs begun on or after January 1, 2006, provided on and after January 1, 2014, no such programs supported by ratepayers, including programs overseen by the Energy Conservation Management Board or third-party programs pursuant to section 16-245m, shall be considered a Class III source, except that any demand-side management project awarded a contract pursuant to section 16-243m shall remain eligible as a Class III source for the term of such contract" (Conn. Gen. Stat. § 16-1(a)(38))

Combined-cycle: A power plant that uses its waste heat from a gas turbine to generate even more electricity for a higher overall efficiency (on the order of 60 percent).

Conductor: A metallic wire, bus bar, rod, tube or cable, usually made of copper or aluminum, that serves as a path for electric flow.

Cogen (Cogeneration plant): A power plant that produces electricity and uses its waste heat for a useful purpose. For example, cogeneration plants heat buildings, provide domestic hot water, or provide heat or steam for industrial processes.

Conservation: The act of using less electricity. Conservation can be achieved by cutting out certain activities that use electricity, or by adopting energy efficiencies.

Customer-side distributed resource: "The generation of electricity from a unit with a rating of not more than sixty-five megawatts on the premises of a retail end user within the transmission and distribution system including, but not limited to, fuel cells, photovoltaic systems or small wind turbines, or a reduction in demand for electricity on the premises of a retail end user in the distribution system through methods of conservation and load management, including, but not limited to, peak reduction systems and demand response systems." (Conn. Gen. Stat. § 16-1(a)(34))

DC (Direct Current): An electric current that flows continuously in one direction as contrasted to an alternating current (AC).

Dual-fuel: The ability of a generator to operate on two different fuels, typically oil and natural gas. Economics, the availability of fuels and environmental (e.g. air emission) restrictions are factors that generating companies consider when deciding which fuel to burn.

Demand: The total amount of electricity required at any given instant by an electric customers. "Demand" can be used interchangeably with the term "load". See Load.

Demand response: The ability to reduce load during peak hours, by turning down/off air conditioning units, industrial equipment, etc. Demand response resources on a scale large enough to affect transmission are typically aggregated through a third party, using automated controls.

Distribution: The part of the electric delivery system that operates at less than 69,000 volts. Generally, the distribution system connects a substation to an end user.

Distributed generation: Generating units (usually on the customer's premises) that connect to the electric distribution system, not to the transmission system. These units are generally smaller than their counterparts.

Energy (electric): The total work done by electricity. Energy is the product of the average load and time. The unit is kilowatt hours (kWh).

Energy efficiency (in the case of an electric generator or of any dynamic process): The actual amount of energy required to accomplish a task, as opposed to a theoretical 100 percent efficiency.

Eversource (The Connecticut Light and Power Company d/b/a Eversource Energy): Eversource is the largest transmission/distribution company in Connecticut.

Feeder: Conductors forming a circuit that are part of the distribution system. See Distribution. See Circuit.

Fuel cell: Fuel cells are devices that produce electricity and heat by combining fuel and oxygen in an electrochemical reaction. A battery is a form of fuel cell. Fuel cells can operate on a variety of fuels, including natural gas, propane, landfill gas, and hydrogen. Unlike traditional generating technologies, fuel cells do not use a combustion process that converts fuel into heat and mechanical energy. Rather, a fuel cell converts chemical energy into heat and electrical energy. This process results in quiet operation, low emissions, and high efficiencies. Nearly all commercially-installed fuel cells operate in a cogeneration mode. See Cogen. In addition, fuel cells provide very reliable electricity and are therefore potentially attractive to customers operating sensitive electronic equipment.

Generator: A device that produces electricity. See Baseload generator, Intermediate generator, and Peaking generator.

Grid: A system of interconnected power lines and generators that is managed so that the generators are dispatched as needed to meet the overall requirements of the customers connected to the grid at various points. "Grid" has the same meaning as "bulk power system."

Grid-side distributed resource: "The generation of electricity from a unit with a rating of not more than sixty-five megawatts that is connected to the transmission or distribution system, which units may include, but are not limited to, units used primarily to generate electricity to meet peak demand." (Conn. Gen. Stat. § 16-1(a)(37))

ISO-NE: (ISO New England): An entity charged by the federal government to oversee the bulk power system and the electric energy market in the New England region.

Intermediate generator: A generator that operates approximately 50 to 60 percent of the time, depending on the system load.

kV (kilovolt): One thousand volts (i.e. 345 kV = 345,000 volts). See Volt.

Line: A series of overhead transmission structures that support one or more circuits; or, in the case of underground construction, a single electric circuit.

Load: Amount of power delivered, as required, at any point or points in the system. Load is created by the aggregate load (demand) of customers' equipment (residential, commercial, and industrial).

Load management: Steps taken to reduce demand for electricity at peak load times or to shift some of the demand to off-peak times. The reduction may be made with reference to peak hours, peak days or peak seasons. Electric peaks are mainly caused by high air-conditioning use, so air-conditioners are the prime targets for load management efforts. Utilities or businesses that provide load management services pay customers to reduce load through a variety of manual or remotely-controlled methods.

Loss or losses: Electric energy that is lost as heat and cannot be used to serve end users. There are losses in both the transmission and the distribution system. Higher voltages help reduce losses.

Megawatt (MW): One million Watts. A measure of the rate at which useful work is done by electricity.

Microgrid: A localized grouping of electricity generation, energy storage, and loads that normally operates connected to a traditional centralized grid or macrogrid. This single point of common coupling with the macrogrid can be disconnected. The microgrid can then function autonomously.

Normal weather: Temperatures and humidity consistent with past meteorological data.

Peak load: The highest electric load experienced during a given time period. See Load.

Peaking unit: A generator that can start under short notice (e.g. 10 to 30 minutes). Peaking units typically operate less than 10 percent of the hours in a year.

Phasor measurement unit (PMU): A device that measures electrical waves on the electric grid via synchronized real-time measurements of multiple remote points on the grid. This monitoring improves reliability. PMUs are also called synchrophasors.

REC (Renewable Energy Credit): A certificate representing proof that one megawatt-hour of electricity has been generated from an eligible renewable energy resource. In Connecticut, a REC is an electronic certificate created by the New England Power Pool Generation Information System. RECs can be sold or traded.

Smart meter: An electrical meter that records consumption of electric energy in intervals of an hour or less and communicates that information at least daily back to the utility for monitoring and billing purposes.

Substation: Electric facilities that use equipment to switch, control and change voltages for the transmission and distribution of electrical energy.

Switching station: A type of substation where no change in voltage occurs.

Terminal structure: A structure typically within a substation that physically ends a section of transmission line.

Transformer: A device used to change voltage levels to facilitate the efficient transfer of electrical energy from the generating plant to the ultimate customer.

Transmission line: Any electric line operating at 69,000 or more volts.

Transmission tie-line or tie: A transmission line that connects two separate transmission systems. In the context of this report, a tie is a transmission line that crosses state boundaries and connects the transmission systems of two states.

UI (The United Illuminating Company): A transmission/distribution company that serves customers in the New Haven – Bridgeport area and its vicinity.

Voltage or volts: A measure of electric force.

WED (Wallingford Electric Division): A municipal electric distribution company that serves the Town of Wallingford and a portion of North Branford.

Wire: See Conductor.

Appendix A **Existing Generation**

Facility	Generation Type	Primary Fuel	Secondary Fuel	Summer SCC	Winter SCC
CDECCA	Combined Cycle	Natural Gas		51.454	0.000
BRIDGEPORT HARBOR 3	Steam Turbine	Coal		383.426	382.527
BRIDGEPORT HARBOR 4	Gas Turbine	Oil		16.380	21.816
WHEELABRATOR BRIDGEPORT, L.P.	Steam Turbine	Refuse		58.488	58.488
BRANFORD 10	Gas Turbine	Oil		15.840	20.950
BRISTOL REFUSE	Steam Turbine	Refuse		11.937	11.949
BULLS BRIDGE	Hydroelectric	Water		3.908	5.664
COS COB 10	Gas Turbine	Oil		18.932	23.000
COS COB 11	Gas Turbine	Oil		18.724	23.000
COS COB 12	Gas Turbine	Oil		19.082	23.000
DERBY DAM	Hydroelectric	Water		2.533	5.666
DEVON 10	Gas Turbine	Oil		14.407	18.839
DEVON 11	Gas Turbine	Oil	Natural Gas	29.299	38.819
DEVON 12	Gas Turbine	Oil	Natural Gas	29.227	38.437
DEVON 13	Gas Turbine	Oil	Natural Gas	29.967	38.967
DEVON 14	Gas Turbine	Oil	Natural Gas	29.704	40.274
FALLS VILLAGE	Hydroelectric	Water		1.480	5.758
FRANKLIN DRIVE 10	Gas Turbine	Oil		15.417	20.527
LISBON RESOURCE RECOVERY	Steam Turbine	Refuse		12.485	13.133
MIDDLETOWN 10	Gas Turbine	Oil		15.515	20.015
MIDDLETOWN 2	Steam Turbine	Oil	Natural Gas	117.000	120.000
MIDDLETOWN 3	Steam Turbine	Oil	Natural Gas	229.910	233.031
MIDDLETOWN 4	Steam Turbine	Oil		399.923	402.000
MILLSTONE POINT 2	Steam Turbine	Nuclear		852.963	859.038
MILLSTONE POINT 3	Steam Turbine	Nuclear		1220.132	1233.633
MONTVILLE 10 AND 11	Internal Combustion	Oil		5.296	5.354
MONTVILLE 5	Steam Turbine	Oil	Natural Gas	81.000	81.590
MONTVILLE 6	Steam Turbine	Oil		405.050	400.401
NEW HAVEN HARBOR	Steam Turbine	Oil	Natural Gas	346.787	439.585
NORWICH JET	Gas Turbine	Oil		15.255	18.593
SECREC-PRESTON	Steam Turbine	Refuse		15.693	16.027

SHEPAUG	Hydroelectric	Water		41.511	42.559
SO. MEADOW 11	Gas Turbine	Oil		35.781	46.921
SO. MEADOW 12	Gas Turbine	Oil		37.649	47.815
SO. MEADOW 13	Gas Turbine	Oil		36.938	47.917
SO. MEADOW 14	Gas Turbine	Oil		36.746	46.346
SO. MEADOW 5	Steam Turbine	Refuse		13.392	14.571
SO. MEADOW 6	Steam Turbine	Refuse		15.714	19.611
STEVENSON	Hydroelectric	Water		28.311	28.711
TORRINGTON TERMINAL 10	Gas Turbine	Oil		15.638	20.748
TUNNEL 10	Gas Turbine	Oil		16.369	18.114
ROCKY RIVER	Pumped Storage Hydro	Water		28.651	28.383
GOODWIN DAM	Hydroelectric	Water		3.000	3.000
WYRE WYND HYDRO	Hydroelectric	Water		0.080	1.876
COLEBROOK	Hydroelectric	Water		0.770	0.481
KINNEYTOWN B	Hydroelectric	Water		0.128	0.466
WILLIMANTIC 1	Hydroelectric	Water		0.000	0.163
WILLIMANTIC 2	Hydroelectric	Water		0.000	0.181
TOUTANT	Hydroelectric	Water		0.000	0.395
PUTNAM	Hydroelectric	Water		0.141	0.501
MECHANICSVILLE	Hydroelectric	Water		0.050	0.162
CEC 004 DAYVILLE POND U5	Hydroelectric	Water		0.000	0.042
SANDY HOOK HYDRO	Hydroelectric	Water		0.000	0.040
PINCHBECK	Steam Turbine	Wood/Wood Waste		0.000	0.000
QUINEBAUG	Hydroelectric	Water		0.345	0.988
BANTAM	Hydroelectric	Water		0.000	0.066
TUNNEL	Hydroelectric	Water		0.000	1.786
ROBERTSVILLE	Hydroelectric	Water		0.000	0.000
SCOTLAND	Hydroelectric	Water		0.000	0.000
TAFTVILLE CT	Hydroelectric	Water		0.393	0.919
NEW MILFORD	Internal Combustion	Methane	Oil	0.673	0.788
BRIDGEPORT ENERGY 1	Combined Cycle	Natural Gas		468.179	576.997
CRRA HARTFORD LANDFILL	Internal Combustion	Methane		0.000	0.729
LAKE ROAD 1	Combined Cycle	Natural Gas		256.337	291.961
LAKE ROAD 2	Combined Cycle	Natural Gas		261.735	276.774

LAKE ROAD 3	Combined Cycle	Natural Gas		266.410	278.048
WALLINGFORD UNIT 1	Gas Turbine	Natural Gas		44.040	50.000
WALLINGFORD UNIT 2	Gas Turbine	Natural Gas		42.220	50.000
WALLINGFORD UNIT 3	Gas Turbine	Natural Gas		43.570	48.027
WALLINGFORD UNIT 4	Gas Turbine	Natural Gas		43.920	50.000
WALLINGFORD UNIT 5	Gas Turbine	Natural Gas		44.643	50.000
MILFORD POWER 1	Combined Cycle	Natural Gas		270.874	295.647
MILFORD POWER 2	Combined Cycle	Natural Gas		266.670	289.707
WATERSIDE POWER	Gas Turbine	Oil		69.154	71.557
DEVON 15	Gas Turbine	Oil	Natural Gas	46.889	49.200
MIDDLETOWN 12	Gas Turbine	Oil	Natural Gas	46.900	49.200
WATERBURY GENERATION FACILITY	Gas Turbine	Natural Gas	Oil	89.536	98.749
PIERCE STATION	Gas Turbine	Natural Gas	Oil	74.085	94.500
EAST WINDSOR NORCAP LFG PLANT	Internal Combustion	Methane		0.000	0.000
COS COB 13	Gas Turbine	Oil		19.053	22.852
COS COB 14	Gas Turbine	Oil		19.209	22.602
KLEEN ENERGY	Combined Cycle	Natural Gas	Oil	620.000	620.000
NORDEN 1	Internal Combustion	Oil		1.789	1.948
NORDEN 2	Internal Combustion	Oil		1.947	1.947
NORDEN 3	Internal Combustion	Oil		1.924	1.941
NORWICH WWTP	Internal Combustion	Oil		2.000	2.000
KIMB ROCKY RIVER PH2	Combined Cycle	Natural Gas		12.866	15.260
NEW HAVEN HARBOR UNIT 2	Gas Turbine	Oil	Natural Gas	42.946	48.324
PLAINFIELD RENEWABLE ENERGY	Steam Turbine	Wood/Wood Waste		37.500	38.062
UDR GLASTONBURY	Fuel Cell	Natural Gas		2.473	2.774
DOMINION BRIDGEPORT FUEL CELL	Fuel Cell	Natural Gas		11.657	10.943
DEVON 16	Gas Turbine	Oil	Natural Gas	46.900	49.200
DEVON 17	Gas Turbine	Oil	Natural Gas	46.900	49.200
DEVON 18	Gas Turbine	Oil	Natural Gas	46.900	49.200
RAINBOW UNIT 1	Hydroelectric	Water		4.100	4.100
RAINBOW UNIT 2	Hydroelectric	Water		4.100	4.100
MIDDLETOWN 13	Gas Turbine	Oil	Natural Gas	46.900	49.200
MIDDLETOWN 14	Gas Turbine	Oil	Natural Gas	46.900	49.200
MIDDLETOWN 15	Gas Turbine	Oil	Natural Gas	46.900	49.200

UI RCP BGPT FC	Fuel Cell	Natural Gas		2.532	2.608
UI RCP NH FC	Fuel Cell	Natural Gas		2.350	2.634
UI RCP WOODBRIDGE FC	Fuel Cell	Natural Gas		2.200	2.200
NEW HAVEN HARBOR UNIT 3	Gas Turbine	Oil	Natural Gas	42.946	48.324
NEW HAVEN HARBOR UNIT 4	Gas Turbine	Oil	Natural Gas	42.946	48.324
DEXTER 1	Combined Cycle	Natural Gas	Oil	39.836	39.965
DEXTER 2	Combined Cycle	Natural Gas		4.666	5.035
ENERGY STREAM HYDRO	Hydroelectric	Water		0.059	0.080
UI RCP BGPT PV	Photovoltaic	Sun		1.136	0.000
CPV TOWANTIC 1A	Combined Cycle	Natural Gas	Oil	378.912	424.617
CPV TOWANTIC 1B	Combined Cycle	Natural Gas	Oil	378.912	424.617
WALLINGFORD UNIT 6	Gas Turbine	Natural Gas		43.666	48.666
WALLINGFORD UNIT 7	Gas Turbine	Natural Gas		44.475	49.506
FUSION SOLAR CENTER	Photovoltaic	Sun		12.959	3.085

Total MW **9175.215** **9806.441**

Appendix B
Planned/Proposed Transmission Lines in Connecticut

Planned/Proposed Transmission Projects in Connecticut	Voltage (kV)	Estimated In-Service Date	Length (miles)	Utility	Status
Southington S/S, Southington - Todd Canal S/S, Wolcott (GHCC) (replace line reactors)	115	2018	N/A	Eversource	Under Construction
South Meadow S/S, Hartford - Bloomfield S/S, Bloomfield (rebuild line section)	115	2018	N/A	Eversource	Under Construction
Devon S/S, Milford - Trumbull Junction, Trumbull (reconductor line section)	115	2018	4.4	Eversource	Under Construction
Devon S/S, Milford - Avagrid border, Trumbull (reconductor line section)	115	2018	4.5	Eversource	Under Construction
Plumtree S/S, Bethel - Brookfield Junction, Brookfield (SWCT) (new transmission)	115	2018	3.4	Eversource	Under Construction
Beacon Falls S/S, Beacon Falls - Indian Well S/S (Avangrid), Derby - Devon S/S, Milford (SWCT) (loop in and out of Pootatuck S/S)	115	2018	N/A	Eversource	Under Construction
Plumtree S/S, Bethel - Stony Hill S/S, Brookfield - Bates Rock S/S, Southbury (SWCT) (line reconfiguration)	115	2018	N/A	Eversource	Under Construction
Plumtree S/S, Bethel - West Brookfield S/S, Brookfield - Shepaug S/S, Southbury (SWCT) (line reconfiguration)	115	2018	N/A	Eversource	Under Construction
Frost Bridge S/S, Watertown - Campville S/S, Harwinton (GHCC) (line separation)	115	2018	N/A	Eversource	Under Construction
Thomaston S/S, Thomaston - Campville S/S, Harwinton (GHCC) (line separation)	115	2018	N/A	Eversource	Under Construction
Newington S/S, Newington - Newington Tap, Newington (GHCC) (reconductor line section)	115	2018	0.01	Eversource	Planned
Newington S/S, Newington - SW Hartford S/S, Hartford (GHCC) (new line and series reactor)	115	2018	4.0	Eversource	Planned
West Brookfield S/S, Brookfield - West Brookfield Junction, Brookfield (SWCT) (reconductor line section)	115	2018	1.4	Eversource	Planned
South Meadow S/S, Hartford - SW Hartford S/S, Hartford (GHCC) (install a series reactor)	115	2018	N/A	Eversource	Planned
Stepstone S/S, Guilford - Green Hill S/S, Madison (line structure replacements)	115	2018	N/A	Eversource	Proposed
Millstone S/S, Waterford - Manchester S/S, Manchester (line structure replacements)	345	2018	N/A	Eversource	Proposed
Long Mountain S/S, New Milford - Plumtree S/S, Bethel (line structure replacements)	345	2018	N/A	Eversource	Proposed
Card S/S, Lebanon - Lake Road S/S, Killingly (line structure replacements)	345	2018	N/A	Eversource	Proposed
Millstone S/S, Waterford - Haddam S/S, Haddam (line structure replacements)	345	2018	N/A	Eversource	Proposed
Montville S/S, Montville - Haddam Neck S/S, Haddam (line structure replacements)	345	2018	N/A	Eversource	Proposed
Millstone S/S, Waterford - Montville S/S, Montville (line structure replacements)	345	2018	N/A	Eversource	Proposed
Millstone S/S, Waterford - Card S/S, Lebanon (line structure replacements)	345	2018	N/A	Eversource	Proposed
Scovil Rock S/S, Middletown - East Shore S/S (Avangrid), New Haven	345	2018	N/A	Eversource	Proposed
Long Mountain S/S, New Milford - Eversource border (CT/NY Line), Kent (line structure replacements)	345	2018	N/A	Eversource	Proposed
Southington S/S, Southington - Scovill Rock S/S, Middletown (line structure replacements)	345	2018	N/A	Eversource	Proposed
Manchester S/S, Manchester - North Bloomfield S/S, Bloomfield (line structure replacements)	345	2018	N/A	Eversource	Proposed
Rocky River S/S, New Milford - Bulls Bridge S/S, New Milford (rebuild line)	115	2019	6.6	Eversource	Planned
Wilton S/S, Wilton - Ridgefield Junction, Ridgefield (SWCT) (reconductor line section)	115	2019	5.1	Eversource	Planned
Peaceable S/S, Redding - Ridgefield Junction, Ridgefield (SWCT) (reconductor line section)	115	2019	0.04	Eversource	Planned
Cos Cob S/S, Greenwich - Greenwich S/S, Greenwich (new transmission)	115	2019	2.4	Eversource	Planned
Cos Cob S/S, Greenwich - Greenwich S/S, Greenwich (new transmission)	115	2019	2.4	Eversource	Planned
Southington S/S, Southington - Berlin S/S, Berlin - Black Rock S/S, New Britain (reconductor line section)	115	2019	5.2	Eversource	Planned
Bean Hill S/S (CMEEC), Norwich - Tunnel S/S, Preston (line struction replacements)	115	2019	N/A	Eversource	Proposed
Bokum S/S, Old Saybrook - Green Hill S/S, Madison (line structure replacements)	115	2019	N/A	Eversource	Proposed
Branford S/S, Branford - North Haven S/S (Avangrid), North Haven (line structure replacements)	115	2019	N/A	Eversource	Proposed

Appendix B
Planned/Proposed Transmission Lines in Connecticut

Card S/S, Lebanon - Tunnel S/S, Preston - Montville S/S, Montville (line structure replacements)	115	2019	N/A	Eversource	Proposed
Card S/S, Lebanon - Stockhouse S/S (CMEEC), Bozrah (line structure replacement)	115	2019	N/A	Eversource	Proposed
Fort Hill Farms S/S (CMEEC), Montville - Stockhouse S/S (CMEEC), Bozrah (line structure replacements)	115	2019	N/A	Eversource	Proposed
Montville S/S, Montville - Bean Hill S/S (CMEEC), Norwich (line structure replacements)	115	2019	N/A	Eversource	Proposed
Bridgeport-Stratford 115-kV Railroad Lines Upgrade Project	115	2019	2.3	UI	Planned
Baird-Housatonic River 115-kV Railroad Lines Upgrade Project	115	2020	1.9	UI	Planned
Killingly S/S, Killingly - Brooklyn S/S, Danielson - Fry Brook S/S, Plainfield - Tunnel S/S, Preston (laminated structure replacements)	115	2020	N/A	Eversource	Proposed
Killingly S/S, Killingy - Exeter S/S, Plainfield - Fry Brook S/S, Plainfield - Tunnel S/S, Preston (laminated structure replacements)	115	2020	N/A	Eversource	Proposed
Bean Hill S/S (CMEEC), Norwich - Tunnel S/S, Preston (laminated struction replacements)	115	2020	N/A	Eversource	Proposed
Card S/S, Lebanon - Tunnel S/S, Preston - Montville S/S, Montville (laminated structure replacements)	115	2020	N/A	Eversource	Proposed
Campville S/S, Harwinton - Thomaston S/S, Thomaston (laminated structure replacements)	115	2020	N/A	Eversource	Proposed

Appendix C
Planned/Proposed Substations

Appendix C: Planned Substation and Switching Station Projects	Voltage (kV)	Est. In-Service Date	Utility	Status	Project
Frost Bridge S/S, Watertown	115	2018	Eversource	Under Construction	Oil circuit breaker replacement project
Southington S/S, Southington	115	2018	Eversource	Under Construction	GHCC - Replace breaker with a series reactor and add a new control hous
Green Hill S/S, Madison	115	2018	Eversource	Under Construction	GHCC - Reconfigure the substation and install a capacitor bank
Westside S/S, Middletown	115	2018	Eversource	Under Construction	GHCC - Install a capacitor bank
Stony Hill S/S, Brookfield	115	2018	Eversource	Under Construction	SWCT - Add a synchronous condenser and relocate a capacitor bank
Campville S/S, Harwinton	115	2018	Eversource	Under Construction	GHCC - Add a circuit breaker
Southwest Hartford S/S, Hartford	115	2018	Eversource	Planned	GHCC - Upgrade terminal equipment
Newington S/S, Newington	115	2018	Eversource	Planned	GHCC - Reconfigure Substation
Devon S/S, Milford	115	2018	Eversource	Proposed	Modify control house
Card S/S, Lebanon	345/115	2018	Eversource	Proposed	Replace autotransformer
Bloomfield S/S, Bloomfield	115/23	2018	Eversource	Proposed	Replace transformer
Pootatuck S/S, Shelton	115	2018	UI	Planned	Substation Modifications
Ansonia S/S, Ansonia	115	2018	UI	Planned	Capacitor bank addition
Baird S/S Rebuild Project	115	2018	UI	Planned	Construct replacement substation
Scitico S/S, Enfield	115	2019	Eversource	Under Construction	Add two circuit breakers for generator
Cos Cob S/S, Greenwich	115	2019	Eversource	Planned	Add two circuit breakers
Greenwich S/S, Greenwich	115/13.2	2019	Eversource	Planned	Add a new substation
Beacon Falls S/S, Beacon Falls	115	2019	Eversource	Planned	Reconfigure substation to a ring bus
Scitico S/S, Enfield	115/23	2019	Eversource	Proposed	Add a distribution transformer and a circuit breaker
Stepstone S/S, Guilford	115/23	2019	Eversource	Proposed	Add a distribution transformer
Manchester S/S, Manchester	115	2019	Eversource	Planned	Control house expansion
North East Simsbury S/S, Simsbury	115/23	2019	Eversource	Concept	Add a distribution transformer
Sandy Hook S/S, Newtown	115/23	2019	Eversource	Concept	Add a distribution transformer
Newington S/S, Newington	115/23	2019	Eversource	Concept	Replace transformer
Newtown S/S, Newtown	115/13.8	2019	Eversource	Concept	Replace both distribution transformers
Rood Avenue S/S, Windsor	115/23	2019	Eversource	Concept	Add a distribution transformer
June Street S/S, Woodbridge	115	2019	UI	Concept	Battery bank addition
Substation Security Upgrade Program	115	2019	UI	Planned	
East Shore S/S, New Haven	345/115	2019	UI	Planned	Replacing 345-kV circuit switchers and raise certain equipment flood eleva
Plumtree S/S, Bethel	115	2020	Eversource	Proposed	Oil circuit breaker replacement project
Mansfield S/S, Mansfield	115/23	2020	Eversource	Concept	Add a distribution transformer
West Brookfield S/S, Brookfield	115/13.8	2020	Eversource	Concept	Add a distribution transformer
Carmel Hill S/S, Woodbury	115/23	2020	Eversource	Concept	Add a distribution transformer
Westside S/S, Middletown	115/13.2	2020	Eversource	Concept	Replace transformer
Franklin Drive S/S, Torrington	115/13.2	2020	Eversource	Concept	Replace both distribution transformers
Old Town S/S Rebuild Project	115	2020	UI	Proposed	Rebuild substation
Pequonnock S/S Rebuild Project	115	2021	UI	Planned	Construct replacement substation
Mansfield S/S, Mansfield	115/23	2021	Eversource	Concept	Add a distribution transformer
Canton S/S, Canton	115/23	2021	Eversource	Concept	Replace distribution transformer
Congress S/S, Bridgeport	115	2021	UI	Concept	Flood wall project
Singer S/S, Bridgeport	345	2022	UI	Concept	Flood wall project
Grand Avenue S/S and Mill River S/S, New Haven	115	2022	UI	Concept	Flood wall project