DOCKET NO. F-2012/2013 – Connecticut Siting Council Review of the Ten-Year Forecast of Connecticut Electric Loads and Resources

Final Report

12/12/2013

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INTRODUCTION

Connecticut's electric system provides service to approximately 3.5 million residents and approximately 78 thousand businesses and impacts our lives in many ways. The system's infrastructure includes 109 generating units whose electrical energy is dispatched onto the regional supply network—over 1,800 circuit-miles of high-voltage conductors that form the transmission grid and more than 130 substations that direct electricity to individual users via the distribution system.

This network of electric connections must be highly reliable, given its importance not only for our State, but for our region. In current global circumstances, with volatile fuel prices, new energy technologies and climate change concerns, reliability is a special challenge. 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 electric transmission 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.

Since 1972, the Connecticut General Assembly has mandated the Connecticut Siting Council (Council) to provide an annual review of 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 needs and resources. As is to be expected, the utility companies themselves provide these forecasts/projections. Most of Connecticut's electric system data is used in common by all the State and regional planners and is supplied by Connecticut generators and by our State's two largest transmission and distribution companies, The Connecticut Light and Power Company (CL&P) and The United Illuminating Company (UI), as well as by the Connecticut Municipal Electric Energy Cooperative (CMEEC). These data have been developed for their own internal planning. Other planning groups model these data to emphasize fuel characteristics, cost issues, efficiency, and so forth. As more and more forecasting has been undertaken by different parties to make sure, in different ways, that the electric system will remain reliable, the more the Council has tried, in its annual forecast review, to emphasize openness, to clarify differences in approach, and to assess consistency.

Pursuant to PA 11-80, the Department of Energy and Environmental Protection (DEEP), in consultation with the Connecticut Energy Advisory Board (CEAB) and the electric distribution companies, 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, 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

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 and will be discussed later.) 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[1].

Loads increase with any increase in the number of electrical devices being used at the same time. Demand also depends on the type of electrical loads and 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 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."

Load forecasting by the three Connecticut utilities is broken down by each company's respective service area. UI serves 17 municipalities in the New Haven area near the coast from Fairfield to North Branford and north to Hamden. The Connecticut Municipal Electric Energy Cooperative (CMEEC) collectively serves all of the municipal utilities in Connecticut, namely, the cities of Groton and Norwich; the Borough of Jewett City; the Second (South Norwalk) and Third (East Norwalk) Taxing Districts of the City of Norwalk; the towns of Wallingford[2] and Groton; and the Mohegan Tribal Utility

Authority. The largest transmission/distribution company is CL&P. CL&P serves all of the remaining municipalities in Connecticut. Collectively, at any given time, the sum of CL&P, UI, and CMEEC loads is equal to the Connecticut load. The Council is mandated by statute to review these three forecasts for the Connecticut load.

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 CL&P, UI, and CMEEC forecasts, even though the statute does not specifically require the Council to do so.

By statute, the Connecticut utilities must provide ten-year forecasts of loads and resources to the Council by March 1 of each year. The ISO-NE forecasts also include projections for ten years based on their planning horizon. In a ten-year forecast, peak loads and electrical energy consumption are predicted for the calendar year that the forecast report is issued and for nine years into the future. Thus, a 2013 ten-year forecast does not predict peak loads and energy usage through 2023, but rather 2022. The 2013 utility and ISO-NE forecast reports will be subjects of the Council's report here, 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[3]. 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[4]. 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 winter.

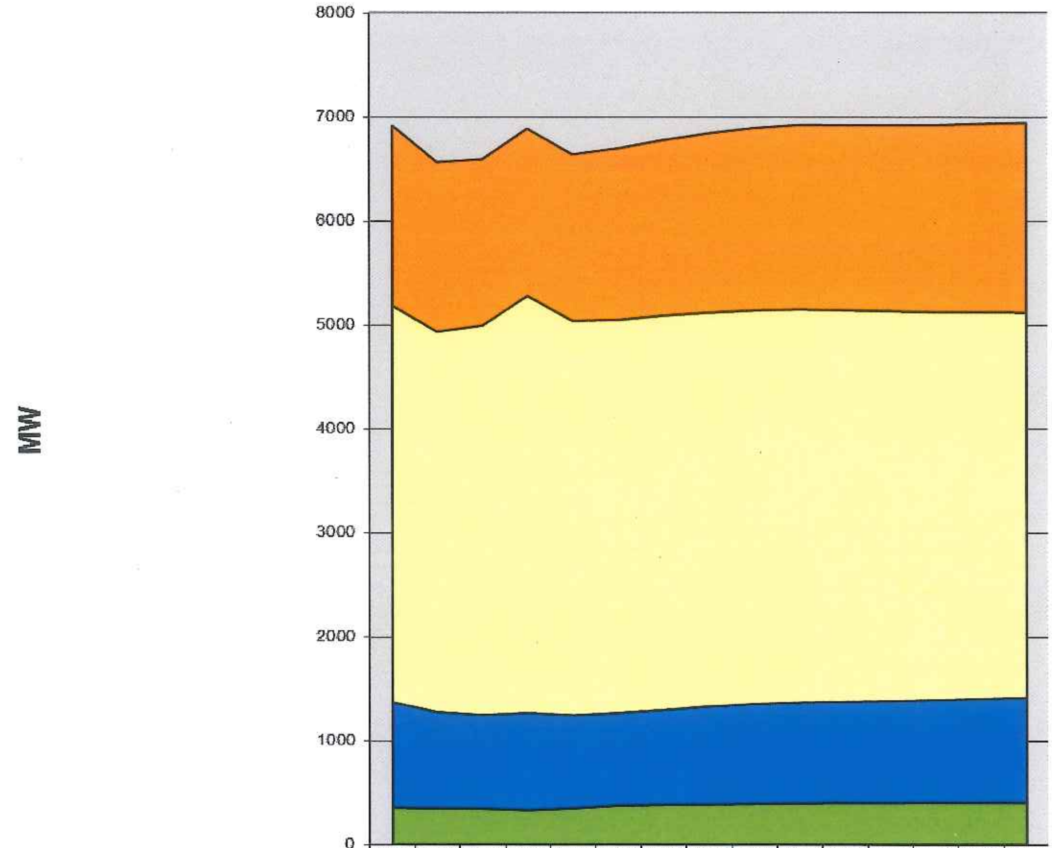
While a detailed discussion of peak loads would have to include additional factors such as customer usage, demographics, conservation efforts, economic conditions, and others, the most important factor is weather—specifically the temperature and humidity. Higher temperatures result in more frequent use 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.

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 has the probability of being exceeded, on average, once every two years.

Normal Weather (50/50) Peak Load Forecast

In its normal weather (50/50) forecast, CL&P predicted a peak load of 5,048 MW for its service area during 2013. This load is expected to grow during the forecast period at a compound annual growth rate (CAGR) of 0.16 percent, reaching 5,121 MW in 2022. UI predicted, in its normal weather (50/50) forecast, a peak load of 1,272 MW for its service area during 2013. This load is expected to grow during the forecast period at a CAGR of 1.20 percent, reaching 1,416 MW in 2022. CMEEC predicted, in its normal weather (50/50) forecast, a peak load of 379 MW for its service area during 2013. This load is expected to grow during the forecast period at a CAGR of 0.82 percent, reaching 408 MW in 2022[5]. All three of 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



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CT Utilities Historical & 50/50 Forecast Peak w/C&LM & DG	6918	6567	6596	6888	6641	6699	6778	6843	6894	6923	6922	6921	6921	6934	6945
CL&P Historical & 50/50 Forecast Peak	5184	4935	4994	5279	5039	5048	5091	5118	5140	5150	5141	5133	5122	5123	5121
UI Historical & 50/50 Forecast Peak	1375	1280	1252	1272	1249	1272	1301	1335	1359	1372	1379	1385	1394	1405	1416
CMEEC Historical & 50/50 Forecast Peak	359	352	350	337	353	379	386	390	395	401	402	403	405	406	408

Megawatts

The sum of the three utilities' forecasts resulted in a projected statewide peak load of 6,699 MW during 2013. This load is expected to grow at a CAGR of 0.40 percent and reach 6,945 MW by year 2022. The statewide CAGR is a weighted average of the three utilities' CAGRs. Since CL&P has the largest service area in Connecticut, and its customers are the dominant source of load in the State, it is not surprising that the statewide CAGR of 0.40 percent is closer to CL&P's CAGR of 0.16 percent than the CAGRs of UI or CMEEC. The statewide CAGR is higher than CL&P's due to the effect of higher projected growth rates in UI and CMEEC territories. (See Figure 1a.)

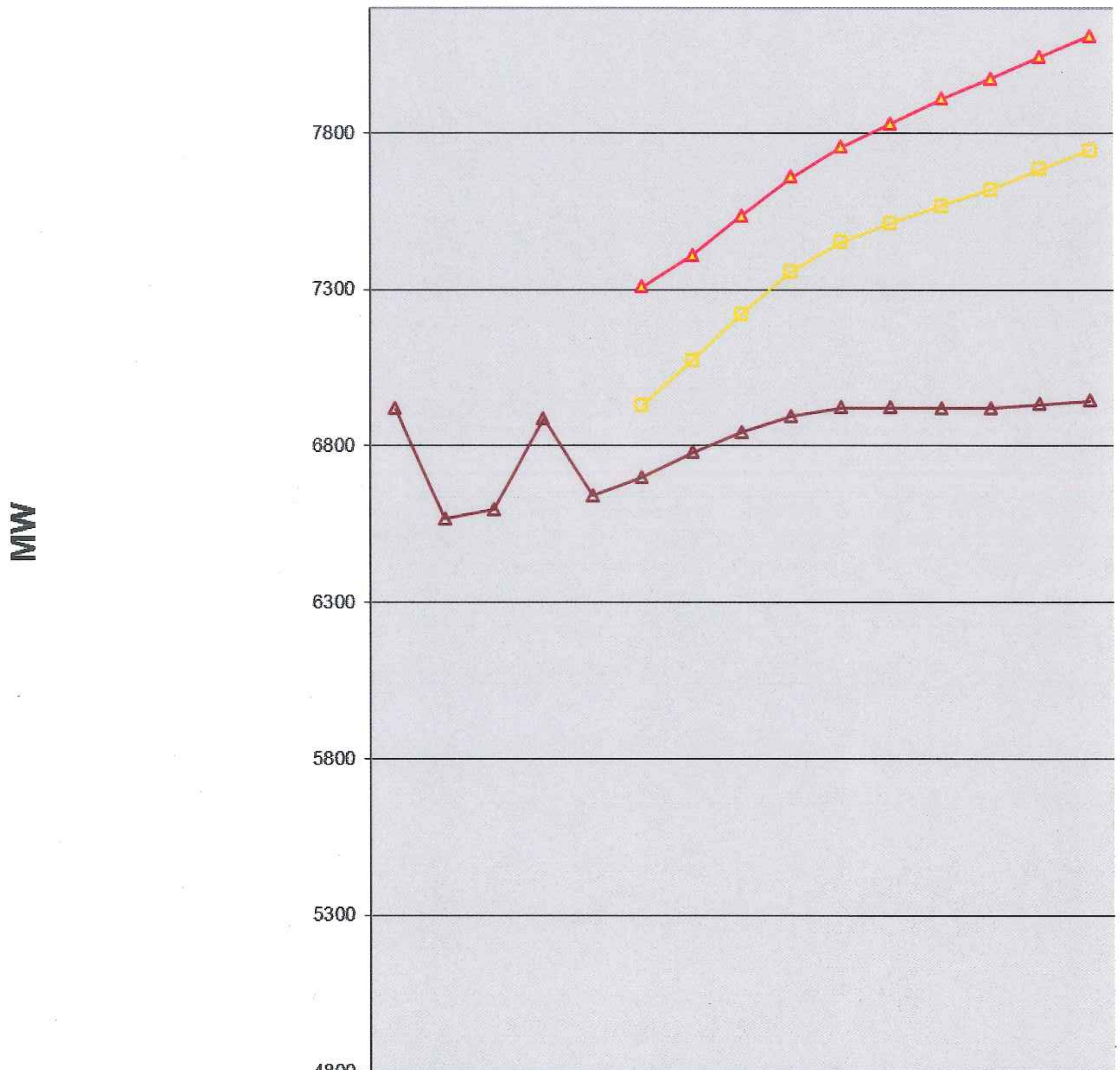
The Council cautions that the sum of three utilities' forecasts can only approximate the Connecticut peak load. Because temperatures and customer usage patterns vary across the State, the three utilities do not necessarily experience their peaks on the same hour and/or same day. Indeed, adding the three utilities' forecasts may slightly overstate the peak load in the State, but the error is generally considered quite small.

In its 50/50 forecast for Connecticut, ISO-NE predicted a peak load of 7,310 MW during 2013. This peak load is expected to grow at a CAGR of 1.16 percent and reach 8,110 MW by year 2022. Note that the ISO-NE 50/50 forecast exceeds the sum of the utilities' forecasts each year by an average of 876 MW. This is due to a difference in the way conservation and load management (C&LM) and distributed generation (DG) are treated, but has no material difference in facility planning. (These topics will be discussed in later sections.) Generally, ISO-NE considers C&LM and DG to be capacity resources (i.e. sources similar to generation) while the Connecticut utilities consider them to be reductions in load. Thus, the forecasts differ by approximately the sum of the C&LM and DG effects. Because of this difference, the ISO-NE forecast numbers appear higher and the utilities numbers appear lower. See ISO-NE and the State utilities' forecasts in Figure 1b.

There are two methods to roughly adjust for this difference and provide more of an "apples to apples" comparison. In the first method, the total amount of C&LM and DG is added back to the utilities forecast, which already has been reduced for them. This cancels out the C&LM and DG effects, removing them from the utilities forecast, and making it comparable to the forecast of ISO-NE. The second method, following a similar logic, subtracts the effects of C&LM and DG from the ISO-NE forecast, which includes them, and thus makes it roughly comparable to the forecasts of UI and CL&P. The Council will use the first method of adjustment in this report.

The adjusted Connecticut utilities forecast has a projected load for 2013 of 6,930 MW. This is expected to grow at a CAGR of 1.24 percent, reaching 7,746 MW by 2022. This adjusted utilities 50/50 forecast CAGR of 1.24 percent more closely matches ISO-NE's CAGR of 1.16 percent. Furthermore, the adjusted utilities 50/50 forecast and the ISO-NE forecast only vary by an annual average of 337 MW or 4.54 percent per year, which is good agreement. See Figure 1b for the comparison of the Connecticut utilities and ISO-NE 50/50 forecasts.

Figure 1b: 50/50 Forecasts in MW



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
ISO-NE 50/50 CT Forecast Peak						7310	7410	7535	7660	7755	7830	7910	7975	8045	8110
CT Utilities Historical & 50/50 Forecast Peak w/o C&LM & DG						6930	7076	7223	7359	7453	7513	7569	7621	7685	7746
CT Utilities Historical & 50/50 Forecast Peak w/C&LM & DG	6918	6567	6596	6888	6641	6699	6778	6843	6894	6923	6922	6921	6921	6934	6945

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.

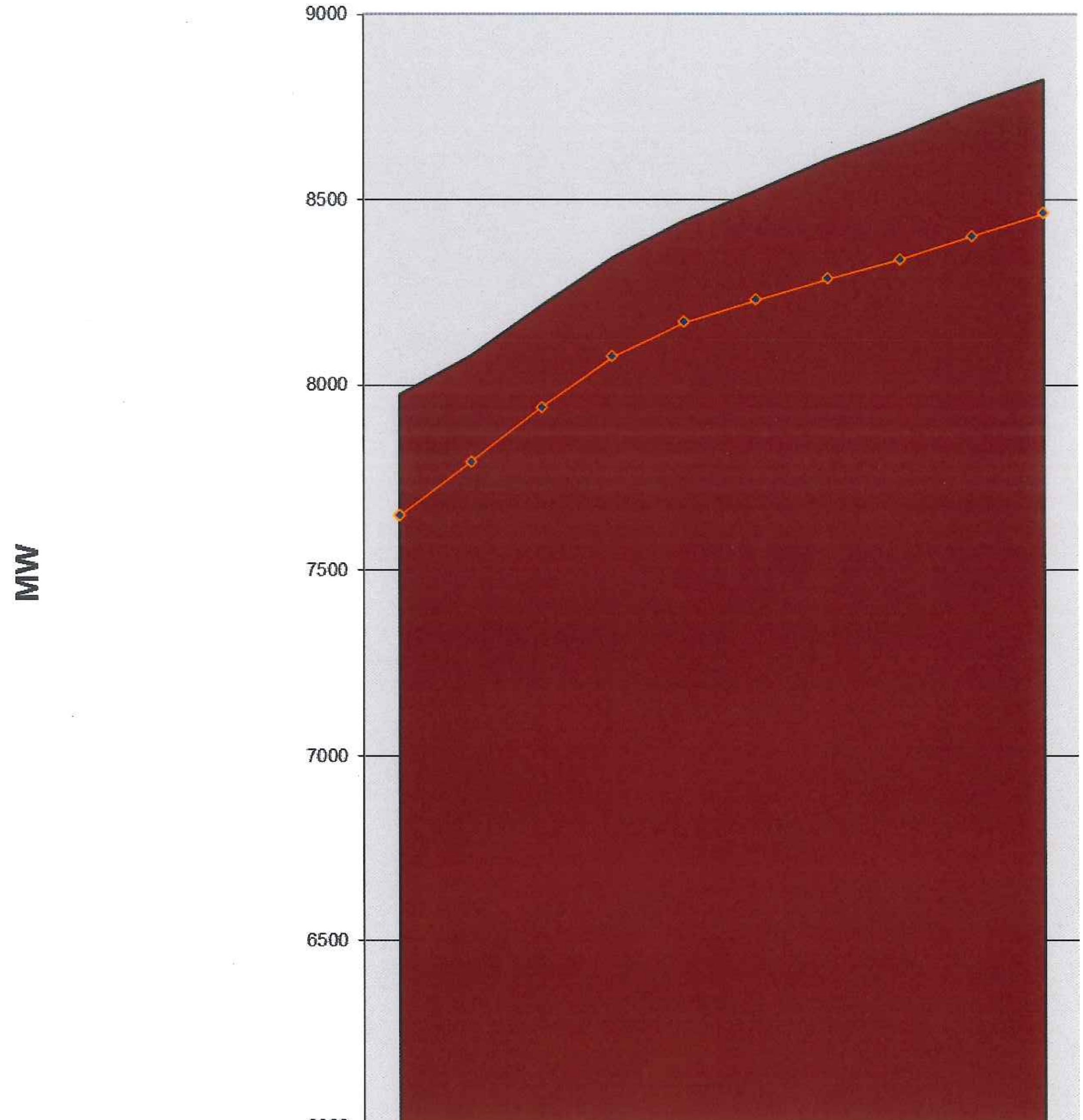
Utility planners must be conservative in estimating risk because they cannot afford the alternative. Just as bank planners should ensure the health of the financial system by maintaining sufficient collateral to meet worst-case liquidity risks, so load forecasters must ensure the reliability of the electric system by maintaining adequate facilities to meet peak loads in worst-case weather conditions. 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) peak load for Connecticut of 7,975 MW in 2013. This load is expected to grow at a CAGR of 1.13 percent and reach 8,825 MW by 2022.

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 C&LM and DG to properly compare the utility projections to ISO-NE's projections. Specifically, the sum of the utilities' extreme weather forecasts <u>adjusted</u> by removing the effects of C&LM and DG is 7,647 MW for 2013. This would grow at a CAGR of 1.13 percent to reach 8,464 MW in 2022.

These adjusted utility extreme weather forecasts only differ from the ISO-NE 90/10 forecast by an annual average of 311 MW, or about 3.83 percent, which is good agreement. The CAGRs are equal to three significant figures, which is very good agreement. See Figure 1c for the extreme weather forecasts.

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



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
ISO-NE 90/10 CT Forecast Peak	7975	8080	8215	8345	8445	8525	8610	8680	8760	8825
CT Utilities Extreme w/o C&LM & DG	7647	7793	7940	8077	8170	8229	8287	8338	8403	8464

Megawatts

Past Accuracy of Peak Load Forecasts

Ten years ago, the Council received the 2003 ten-year forecast reports from the utilities. These reports projected annual peak loads for 2003 through 2012. The Council has compared the 2003 forecast projections from CL&P, UI, and CMEEC to the weather-normalized historical peak loads provided by the utilities[6] for 2003 through 2012 in order to determine the percent errors for each utility service area and the State for each of those years. 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 <u>average accuracy</u> 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.) <u>The reason this is done is to remove the effects of weather.</u> 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	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Avg. % Error**
CT Utilities Weather Normalized Historical Loads	6731	6715	6987	6821	6961	6918	6567	6596	6888	6641	
CT Utilities 2003 Forecast Loads	6626	6648	6716	6758	6790	6824	6874	6968	7055	7144	
CL&P Weather Normalized Historical Loads	5093	5056	5277	5084	5209	5184	4935	4994	5279	5039	
CL&P 2003 50/50 Forecast	5049	5056	5112	5145	5169	5194	5235	5320	5399	5479	
UI Weather Normalized Historical Loads	1280	1297	1349	1374	1389	1375	1280	1252	1272	1249	
UI 2003 50/50 Forecast	1221	1229	1235	1241	1247	1253	1259	1265	1271	1277	
CMEEC Weather Normalized Historical Loads	358	362	361	363	363	359	352	350	337	353	
CMEEC 2003 50/50 Forecast	356	363	369	372	374	377	380	383	385	388	
% Error for State 50/50 Forecast	-1.56	-1.00	-3.88	-0.92	-2.46	-1.36	4.67	5.64	2.42	7.57	3.15
% Error for CL&P 50/50 Forecast	-0.86	0.00	-3.13	1.20	-0.77	0.19	6.08	6.53	2.27	8.73	2.98
% Error for UI 50/50 Forecast	-4.61	-5.24	-8.45	-9.68	-10.22	-8.87	-1.64	1.04	-0.08	2.24	5.21
% Error for CMEEC 50/50 Forecast	-0.6	0.3	2.2	2.5	3.0	5.0	8.0	9.4	14.2	9.9	5.51

As noted in Table 1, CL&P's average percent error for the ten-year (2003 through 2012) forecast period is 2.98 percent. UI's average percent error is 5.21 percent. CMEEC's is 5.51 percent. This results in a weighted average state-wide forecast error of 3.15 percent. (As already noted, the state-wide average is weighted more towards CL&P because they serve the largest load.)

In the Council's Interim Forecast Report dated December 27, 2012, the Council reported that the statewide 2002 forecast had an average accuracy of 5.16 percent. Thus, the Council notes a significant increase in accuracy in the statewide 2003 forecast, with the percent error declining to 3.15 percent.

Overall, an average forecast accuracy to approximately plus or minus 3.15 percent is excellent[7]. In addition, the utilities continue to refine their forecasts, so future forecast accuracy is expected to improve.

ELECTRIC ENERGY CONSUMPTION

Forecasting Electric Energy Consumption

Energy consumption is the product of the average load and time. As an analogy, load (or rate of energy consumption) can be thought of as the gallons per minute running out of a water faucet to fill a sink, while energy consumption can be thought of as the total number of gallons of water that accumulate in the sink, or average gallons per minute multiplied by the number of minutes.

Energy consumption is also the total work done by the electricity over time. A smaller load operating for a longer period of time could consume as much energy as larger load operating for a smaller amount of time[8].

Energy consumption is represented in units of load multiplied by time or Watt-hours. On a household scale and for most electric sales, a unit of kilowatt-hours is used (kWh, or one thousand watt-hours). A household or business electric meter essentially records the sum of the energy in kilowatt-hours of all loads that have operated on the premises during the billing period[9].

For residential customers, CL&P reports an average monthly usage of 700 kWh. UI reports 650 kWh. CMEEC's most recent data shows 717 kWh for a typical residential customer for one month. This results in a weighted statewide average of about 692 kWh per month for residential customers. This is about 26.4 percent below the national average of 940 kWh reported by the U.S. Department of Energy (DOE) in 2011[10].

On a larger statewide scale, the units used are megawatt-hours (MWh, or one million watt-hours), or gigawatt-hours (GWh, or one billion watt-hours). While load (demand) is measured as an instantaneous snapshot of time (usually recorded hourly by utilities) and can go up or down, annual energy consumption acts like a "running total" that starts at zero at the beginning of the calendar year and increases all during the year, reaching a final annual total at year-end. Also, unlike annual peak loads, every season in Connecticut affects the total annual energy consumption, including winter.

The three transmission/distribution utilities maintain records of total energy consumption in their service area. This total is generally the sum of the customers' consumption, the utilities' internal consumption, and losses in the system. The sum of the three utilities' energy consumption approximates the electric energy consumption in Connecticut.

CL&P predicts a total electrical energy consumption in its service area of 23,273 GWh for calendar year 2013. The calculated CAGR is -0.48 percent. This means annual energy consumption in CL&P's service territory is forecast to decrease over time and reach 22,281 GWh by 2022.

UI predicts a total electrical energy consumption in its service area of 5,359 GWh for 2013. UI's projections result in a CAGR of -0.23 percent. That is, UI's annual electric energy consumption is expected to decrease over the forecast period to reach 5,250 GWh by 2022.

CMEEC predicts a total electrical energy consumption in its service area of 1,802 GWh for 2013. This number is expected to grow at a CAGR of 0.96 percent, reaching 1,964 GWh by 2022.

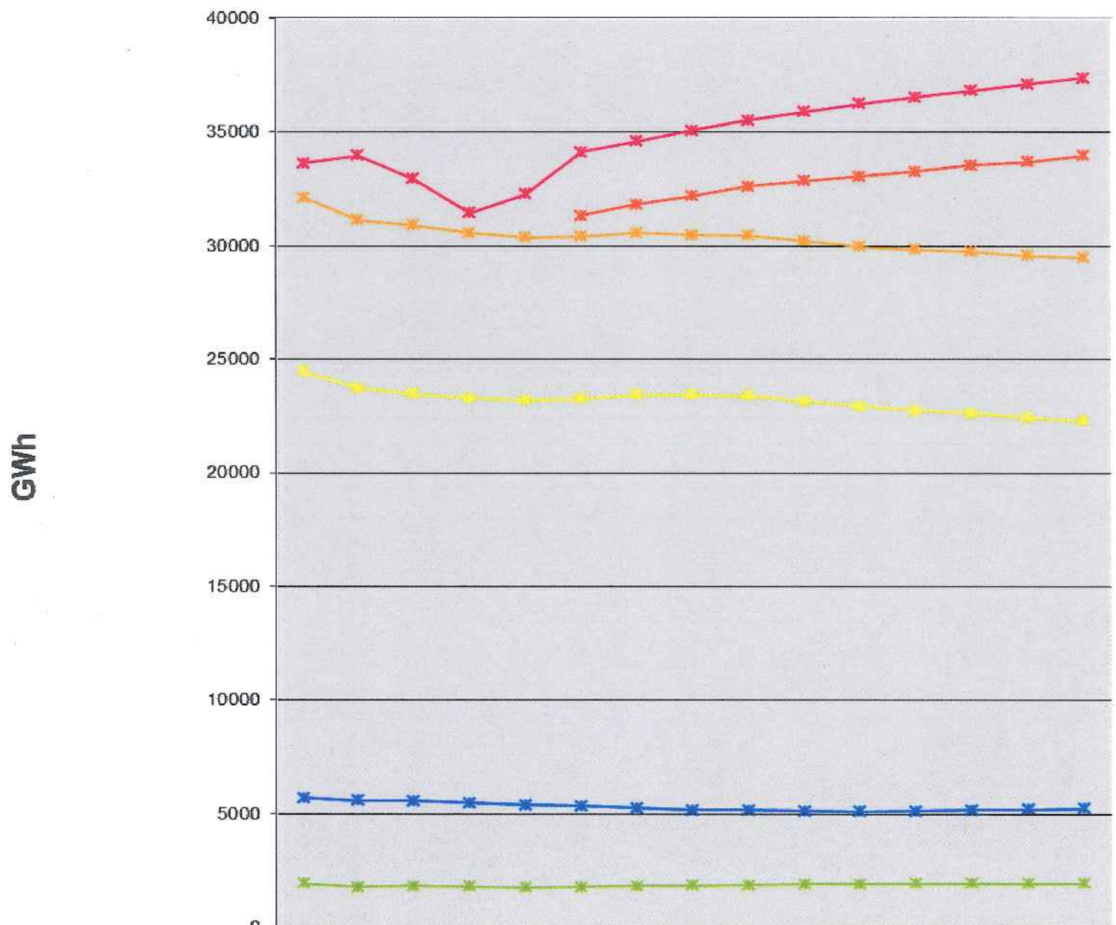
Taken together, these data result in a projected statewide electrical energy consumption of approximately 30,434 GWh for 2013. This number is expected to decrease due to a (weighted) CAGR of -0.35 percent and reach 29,495 GWh by 2022.

Just as ISO-NE forecasts electric load for Connecticut, is also forecasts the State's energy consumption. Specifically, ISO-NE predicts electric energy consumption in Connecticut to be 34,145 GWh in 2013. This number is expected to grow at a CAGR of 1.02 percent and reach 37,400 GWh by 2022. Figure 2 depicts the four energy consumption requirement forecasts.

Figure 2 also includes two curves showing Connecticut both with and without C&LM and DG. Similar to the 50/50 peak load forecasts, the curve for Connecticut adjusted by removing C&LM and DG is closer to the ISO-NE curve because of different approaches to C&LM and DG in the modeling done by ISO-NE and the Connecticut utilities. Accordingly, the CAGR for the adjusted Connecticut utilities annual energy consumption forecast total is approximately 0.91 percent, which is comparable to ISO-NE's CAGR of 1.02 percent.

On the surface, the statewide energy consumption CAGR of -0.35 percent (taking into account C&LM and DG effects) might seem inconsistent compared with the +0.40 percent CAGR of peak electric load in the State (also taking into account C&LM and DG). Furthermore, when the effects of C&LM and DG are removed, the Connecticut utilities annual energy consumption CAGR becomes positive. The only explanation is that C&LM and DG are predicted to eliminate the average increases in electric energy consumption. While not eliminating the peak load growth, C&LM and DG help to mitigate peak load increases, as will be discussed in Conservation and Load Management and Distributed Generation section.

Figure 2: State and Utility Energy Requirements in GWh



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
ISO-NE	33655	33981	32964	31443	32295	34145	34610	35080	35525	35910	36250	36545	36835	37120	37400
CT no C&LM and DG						31330	31834	32202	32639	32869	33078	33296	33558	33723	33979
CT w/C&LM and DG	32134	31136	30908	30591	30394	30434	30575	30488	30465	30224	29987	29839	29756	29583	29495
CL&P	24467	23735	23484	23286	23196	23273	23453	23433	23388	23149	22927	22748	22616	22417	22281
UI	5709	5593	5587	5485	5411	5359	5275	5186	5179	5141	5119	5144	5185	5209	5250
CMEEC	1958	1808	1837	1820	1787	1802	1847	1869	1898	1934	1941	1947	1955	1957	1964

Gigawatt-Hours (GWh)

Electric Vehicles

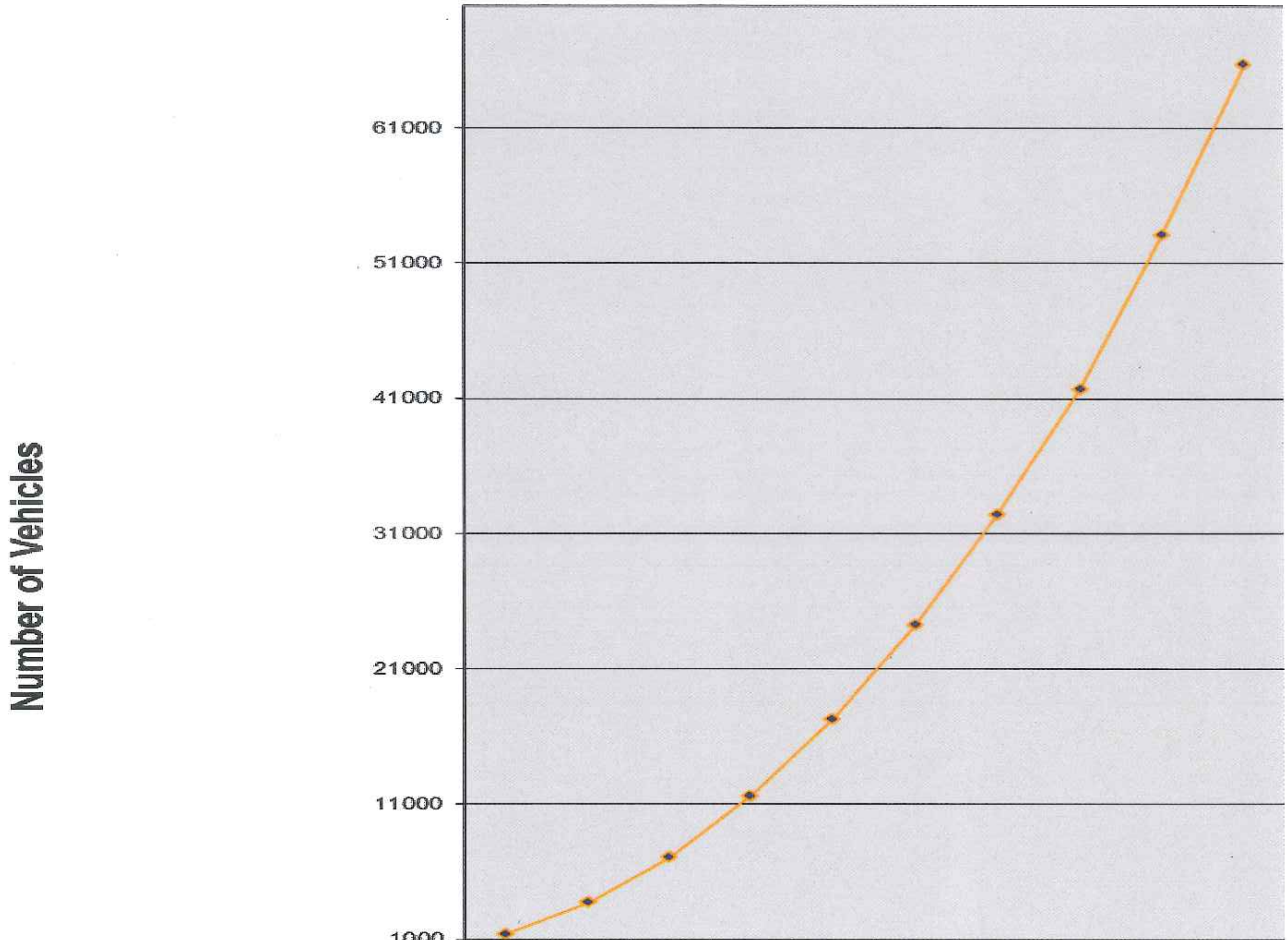
Electric vehicles (EVs) are propelled by an electric motor (or motors) powered by rechargeable battery packs. They have several advantages over internal combustion vehicles such as higher efficiency, lower noise, and zero tailpipe emissions[11]. The tradeoffs are the battery size and weight, cost, and concerns about limited range.

Some vehicles are known as hybrids. Hybrid vehicles have a gasoline engine and an electric motor. For some hybrid vehicles, the motor is only a supplement to the engine. Other hybrid vehicles can operate in electric-(motor)-only mode for a certain distance before the gasoline engine must start in order to charge the batteries. Furthermore, there are also "plug-in hybrids" that can be charged at home. Thus, someone with a plug-in hybrid and a relatively short commute could operate in electric mode during their commute and recharge their vehicle at home at night. They would have many of the benefits of an electric vehicle, but would still have the added range afforded by the gasoline engine if needed.

Of the three transmission/distribution companies, currently only CL&P expects that EVs would materially affect its forecast. Most charging would be performed at night, so no impact on the peak loads would be expected. But electric vehicles are projected to impact CL&P's energy forecast.

Figure 3a shows the projected number of EVs in CL&P's service area during the forecast period. CL&P predicts approximately 1,450 EVs in its service area for 2013. This is expected to grow at a very sizeable CAGR of 52.8 percent, reaching 65,744 EVs by 2022.

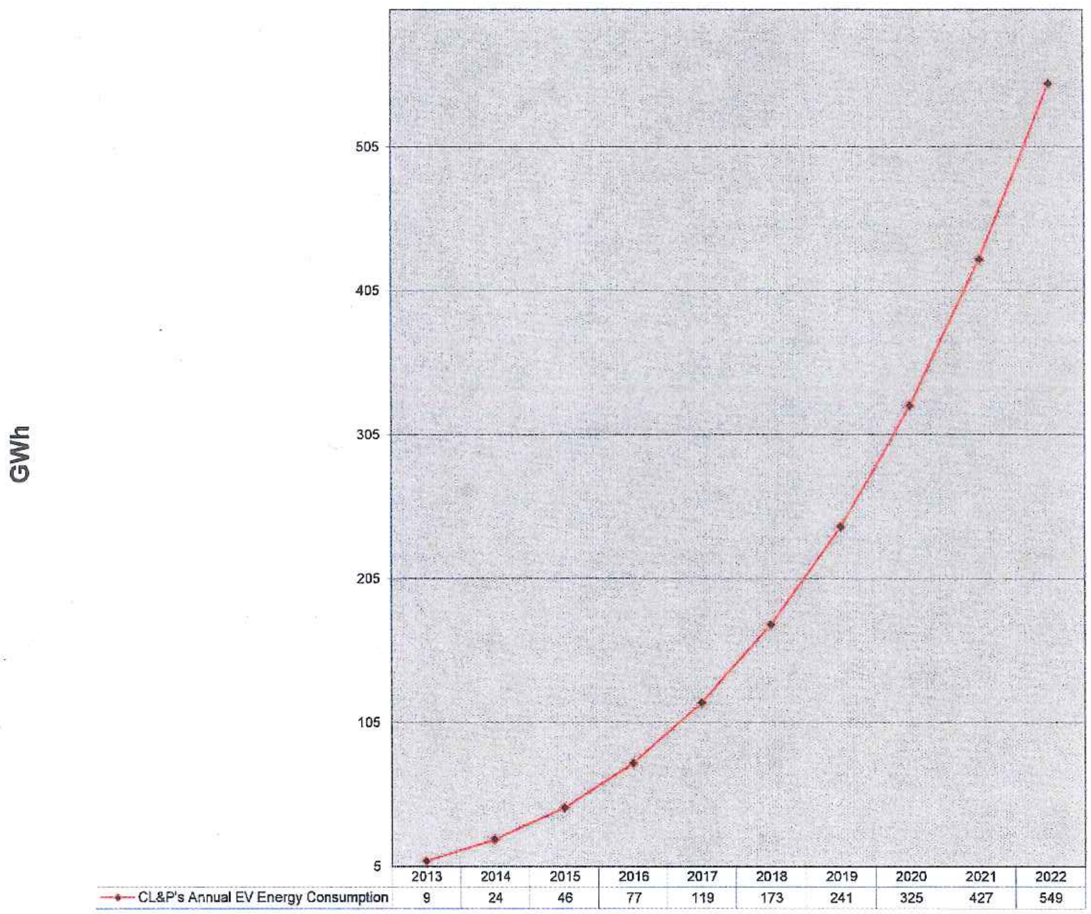
Figure 3a: CL&P's Forecast Number of New Electric Vehicles



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CL&P's Forecast Number of Electric Vehicles	1450	3759	7111	11624	17330	24236	32367	41745	53093	65744

Figure 3b shows CL&P's projected annual energy consumption related to EV battery charging. CL&P predicts approximately 9 GWh for 2013. This is also expected to grow at a very sizeable CAGR of 57.9 percent, reaching 549 GWh by 2022. This energy consumption is already included in CL&P's electrical energy consumption forecast of the previous section and is therefore also included in the statewide utility forecast numbers.

Figure 3b: CL&P's Projected EV Annual Energy Consumption



CONSERVATION AND LOAD MANAGEMENT AND DISTRIBUTED GENERATION

Conservation and Load Management (C&LM) and Distributed Generation (DG) are all types of energy efficiency: that is, they are all methods of reducing load on the electric system without compromising essential service to the end user. Conservation means reducing wasted energy; Load Management means turning off non-essential loads during peak periods; and DG means generation that is connected not to transmission, which is regional, but to distribution, which is local.

Of the C&LM and DG components, conservation has the greatest effect on net energy consumption because it is in effect during more hours of the year. Load management tends to have a minimal effect on energy consumption because the savings come during a very limited number of hours. DG has relatively small power outputs currently, so even with greater run time, the effect on net energy consumption is also quite small.

Collectively, these methods can be considered either as a reduction in demand or an increase in supply. As mentioned earlier, the Connecticut utilities consider C&LM and DG a reduction in load, while ISO-NE considers it a supply resource. Either way, the net result is the same: less stress on the electric system, reduced need to construct additional generation and transmission, and greater ability to serve loads while reducing pollution from burning fuel, particularly fossil fuel. C&LM can also have economic benefits, since the marginal cost per kW of energy efficiency can be less than that of new generation, depending on the method employed. DG can have reliability benefits because some DG can be used for backup power.

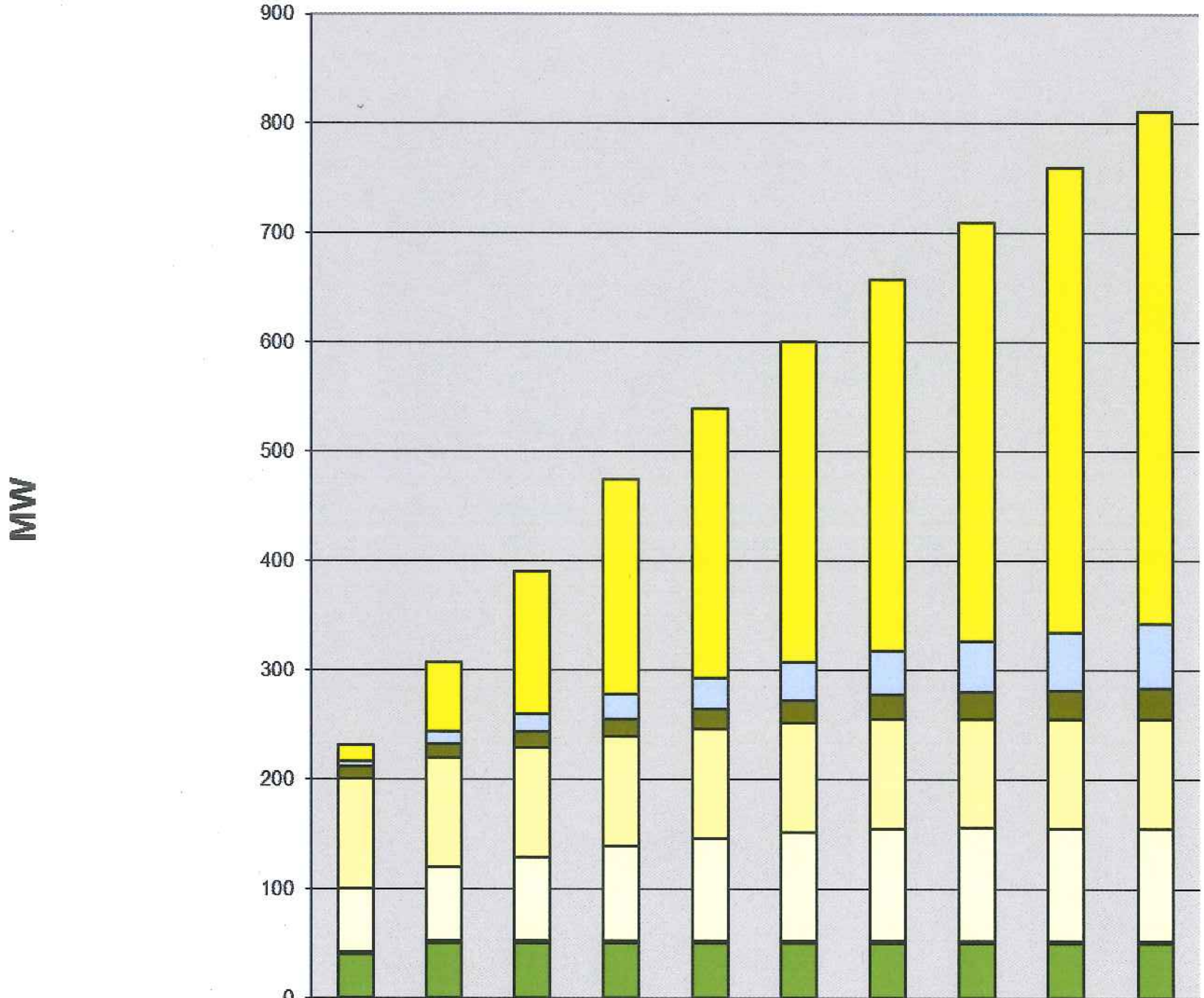
The Connecticut Energy Efficiency Board (EEB), formerly known as the Energy Conservation Management Board, is an appointed group of 15 members representing private and public entities; they serve voluntarily and meet year-round. The original purpose of the EEB was to advise and assist the state's two electric distribution companies, CL&P and UI, in both the development and implementation of Energy Efficiency Fund programs. With the passage of 2005 legislation, the EEB's oversight was expanded to include the energy efficiency programs of CMEEC, as well as the State's natural gas utilities: Connecticut Natural Gas, The Southern Connecticut Gas Company, and Yankee Gas Services Company[12].

The EEB submits an annual report to the legislature regarding energy efficiency programs in Connecticut. In the EEB report dated March 1, 2013, the EEB notes that the 2012 residential energy efficiency programs (for CL&P, UI, and CMEEC) resulted in annual energy savings of 136.6 GWh and lifetime savings of 965.9 GWh. The 2012 commercial and industrial energy efficiency programs results in annual energy savings of 185.5 GWh and lifetime savings of 2,300 GWh. Thus, the combined (residential plus commercial/industrial) 2012 energy efficiency programs results in an annual energy savings of 322.1 GWh, or roughly 1 percent of ISO-NE's reported 2012 energy consumption for Connecticut.

UI projected a load reduction (excluding DG) of 5.3 MW in 2013. This reduction is expected to increase to 59.1 MW by 2022. Load management has been assumed to be zero by UI for the forecast period. This conservative assumption is based on the fact that participation in the load management program is voluntary and difficult to predict accurately. However, CL&P has included their load management projections in their total forecast load reductions. Specifically, CL&P projected a load reduction (excluding DG) of 114 MW in 2013 due to C&LM. This reduction is expected to grow to 568 MW by 2022. Finally, CMEEC reported a projected load reduction (excluding DG) of 11.0 MW for 2013. This reduction is expected to grow to 29 MW by 2022. CMEEC also reports zero load management in its forecast report for the same reason as UI.

Collectively, these reductions result in a statewide peak load reduction due to C&LM (and excluding DG) of 130.3 MW in 2013. The cumulative load reduction is projected to increase annually with a substantial CAGR of 19.7 percent and reach 656.1 MW by 2022, the end of the forecast period. The magnitude of this reduction in load is more than the output of the Kleen Energy Facility in Middletown. See Figure 4.

Figure 4: Load Reductions Due to Conservation, Load Management/Response, and Distributed Generation



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CL&P Conservation	14	64	130	197	247	294	340	383	426	468
UI Conservation	5.3	10.8	16.4	22.3	28.3	34.3	40.4	46.6	52.9	59.1
CMEEC Conservation	11	13	15	17	19	21	23	25	27	29
CL&P Load Management	100	100	100	100	100	100	100	100	100	100
UI Load Management	0	0	0	0	0	0	0	0	0	0
CMEEC Load Management	0	0	0	0	0	0	0	0	0	0
CL&P DG and Renewable Energy Credits	58	67	76	86	93	99	102	103	102	102
UI DG	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
CMEEC DG	40	50	50	50	50	50	50	50	50	50

Megawatts

The data in this forecast show that energy efficiency and related programs are an extremely important part of Connecticut's electric energy strategy. Increased efficiency allows the State's electric needs to be met, in part, without incurring the financial costs and the incremental pollution that would be caused by dispatching generation to serve the additional load. Reductions in peak load due to increased efficiency can also impact the schedule of necessary changes to existing utility infrastructure, such as transmission lines and substation equipment (transformers, distribution feeders, etc.) and hence tend to hold down utility costs. Electric energy efficiency also reduces federal congestion charges and the costs of new generation. Currently, Connecticut ranks fifth for energy efficiency in the national rankings put out by the American Council for an Energy-Efficient Economy for 2013. (See annual scorecard at http://aceee.org/sector/state-policy/scorecard.)

Regarding total per capita energy usage, in 2011, according to the United States Department of Energy – Energy Information Administration, Connecticut had one of the lowest amounts of total energy consumed per capita in the U.S. Specifically, Connecticut ranked 49th out of 51 (i.e. 50 states plus District of Columbia) in per capita energy consumption, at 207 million British Thermal Units (BTUs) per person.[13] Wyoming had the highest energy consumption, at 975 million BTUs. The lowest was Rhode Island, at 175 million BTUs.

LREC/ZREC Program

As part of Public Act 11-80, the State of Connecticut directed CL&P and UI to launch a program to promote, fund, and expand renewable DG installed behind the utility customer's meter. This program, sometimes referred to as the Low Emissions Renewable Energy Credit/Zero Emissions Renewable Energy Credit (LREC/ZREC) Program, creates a market-driven bidding process for projects to compete to obtain a 15-year revenue stream from the sale of renewable energy credits (RECs) to the electric utilities[14]. The utilities would solicit these projects for up to a six-year period via requests for proposals (RFP).

LREC projects are low emissions projects 2,000 kW (2 MW) or less in size. One example of a low emissions project would be a fuel cell that operates on natural gas. See the Fuel Cell section of this report.

ZREC projects are zero emissions projects. Examples would be solar and wind power. ZREC projects are broken down into two sizes. Medium-sized ZREC projects range in size from 100 kW to 250 kW. Large ZREC programs range in size from 250 kW to 1,000 kW (1 MW).

CL&P and UI jointly issued their first request for proposals (RFP) in May 2012. A total of 150 bids for medium-sized ZRECs were received in 2012. 60 projects were selected. A total of 162 bids for large-sized ZRECs were received in 2012. 27 projects were selected.

CL&P's forecast includes LREC and ZREC projects in both its energy and peak load forecasts. Since LREC/ZREC projects are a form of DG, the Council has included them along with other DG in Figure 4 on page 22. UI's approach is slightly more conservative. UI included the winning LREC/ZREC bidders for the energy forecast; but for the load forecast, UI only included LREC/ZREC DG projects that have filed interconnection applications with UI, and thus are the most likely to go forward.

Distributed Generation Forecast

CL&P forecasts a total of 58 MW of DG for 2013, including LREC and ZREC projects. This is expected to grow at a CAGR of 6.47 percent and reach 102 MW by 2022. CL&P's forecasts 58 MW of DG (includes LREC and ZREC projects) for 2013. This is expected to grow at a CAGR of 6.47 percent and reach 102 MW by 2022. UI forecasts 2.7 MW of DG for the entire forecast period. LREC and ZREC projects in UI's territory appear to be separate and included in the forecast itself. CMEEC forecasts 40 MW for 2013 and 50 MW for the remainder for the forecast period. This 10 MW increment is associated with 10 MW of approved backup generation for Backus Hospital in the City of Norwich. See section titled "New Generation." Taking into account the three utilities' DG forecasts, the statewide total would be 100.7 MW for 2013, which is expected to grow at an CAGR of 4.89 percent and reach 154.7 MW by 2022.

ELECTRIC SUPPLY

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. 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 December 2013 ISO-NE dispatched generation output is 7,612 MW in the summer and 8,397 MW during the winter[15].

Even taking into account the most conservative forecast (the ISO-NE 90/10 forecast), and the worst-case generating output (the summer output), the Council anticipates that electric generation supply during the forecast period will be adequate to meet demand. While possible plant retirements could decrease generation, the New England East – West Solution (NEEWS) transmission projects would offset generation losses by increasing import capacity. See Table 4, and also the section on Transmission. Any deficits prior to the significant Interstate Reliability Project import upgrade and inclusion of Lake Road in Connecticut could be made up fairly easily by activating the full range of available generation, maximizing the use of active demand response resources, and devising other such operational strategies.

New and Pending Generation

The largest addition to Connecticut's generation resources in recent years is the Kleen Energy facility in Middletown. Kleen is a 620 MW natural gas-fired (with oil pipeline backup) combined-cycle generating facility. The plant was approved by the Council in Docket No. 225. Kleen was later selected by the former Department of Public Utility Control (DPUC) as a project that would significantly reduce federally mandated congestion charges (FMCCs). It went into service on July 12, 2011. Accordingly, the Kleen Energy plant is reflected in the load/resource balance table (Table 4). Other recent additions to Connecticut's electric generation fleet include Waterbury Generation, a 96 MW natural gas-fueled combustion turbine facility. Along with Kleen Energy and Waterside Power, the Waterbury Generation project was one of the generating projects selected to reduce FMCCs. This project went into commercial operation in May 2009.

In June/July of 2010, Devon Units #15 through 18 in Milford went into commercial operation. These units are natural gas turbines. Per ISO-NE, each unit has a summer rating of approximately 46.9 MW. Combined, they provide nearly 188 MW of available generation for Connecticut.

In June 2011, Middletown units #12 through #15 went into commercial operation. These units are also natural gas turbines with a summer rating of 46.9 MW each. Combined, they also provide nearly 188 MW of generation for Connecticut.

In May 2012, the New Haven Harbor Units #2 through #4 in New Haven went into commercial operation. These units are also natural gas turbines. Each unit has a summer rating of 43.2 MW. Combined, they provide nearly 130 MW of available generation for Connecticut.

Public Act 07-242

Public Act 07-242, An Act Concerning Electricity and Energy Efficiency, included an expedited Council review and approval process to facilitate the siting of certain new power plants. (This section was updated by Public Act 11-80.) The Council is mandated to approve by declaratory ruling:

- the construction of a facility solely for the purpose of generating electricity, other than an electric generating facility that uses nuclear materials or coal as a fuel, at a site where an electric generating facility operated prior to July 1, 2004;
- the construction or location of any fuel cell—unless the Council finds a substantial adverse environmental effect—or of any customer-side distributed resources project or facility or grid-side distributed resources project or facility with a capacity of not more than 65 megawatts, so long as such the project meets the air and water quality standards of the Department of Energy and Environmental Protection;
- the siting of temporary generation solicited by the Public Utilities Regulatory Authority pursuant to section 16-19ss.

Many projects, instead of being submitted to the Council as applications for Certificates of Environmental Compatibility and Public Need, were submitted as petitions for declaratory rulings under this provision. Several Project 150 proposals (see below) were in this category.

Project 150

Project 150 is a program funded by the Connecticut Clean Energy Finance and Investment Authority (CCEFIA) formerly known as the Connecticut Clean Energy Fund (CCEF). The aim of this program is to stimulate Class I renewable energy generation. Furthermore, Project 150 was created because large renewable energy projects are difficult to finance without long-term contracts. The legislation requires local distribution companies to enter into long-term electric purchase agreements (EPAs) with generators of Class I renewable energy for no less than 150 MW.

In the implementation process, the CCEF[16] was charged with issuing requests for proposals from developers as well as screening, evaluating and selecting projects to recommend to PURA, formerly known as the Department of Public Utility Control. The projects were then forwarded to CL&P and UI for contract negotiation. Those projects approved by PURA for long-term EPAs received financial support from CCEFIA.

Siting review and approval for these distributed generation projects is performed by the Council. Table 2 reports each applicant's status before the Council, and estimated in-service dates for those already approved. (See also later sections on renewable generation projects.) In some cases, the actual power to be provided to the utilities under contract for Project 150 could be less than the project's power output. The remaining output may be sold to the grid under other terms or arrangements.

Table 2: Renewable Generation Projects Selected in Project 150

Project	*Location*	*Project MW*	*Contract MW*	*Est. In-service Date*	*Council Review Status*
DFC-ERG Bloomfield	Bloomfield	3.65	3.65	2013[17]	Approved
DFC-ERG Glastonbury	Glastonbury	3.4	3.4	2013[17]	Approved
Bridgeport Fuel Cell Park	Bridgeport	14.93	14.93	2014	Approved
Plainfield Renewable Energy	Plainfield	37.5	30	2013[17]	Approved
Total Capacity Approved by Council		59.48	51.98		
Project	*Location*	*Project MW*	*Contract MW*	*Est. In-service Date*	*Review Status*
DFC-ERG Trumbull	Trumbull	3.4	3.4	2013[17]	Not Rec'd
Stamford Hospital Fuel Cell CHP	Stamford	4.8	4.8	2013	Not Rec'd
Waterbury Hospital Fuel Cell CHP	Waterbury	2.8	2.8	2013[17]	Not Rec'd
Other Project Capacity		11	11		

Source: CL&P Forecast dated March 1, 2013

Wind Renewable Projects

On November 17, 2010, BNE Energy Inc. (BNE), submitted a petition to the Council for a declaratory ruling that no Certificate is required for the construction, maintenance, and operation of a 3.2 MW Wind Renewable Generating facility at 178 New Haven Road in

Prospect, Connecticut. The proposed project is referred to as "Wind Prospect." The Wind Prospect project (Petition No. 980) was denied by the Council on May 12, 2011[18].

On December 6, 2010, BNE submitted a petition to the Council for a declaratory ruling that no Certificate is required for the construction, maintenance, and operation of a 4.8 MW Wind Renewable Generating facility at Flagg Hill Road in Colebrook, Connecticut. The proposed project is referred to as "Wind Colebrook South." The Wind Colebrook South project (Petition No. 983) was approved by the Council on June 2, 2011[19].

On December 13, 2010, BNE submitted a petition to the Council for a declaratory ruling that no Certificate is required for the construction, operation, and maintenance of a 4.8 MW Wind Renewable Generating facility located on Winsted-Norfolk Road (Route 44) and Rock Hall Road in Colebrook, Connecticut. The project is referred to as "Wind Colebrook North." The Wind Colebrook North project (Petition No. 984) was approved by the Council on June 9, 2011[20].

While a total of 9.6 MW of new wind generation has been approved by the Council, the precise in-service dates of the projects are not yet known. BNE has partially begun construction on the Colebrook South site and has been in litigation for more than two years. Accordingly, to be conservative, the wind projects have not yet been included in the current Council forecast.

PA 11-245 placed a moratorium on future wind development projects pending the adoption of regulations regarding the siting of wind projects. Specifically, the Council cannot act on any application or petition for the siting of a new wind turbine until after the adoption of regulations. These regulations would include but not be limited to setbacks, flicker, requirements to decommission the facility at the end of its useful life, ice throw, blade shear, noise, impact on natural resources, and a requirement for a public hearing. The regulations were to be adopted on or before July 1, 2012. They were submitted on time to the Legislative Regulations Review Committee (LRRC) and re-submitted twice after that with modifications per LRRC recommendations. This is an ongoing, iterative process. The latest version of the draft wind regulations was submitted to the LRRC on November 5, 2013 for review and approval. The LRRC, despite the recommendation in the Legislative Commissioner's Office Report to approve the draft wind regulations in whole, rejected the draft wind regulations without prejudice for the fourth time at a LRRC meeting held on November 26, 2013.

Solar Renewable Projects

In PA 11-80, section 127, an electric distribution company or owner or developer of generation projects that emit no pollutants may submit a proposal to DEEP to build, own or operate one or more generation facilities up to an aggregate of 30 MW using Class I renewable energy sources. Each facility shall be greater than one MW and less than five MW. Solar projects are a natural fit for this description given the size, zero emissions requirement, and Class I renewable status.

Accordingly, on October 31, 2012, Somers Solar Center, LLC (SSC) submitted a petition to the Council for a declaratory ruling that no Certificate is required for the construction, maintenance, and operation of a 5.0 MW alternating current (AC) solar photovoltaic generating facility at 458 and 488 South Road in Somers, Connecticut. This project (Petition No. 1042) was approved by the Council on March 21, 2013[21]. The project is expected to be in service by 2014. This is reflected in Table 4.

On December 17, 2012, GRE 314 East Lyme, LLC (GRE) submitted a petition to the Council for a declaratory ruling that no Certificate is required for the construction, maintenance, and operation of a 5.0 MW AC solar photovoltaic generating facility at Grassy Hill Road and Walnut Hill Road in East Lyme, Connecticut. This project (Petition No. 1056) was approved by the Council on May 16, 2013[22]. The project is expected to be in service in 2014. This is reflected in Table 4.

Generation for Backup Power/Microgrids

Per Section 7 of PA 12-148, a "microgrid" means "a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and that connects and disconnects from such grid to enable it to operate in both grid-connected or island mode."

Pursuant to the same section, DEEP was charged with establishing a microgrid grant and loan program to support local distributed generation for critical facilities. DEEP issued an RFP and, as a result, nine projects in the following municipalities were selected for microgrids: Windham, Bridgeport, Fairfield, Woodbridge, Groton, Hartford, Middletown, and Mansfield (Storrs).

While Norwich Public Utilities (NPU) in Norwich was not selected for an award for a microgrid, NPU went forward with its own proposal. Specifically, on July 28, 2013, the Council received a petition from CMEEC for a declaratory ruling that no Certificate of Environmental Compatibility and Public Need is required for the proposed installation of four 2.49 MW generating units at 4 Matlack Road, Norwich. As part of the microgrid project, in the event of a long-term blackout, the generators would provide back-up power to Backus Hospital as a priority recipient and to other "critical facilities" defined under Section 7 of PA 12-148 as "a hospital, police station, fire station, water treatment plant, sewage treatment plant or commercial area of a municipality." The proposed generators could also be utilized to minimize peak demand on the regional power grid. It was approved by the Council on August 9, 2013. The projected is expected to be in service in 2014. The approximately 10 MW associated with this project is already included in Figure 4, beginning in 2014.

Existing Generation

Nuclear Powered Generation

Nuclear plants use nuclear fission (a reaction in which uranium atoms split apart) to produce heat, which in turn generates steam, and the steam pressure operates the turbines that spin the generators. Since no step in the process involves combustion (burning), nuclear plants produce electricity with zero air emissions. Pollutants emitted by fossil-fueled plants are avoided, such as sulfur dioxide (SOx), nitrogen oxides (NOx), mercury, and carbon monoxide. (SOx and NOx contribute to acid rain and smog.) Nuclear plants also do not emit carbon dioxide (CO_2), which is a significant advantage in the effort to curb greenhouse gas emissions. However, issues remain with regard to security, the short and long-term storage of nuclear waste, and the cost of new plants.

Connecticut currently has two operational nuclear electric generating units (Millstone Unit 2 and Unit 3) contributing a total of 2,097 MW of summer capacity, approximately 27.6 percent of the State's peak generating capacity. The Millstone facility is the largest generating facility in Connecticut by power output.

The former Millstone Unit 1 reactor has been decommissioned in place. Dominion Nuclear Connecticut Inc. (Dominion), owner of the Millstone units, has no plans at this time to construct another nuclear power generating unit at the site.

While the number of active nuclear units in Connecticut remains unchanged at two, nuclear power output has gradually increased over time due to modifications that improve the output of the units. Ten years ago, the Council reported in its 2003 Forecast Report that Connecticut had approximately 1,928 MW of nuclear electric generating capacity from the two units. Today, we have 2,097 MW, or a total of 8.06 percent increase over the past ten years.

Dominion submitted license renewal applications to the United States Nuclear Regulatory Commission (NRC) on January 22, 2004. On November 28, 2005, the NRC announced that it had renewed the operating licenses of Unit 2 and Unit 3 for an additional 20 years. With this renewal, the operating license for Unit 2 is extended to July 31, 2035 and the operating license for Unit 3 is extended to November 25, 2045.

Coal Powered Generation

In conventional coal-fired plants, coal is pulverized into a dust and burned to heat steam for operating the turbines. In general, using coal as fuel has the advantages of an abundant domestic supply (US reserves are projected to last approximately 222 years[23]), and an existing rail infrastructure to transport the coal. Despite the advantages of domestic coal, generators sometimes find imported coal more economical to use.

However, burning coal to make electricity causes air pollution. Pollutants emitted include sulfur dioxide, carbon dioxide, and mercury. Coal-fired power plants also have high CO_2 emissions relative to plants using other fuels; thus, they are considered particularly significant contributors to global warming. In addition, fossil-fueled power plants, in general, are facing more stringent standards with regard to CO_2 emissions.

Ten years ago, the Council reported approximately 553 MW of coal-fired generating capacity in Connecticut. This was the sum of AES Thames in Montville at 181 MW and

Bridgeport Harbor #3 at 372 MW. AES Thames retired from service in 2011, and Bridgeport Harbor #3 had a power increase of about 11 MW, yielding a total net loss of 170 MW, or a 30.8 percent reduction in coal-fired generation capacity in Connecticut during the past ten years.

Currently, Connecticut's only active coal-fired generation facility is the Bridgeport Harbor #3 facility located in Bridgeport. It has a summer power output of approximately 383 MW, or approximately 5.0 percent of the State's current capacity.

Given the tightening CO_2 emissions standards and higher carbon content than other fossil fuels, no new coal-fired generation is expected in Connecticut at this time. See the sections on the "Regional Greenhouse Gas Initiative" and "Carbon Dioxide Pollution Standard for New Power Plants" for more on the legislative and regulatory requirements relative to CO_2 emissions.

Petroleum Powered Generation

Connecticut currently has 29 active oil-fired electric generating facilities contributing 2,136 MW, or 28.1 percent of the State's current peak generating capacity.

The Council notes that oil-fueled peak power output in Connecticut has declined. Ten years ago, the Council reported in its 2003 Forecast Report that Connecticut had approximately 2,611 MW of petroleum-fueled generation capacity. Today, we have 2,136 MW or a <u>total</u> of 18.2 percent decline over the past ten years. This is likely due to the increasing age of the fleet and the loss of Devon 7 (107 MW) and Devon 8 (107 MW). Also, according to ISO-NE's December 2013 Seasonal Claimed Capability Report, Norwalk Harbor #1, 2, and 3, (342 MW), Bridgeport Harbor #2 (130 MW), and John Street Nos. #1, 2, and 3 (6 MW) all have reported seasonal claimed capabilities of zero in the summer. This essentially amounts to losses of active oil-fired generation capacity in Connecticut. However, these reductions were partially offset by the installation of Cos Cob units #13 and #14 (about 38 MW total), CMEEC Norden (6 MW), CMEEC Norwich Wastewater Treatment Facility (2 MW), and the largest of the recent additions: Waterside Power (69 MW).

Additional oil-fired generation is not likely in the near future, due to market volatility and mounting oil prices: the price of crude oil currently is about $104 per barrel as of October 8, 2013. This is compared to approximately $27 per barrel ten years ago (i.e. October 2003). However, replacement and/or repowering of existing aging units may occur.

Moreover, oil-fired generation presents environmental problems, particularly related to the sulfur content of the oil, and faces tighter air-emissions standards particularly related to CO_2. Oil-fired power plants are also significantly affected because oil is the second highest carbon fossil fuel. See the sections on the "Regional Greenhouse Gas Initiative" and "Carbon Dioxide Pollution Standard for New Power Plants" for more on the legislative and regulatory requirements relative to CO_2 emissions.

Some of the oil-fired generating facilities in Connecticut are dual-fueled, meaning that they can switch to natural gas if necessary. Currently, four generating units in Connecticut (Middletown #2 and #3; Montville #5; and New Haven Harbor #1), totaling approximately 880 MW, have the ability to change from oil to gas. The Council believes that dual-fuel capability is an important part of diversifying the fuel mix for electric generation, with the benefit of avoiding overdependence on a particular fuel.

Natural Gas Powered Generation

Natural gas-fired electric generating facilities are preferred over those burning coal or oil primarily because of higher efficiency, lower initial cost per MW, and lower air pollution. Natural gas is also the lowest carbon fossil-fuel, which is a significant environmental advantage given tightening CO_2 standards. See the sections on the "Regional Greenhouse Gas Initiative" and "Carbon Dioxide Pollution Standard for New Power Plants" for more information on the legislative and regulatory requirements relative to CO_2 emissions.

Some natural gas generating plants, such as Bridgeport Energy, Milford Power, Lake Road, and the new Kleen Energy plant are combined-cycle. Added to the primary cycle, in which gas turbines turn the generators to make electricity, is a second cycle, in which waste heat from the first process is used to generate steam: steam pressure then drives another turbine that generates even more electricity. Thus, a combined-cycle plant is highly efficient, with an efficiency on the order of 60 percent. However, the tradeoffs are higher initial costs and increased space requirements for the extra generating unit.

Natural gas generating facilities also have the advantage of being linked directly to their domestic or North American fuel source via a pipeline. Furthermore, abundant domestic natural gas supplies and lower fuel costs also make natural gas attractive.

Connecticut currently has 29 natural gas-fired generating units (not including Lake Road[24] which is electrically more a part of Rhode Island than Connecticut) contributing a total of 2,657 MW, or 35.4 percent of the State's generating capacity. This includes additions such as Waterbury Generation, Kleen Energy, Middletown #12-15, and Devon #15-18 with summer ratings of 96 MW, 620 MW, 188 MW, and 188 MW, respectively.

Natural gas fueled-generation has been the fastest growing type of electrical generation in Connecticut. Ten years ago, the Council reported in its 2003 Forecast Report that Connecticut had approximately 879 MW of natural gas-fueled electric generating capacity (also not including Lake Road). Today, we have 2,657 MW, or a total of 202 percent increase over the past ten years. Overall, natural gas-fired generation is expected to remain a popular choice for new generation as well as repowering older generation, but concerns do exist about possible overreliance on natural gas as a fuel as fuel diversity decreases.

Hydroelectric Power Generation

Hydroelectric generating facilities use a renewable energy source, emit zero air pollutants, and have a long operating life. Also, some hydro units have black start capability.

Connecticut's hydroelectric generation consists of 28 facilities contributing approximately 118 MW, or 1.7 percent of the State's current peak generating capacity. FirstLight Power Enterprises, Inc. (FirstLight), Connecticut's largest provider of hydroelectric power, owns the following hydroelectric facilities: Bantam, Bulls Bridge, Falls Village, Robertsville, Scotland, Stevenson, Taftville, Tunnel 1-2, Rocky River, and Tunnel 10. Other hydroelectric facilities (over 5 MW) not owned by FirstLight include Derby Dam and Rainbow Dam located in Shelton and Windsor, respectively.

The Council notes that hydroelectric power output in Connecticut has been declining. The 2003 Forecast Report indicated that Connecticut had approximately 150 MW of hydroelectric energy capacity. Today, we have 118 MW, or a total of a 21.3 percent decline over the past ten years. This is likely the result of naturally changing water flows.

The main obstacle to the development of additional hydroelectric generation in Connecticut is a lack of suitable sites.

Solid Waste Power Generation

Solid waste has the advantage of being a renewable, locally supplied fuel and it contributes to Connecticut's fuel diversity. It is not affected by market price volatility, nor supply disruptions—significant advantages over fossil fuels. In addition, the combustion of solid waste reduces the amount of space needed for landfills. Solid waste-fueled facilities are considered Class II renewable resources.

Connecticut currently has approximately 165 MW of solid waste-fueled generation, or approximately 2.2 percent of the State's peak generation capacity. The Exeter generating plant in Sterling burns used tires, and has a summer rating of approximately 9.5 MW. The remaining approximately 156 MW of solid waste-fueled generation includes: Bridgeport Wheelabrator; Bristol Resource Recovery Facility (RRF); Lisbon RRF; Preston RRF; Wallingford (Covanta) RRF; and the Connecticut Resource Recovery Agency South Meadows facility. See Table 3.

Table 3

Solid Waste-fueled Generation	**MW**
Bridgeport Wheelabrator	59.27
Bristol Resource Recovery Facility	12.22
Lisbon Resource Recovery Facility	13.46
Preston Resource Recovery Facility	16.10
Wallingford Resource Recovery (Covanta) Facility	6.88
Connecticut Resource Recovery Agency - South Meadows Unit #5	26.42
Connecticut Resource Recovery Agency - South Meadows Unit #6	21.21
Exeter Tire-burning Facility	9.50
Total	165.06

The Council notes that waste-to-energy peak power output in Connecticut has declined. Ten years ago, the Council reported in its 2003 Forecast Report that Connecticut had approximately 186 MW of solid waste-fueled generation capacity. Today, we have 165 MW or a total of 11.4 percent decline over the past ten years. This is likely due to the increasing age of the fleet.

Landfill Gas Power Generation

Connecticut's landfill gas generation consists of three facilities contributing approximately 3.92 MW, or a negligible 0.05 percent of the State's current peak generating capacity. These facilities are located in Hartford, East Windsor, and New Milford and have power outputs of 1.56 MW, 0.98 MW, and 1.38 MW, respectively. Landfill gas (essentially methane), like solid waste, has the advantage of being a locally supplied fuel. In addition, landfill gas-fueled facilities are considered Class I renewable resources.

Ten years ago, in the 2003 Forecast Report, the Council reported 5.58 MW of landfill gas generating capacity. As of today, there is a net reduction of 1.66 MW or a total reduction of 42.3 percent since 2003. The amount of methane gas available at a given landfill site at a given time is variable and depends on many factors. Landfill gas power outputs can vary as conditions and decomposition rates change.

Miscellaneous Distributed Generation

Fuel Cells

Fuel cells have very low emissions compared with other generation technologies. Some fuel cells can offer waste heat for use for domestic heating, hot water, industrial processes, etc. This can further increase overall efficiency. Fuel cells are also considered Class I renewable resources. Fuel cells have not been included in Table 4 because they are not ISO-NE dispatched. Many of these fuel cells provide base load power to the customer and serve to reduce load on the system. Some do sell excess power to the grid, but it is at the distribution level and thus not under ISO-NE's control.

The number of petitions for distribution-connected fuel cells that are being filed with the Council has increased significantly. Specifically, the Council has approved four projects totaling 1,600 kW or 1.6 MW in 2012. From the beginning of calendar year 2013 through the end of December 2013, the Council has received and approved 18 fuel cell projects totaling 12,080 kW or 12.08 MW. Thus, the number of petitions being filed has increased from 0.33 petitions per month (or one every three months) for 2012 to 1.50 petitions per month (or three every two months) for 2013. This is a substantial increase of 355 percent, largely due to the success of the LREC/ZREC Program. See previous section titled, "LREC/ZREC Program." The Council strongly supports fuel cells as a very clean, efficient, and reliable source of electricity.

Other Miscellaneous Distributed Generation

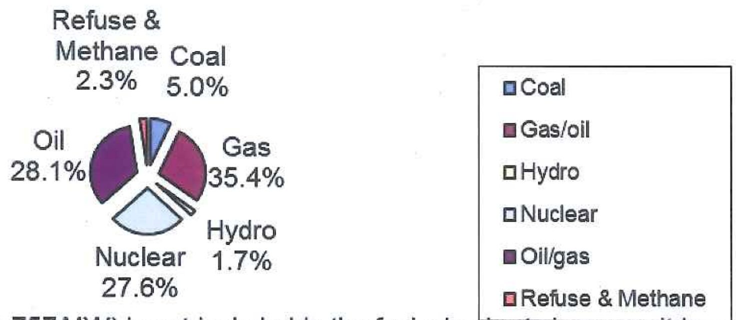
Approximately 134 MW of electricity is generated by 67 independent entities in Connecticut such as schools, businesses, and homes. They range from 5 kW to 32.5 MW in size and are fueled primarily by natural gas, with several others using oil, solid waste, hydro, landfill gas (essentially methane), and propane. For example, a 24.9 MW cogeneration facility was installed at the University of Connecticut. It was put into service in August 2005.

These miscellaneous distributed generators are not credited to the State's capability to meet demand because ISO-NE does not control their dispatch. However, these privately-owned units also serve to reduce the net load on the grid. It is possible some unreported units may be in service in Connecticut, and others may have been removed from service. Therefore, the total amount of miscellaneous small generation capacity is a very rough approximation, and thus, it is not included in Appendix A.

Fuel Mix

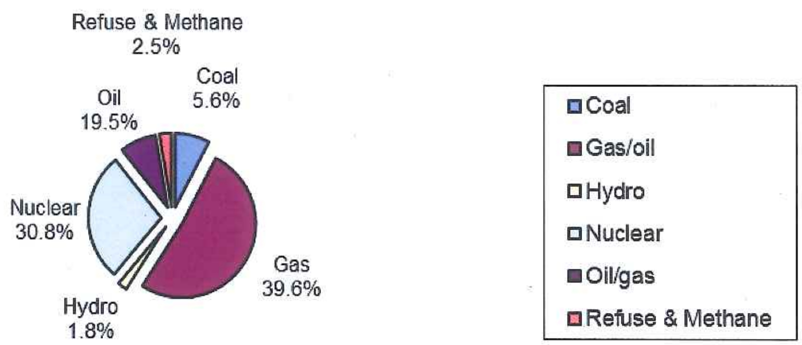
Based on existing generation and future (approved) generation projected in Table 1, the estimated fuel mix (by MW) is provided below for 2013 and also 2022, the end of the forecast period. The retirement assumptions of the 2012 IRP are included in the 2022 Fuel Mix chart. See Figure 4a and 4b below.

Figure 4a: 2013 Fuel Mix (Capacity)



*Lake Road plant (~757 MW) is not included in the fuel mix charts because it is electrically more a part of Rhode Island than Connecticut.

Figure 4b: 2022 Fuel Mix (Capacity)



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 electric energy. Connecticut can reliably import approximately 1,500 MW to 2,500 MW of power from the neighboring states of New York, Rhode Island, and Massachusetts. 2,500 MW is considered the maximum and best-case scenario at this time. To be conservative, the Council has assumed only 2,000 MW of import capacity.

The ISO-NE 90/10 annual peak demand for Connecticut averages 8,446 MW over the forecast period. Thus, the 2,500 MW maximum import capability only represents 29.6 or about 30 percent of the State's peak 90/10 demand. Looking ahead, CL&P is developing a transmission upgrade plan, known as New England East – West Solution (NEEWS), that would increase the State's import capacity to over 40 percent of peak demand. NEEWS would significantly increase the reliability of Connecticut's supply system and allow for greater import of economical supply. (See Transmission section.)

Demand/Supply Balance

Table 4 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, basically: in case a large generating unit trips off-line, reserves must be available to compensate rapidly for that loss of capacity. The largest reserve requirement is 1,225 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 4 is based on the 7,908 MW of total existing generation in Connecticut listed in Appendix A. Appendix A data is from ISO-NE's December 2013 Seasonal Claimed Capability report. Approved generation projects (not yet constructed and/or complete) are also included in Table 4. As indicated, in-service dates for these facilities are estimates and may be subject to change.

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. Specifically, the 2012 IRP assumes that Bridgeport Harbor #2 (130 MW) and AES Thames (183 MW) would retire in 2013. AES Thames is now retired and has been deleted from Appendix A (Existing Generation) data. PSEG made a Non-Price Retirement Request to ISO-NE on September 20, 2013. ISO-NE accepted the retirement request in October 2013. Since the Seasonal Claimed Capability of Bridgeport Harbor #2 is zero, to avoid double accounting, Bridgeport Harbor #2 is not deducted from Table 4 in the 2012 IRP retirement section.

The 2012 IRP also assumes the retirement of Middletown #4 (400 MW) and Montville #6 (405 MW) in 2015. Accordingly, Table 4 reflects this assumption.

Approved generation associated with Project 150 (from Table 2), as well as two new approved solar projects have been included in Table 4 as new generation resources. Other new generation resources such as Kleen Energy, Devon #15 through #18, Middletown #12 through #15, New Haven Harbor #2, #3 and #4, and Waterbury Generation are not listed on Table 4 because they are already reflected in the existing generation listed in Appendix A.

Import capacity into Connecticut is expected to increase as a result of the Greater Springfield NEEWS project and the Interstate Reliability NEEWS project. These projects would increase import by 100 MW in 2014 and 800 MW in 2016, respectively.

These increases, as reported in the 2012 IRP, have been reflected in Table 4. Lake Road is not included in the existing generation total of Table 4 because ISO-NE does not currently consider it a Connecticut resource. However, the transmission system upgrades associated with the Interstate Reliability Project will allow Lake Road to count as a Connecticut resource. Per the 2012 IRP, Lake Road is included in Table 4 beginning in approximately 2016.

Table 4: Connecticut Generation vs. Peak Load

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
90/10 Load	7975	8080	8215	8345	8445	8525	8610	8680	8760	8825
Reserve (Equiv. Millstone 3)	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225
Load + Reserve	9200	9305	9440	9570	9670	9750	9835	9905	9985	10050
Existing Generation	7612	7612	7612	7612	7612	7612	7612	7612	7612	7612
Installed Capacity Derate	746	747	694	653	668	690	705	727	745	762
Available Generation	6866	6865	6918	6959	6944	6922	6907	6885	6867	6850
Normal Import[1]	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Energy Efficiency[2] per Fig. 3	30	88	161	236	294	349	403	455	506	556
Total Avail. Resources	8896	8953	9079	9195	9238	9271	9310	9340	9373	9406
Surplus/Deficiency[3]	**-304**	**-352**	**-361**	**-375**	**-432**	**-479**	**-525**	**-565**	**-612**	**-644**
Approved Generation Projects										
Project 150[4]	37	52	52	52	52	52	52	52	52	52
Somers - Solar PV		5	5	5	5	5	5	5	5	5
GRE - Solar PV		5	5	5	5	5	5	5	5	5
Surplus/Deficiency	**-267**	**-290**	**-299**	**-313**	**-370**	**-417**	**-463**	**-503**	**-550**	**-582**
Possible Generation Retirements Per 2012 IRP[5]										
Middletown #4			-400	-400	-400	-400	-400	-400	-400	-400
Montville #6			-405	-405	-405	-405	-405	-405	-405	-405
Surplus/Deficiency	**-267**	**-290**	**-1104**	**-1118**	**-1175**	**-1222**	**-1268**	**-1308**	**-1355**	**-1387**
NEEWS Import + Lake Road										
NEEWS - Greater Springfield		100	100	100	100	100	100	100	100	100
NEEWS - Interstate				800	800	800	800	800	800	800
NEEWS - Interstate - Lake Road				757	757	757	757	757	757	757
Total Net Surplus/Deficiency	**-267**	**-190**	**-1004**	**539**	**482**	**435**	**389**	**349**	**302**	**270**

[1]This is an average value. The actual import capacity can range between 1,500 MW to 2,500 MW.

[2]This takes into account only passive (non-dispatched) demand reductions such as energy efficiency, to be conservative.

[3]This is based on a one-in-ten years event and assumes conservative import capacity, no load response, and no newly-approved DG.

[4]Projects not yet received by the Council are not included.

[5]Such retirements are hypothetical based on certain conditions, and are difficult to predict with certainty at this time.

Market Rules Affecting Supply

Forward Capacity Market (FCM)

Deregulation of the electric system in Connecticut and other New England states was intended to introduce competition into the wholesale market for electric capacity and increase investment in generation while driving prices down. This laudable aim was difficult to achieve, mainly because electricity was and is such a necessity that market rules at the time—as established by FERC and practiced by ISO-NE—imposed penalties suppressing competition on behalf of reliability targets. During a chaotic transition period of about seven years after deregulation, 1998-2005, ISO-NE's authority to enforce reliability brought more control over the increasingly complex and extended electric system into its hands. At the same time, State ratepayers saw prices rise steeply, while diversified generation did not replace traditional resources to the extent expected, and transmission improvements, instead, were proposed and approved by the Council to meet increased load. At length, in 2006 the states reached a settlement with FERC whereby a new electric market in New England was created to satisfy the twin aims of competition and reliability more equally.

This new market, the FCM, starts with ISO-NE's projections of system needs three years in advance, then holds an annual declining auction to purchase generation meeting those needs. The FCM has begun to assure lower pro-rated capacity prices along with reliable supply. It has introduced greater stability to the markets because it: a) assures capacity and price three years ahead; b) establishes rigorous financial tests that generators must pass to qualify for the auction; and c) includes effective rules to enforce auction commitments. Above all, the FCM has succeeded because its rules are more transparent and because it puts traditional generators, renewables, imports and demand response resources more on par. The results of the first seven FCM auction results are listed below in Table 5.

Table 5: FCM Auction Results

	Cleared Generation	Cleared Demand Resources	Cleared Imports	Total Capacity Acquired	Projected Capacity Need	Clearing Price	Excess Supply	Prorated Price
	MW	MW	MW	MW	MW	$/kW-month	MW	$/kW-month
2010/11	30865	2279	933	34077	32305	4.50	1772	4.25
2011/12	32207	2778	2298	37283	32528	3.60	4755	3.12
2012/13	32228	2867	1900	36996	31965	2.95	5031	2.54
2013/14	32247	3261	1993	37501	32127	2.95	5374	2.53
2014/15	31439	3468	2011	36918	33200	3.21	3718	2.86
2015/16	30757	3628	1924	36309	33456	3.43	2853	3.13
2016/17	31641	2748	1830	36220	32968	3.15	3252	2.74
Source: ISO-NE Press Release dated February 27, 2013								

Other ISO-NE Markets

ISO-NE runs other wholesale markets, most notably its day-ahead and real-time energy markets, where generators sell actual MW, as opposed to capacity. The smaller markets in which electricity is sold for specialized purposes need not be discussed here: suffice to say that discussion is ongoing within ISO-NE about possible changes to these markets, too, to promote further competition and investment. For a complete overview of New England's wholesale electricity markets, please see the latest Annual Markets Report: http://www.iso-ne.com/markets/mkt_anlys_rpts/annl_mkt_rpts/index.html.

Legislation Affecting Supply

Regional Greenhouse Gas Initiative (RGGI)

The Regional Greenhouse Gas Initiative (RGGI) is the nation's first mandatory, market-based program to reduce emissions CO_2, the principal human-caused greenhouse gas. The states participating in RGGI (CT, DE, MA, MD, ME, NH, NY, RI, and VT) have established a regional cap on CO_2 emissions from the power sector and are requiring power plants 25 MW or greater in size to possess a tradable CO_2 allowance for each ton of CO_2 they emit.

Each state issues the CO_2 allowances to power plants within its own state, based on its independent legal authority. RGGI is composed of these individual CO_2 budget trading programs. RGGI compliance occurs in three-year control periods. At the end of each control period, all regulated power plants must submit the required CO_2 allowances. The first control period began on January 1, 2009, and extended through December 31, 2011. The second control period began on January 1, 2012, and extends through December 31, 2014. The annual cap for power sector emissions in the region was set at 165 million tons per year through 2014[28].

The auction proceeds for the region through December 5, 2012 exceed $1.1B, of which, $65M is for Connecticut. Overall, 80 percent of the $1.1B is invested in consumer benefit programs, including energy efficiency, renewable energy, direct energy bill assistance, and other greenhouse gas reduction programs.

However, falling natural gas prices (due in large part to new Marcellus gas supplies) have encouraged power plants to switch to burning natural gas wherever feasible. Since natural gas is the lowest carbon fuel of the three fossil fuels (coal, oil, natural gas), power plant CO_2 emissions in this region have plummeted to record low levels. Annual emissions are on the order of 91 million tons, which is about 45 percent below the previous RGGI cap of 165 million tons[29].

Upon further review and analysis, changes were made to RGGI to address this issue. The *Updated Model Rule and Program Review Recommendations Summary* released on

February 7, 2013 made changes that will take effect on January 1, 2014. These changes include but are not limited to the following.

- The 2014 regional CO_2 budget (RGGI Cap) will be reduced from 165 million to 91 million tons – a reduction of 45 percent. Starting in 2015, the RGGI Cap will decline 2.5 percent every year until 2020.
- Unsold 2012 and 2013 CO_2 allowances will not be re-offered.
- Regulated entities will be required to hold allowances equal to at least 50 percent of their emissions in each of the first two years of the three-year compliance period, in addition to demonstrating full compliance at the end of each three-year compliance period[30].

A continuing uncertainty is how RGGI will relate to new standards for carbon emissions set by the U.S. Environmental Protection Agency (EPA). See next section. So far, the lack of a national cap-and-trade bill has isolated RGGI; on the other hand, it's possible that RGGI could be taken as a model for a national bill. Due to these and other uncertainties, RGGI's impacts to Connecticut's electric loads and resources cannot yet be quantified for 2013-2022.

Carbon Dioxide Pollution Standard for New Power Plants

On September 20, 2013, the U.S. Environmental Protection Agency (EPA) proposed Clean Air Act Standards to cut carbon pollution from new power plants in order to combat climate change and improve public health. Under this proposal, new large natural gas-fired turbines would need to meet a limit of 1,000 pounds of CO_2 per megawatt-hour, while new small natural gas-fired turbines would need to meet a limit of 1,100 pounds of CO_2 per megawatt-hour. New coal-fired units would need to meet a limit of 1,100 pounds of CO_2 per megawatt-hour and would have the option to meet a somewhat tighter limit if they choose to average emissions over multiple years, giving those units additional operational flexibility.

The proposed standards would ensure that the power plants of the future are built with clean technologies already available in the power industry, such as efficient natural gas, advanced coal technology, nuclear power, wind and solar. Some of the standards provide flexibility by allowing plants to phase in such technologies. EPA has sought comments on its proposed standards, will hold a public hearing, and will take the input into account as it completes the rulemaking process.

In accordance with the June 25, 2013 Presidential Memorandum[31], EPA will issue final standards for existing power plants by June 1, 2014. It is too soon to tell how Connecticut's existing and future generation fleet would be affected.

TRANSMISSION SYSTEM

Transmission is often referred to as the "backbone" of the electric system, since it efficiently transports large amounts of electricity over long distances by using high voltage. High voltages are efficient because the laws of physics dictate that the greater the voltage, the greater the amount of electricity the lines can carry, and the smaller the amount of electric energy wasted from the lines as heat.

In Connecticut, electric lines with a line voltage of 69 kilovolts (kV) or more are considered transmission lines. The highest transmission line voltage in Connecticut is 345-kV.

Distribution lines are those below 69-kV. They are the lines that come down our streets to connect (via a transformer) with even lower-voltage lines supplying each residence or business.

Large generating units are typically connected to the 345-kV transmission system because of its high capacity[32]. Older, smaller units are connected to the 115-kV system.

Substations and Switching Stations

A substation is a grouping of electrical equipment that includes switches, circuit breakers, buses, transformers and controls for switching power circuits and transforming electricity from one voltage to another. One common type of substation connects the transmission system to the distribution system. For example, the input might be 115-kV transmission and the output might be 13.8-kV distribution. Another type of substation connects a generator to the grid. Since a generator's output voltage is much less than the transmission voltage, it has to be raised before the power generated can be fed into the grid. Lastly, some substations, called switching stations, simply interconnect transmission lines to others at the same voltage.

As depicted in Appendix C, as many as five new substations are planned for the next six years to address high load areas within the State. Other new substations and/or upgrades to existing substations are also being considered, with the estimated in-service dates to be determined.

Predicting the pace and location of substation development is difficult. Even if predicted load growth overall is low, growth in certain geographical areas can exceed predicted levels due to unplanned population shifts and consequent economic development.

Interstate Connections and Imports

Connections with other systems outside the State are critical to overall reliability and economic efficiency. There are 11 such AC connections or ties: one at 69-kV; one at 138-kV (the underwater set of cables from Norwalk to Long Island); six at 115-kV; and three at 345-kV. In addition, the Cross Sound Cable, a DC tie between New Haven and Long Island, is at 150-kV.

Of these interstate connections, the most prominent are a 345-kV tie with National Grid in Rhode Island; a 345-kV tie with Central Hudson in New York state; and five ties (one 345-kV and four 115-kV) with the Western Massachusetts Electric Company (WMECO).

New England East –West Solution (NEEWS)

In approximately 2004, a working group consisting of National Grid – a utility company that provides service in various parts of New England outside of Connecticut – Northeast Utilities Service Company, and ISO-NE began planning a major tri-state transmission upgrade to improve electricity transfers between Connecticut, Massachusetts, and Rhode Island. Known as NEEWS, the large-scale upgrade is comprised of four separate projects, described below.

The Interstate Reliability Project is the most comprehensive. It consists of a new 345-kV transmission line to tie National Grid's Millbury Substation in central Massachusetts with CL&P's Card Street Substation in Lebanon, thus connecting electric service more efficiently from Massachusetts to eastern Connecticut, via the location of an existing transfer point with Rhode Island. When combined with the three other projects within NEEWS, this one increases the east-west power transfer capability across New England in general and may allow Lake Road to count towards Connecticut's generation capacity. This Connecticut portion of the project was approved by the Council on December 27, 2012.

The Greater Springfield Reliability Project improves connections between Connecticut and Massachusetts to address particular problems in the Springfield, Massachusetts area. New 345-kV facilities were built to tie WMECO's Ludlow Substation with its Agawam Substation and also to connect Agawam Substation with CL&P's North Bloomfield Substation in Bloomfield. This portion of the project has been built and is in the restoration phase. Also, the 345-kV connections from Manchester Substation to the south to Meekville Junction to the north have been improved. This portion of the project is complete.

The Central Connecticut Reliability Project is intended to increase the reliability of power transfers from eastern Connecticut to western and southwestern Connecticut. A new 345-kV transmission line would connect the North Bloomfield Substation in Bloomfield and the Frost Bridge Substation in Watertown. Associated upgrades to the 115-kV facilities in the area would also be necessary. This project is still under review by the utilities and ISO-NE. To date, no application has been received by the Council.

The Rhode Island Reliability Project principally would affect Rhode Island. New 115-kV and 345-kV facilities would be built to improve Rhode Island's access to the regional 345-kV grid and decrease its dependence on local generation. National Grid would construct the facilities. This transmission project is complete.

Overall, the aggregate of the southern New England transmission reinforcements provided by NEEWS is expected to increase Connecticut's import capacity significantly. See also earlier section on "Import Capacity."

Transmission associated with Renewable Portfolio Standards (RPS)

The requirements that certain percentages of electrical energy for Connecticut come from Class I, Class II, and Class III renewable resources increase annually during the forecast period. See Table 6 below.

Table 6: Connecticut Renewable Portfolio Standards

Year	Percent Class I	Addt'l Percent Class II or Class I	Percent Class III	Total
2005	1.5	3.0		4.5
2006	2.0	3.0		5.0
2007	3.5	3.0	1.0	7.5
2008	5.0	3.0	2.0	10.0
2009	6.0	3.0	3.0	12.0
2010	7.0	3.0	4.0	14.0
2011	8.0	3.0	4.0	15.0
2012	9.0	3.0	4.0	16.0
2013	10.0	3.0	4.0	17.0
2014	11.0	3.0	4.0	18.0
2015	12.5	3.0	4.0	19.5
2016	14.0	3.0	4.0	21.0
2017	15.5	3.0	4.0	22.5
2018	17.0	3.0	4.0	24.0
2019	19.5	3.0	4.0	26.5
2020	20.0	3.0	4.0	27.0
Source: PURA Website: http://www.ct.gov/pura/cwp/view.asp?a=3354&q=415186				

To achieve these targets, Connecticut will have to utilize imports as well as in-state generation. Six substantial merchant transmission projects have been proposed in the last several years that would bring electricity into southern New England or New York generated by renewable sources farther north. Most of these are planned to run partly or wholly along waterways: routes through Lake Champlain and the Hudson River, the upper reaches of the Connecticut River, or the Atlantic. None of them would come directly to Connecticut. One currently under review is the Northern Pass Project, to be discussed in the next section.

The Northern Pass Project

The Northern Pass is a $1.4B transmission project that would bring 1,200 MW of clean, low-cost energy from Hydro-Québec's hydroelectric plants in Québec, Canada to New Hampshire and the rest of New England. A new direct current (DC) transmission line from the Canadian border to Franklin, New Hampshire is planned. A converter terminal in Franklin would convert the DC power to alternating current (AC) power for use in the New England power grid. Northern Pass Transmission LLC announced its updated, preferred route on June 27, 2013 and on July 1, 2013, filed an amended application with DOE for a Presidential Permit to authorize the construction, connection, operation, and maintenance of facilities for the transmission of electricity at an international border.

Electric Transmission in Southwest Connecticut

Bethel-Norwalk Project and Middletown-Norwalk Project – Dockets 217 and 272

Lying close to New York and along the coast of Long Island Sound, Southwest Connecticut (SWCT) is the most densely-populated part of the State. Well before the turn of the century, it became evident that the 115-kV lines serving SWCT were reaching the limit of their ability to support the area's current and projected loads reliably and economically. ISO-NE, CL&P, and UI devised a large-scale, long-term plan to supplement the existing 115-kV transmission lines with a new 345-kV "loop" though SWCT that would integrate the area better with the 345-kV system in the rest of the State and New England, and provide electricity more efficiently. Council Docket No. 5 was the first phase of this "macro" upgrade: approved in 1975, it connected New Milford and Danbury.

The second phase of the upgrade plan involved the construction of a 345-kV transmission line from Plumtree Substation in Bethel to the Norwalk Substation in Norwalk. This was the subject of Council Docket No. 217, approved by the Council on July 14, 2003. The line was activated in October 2006.

The third phase of the upgrade plan, by far the largest, completed the loop with a 345-kV transmission line from Middletown to Norwalk Substation. This was Docket No. 272. It was approved by the Council on April 7, 2005. Construction began in 2006. The project went into service in late 2008.

Glenbrook-Norwalk Cable Project – Docket 292

Due to significant economic and population growth in the Norwalk-Stamford area, CL&P proposed to address the associated increase in electric demand with the construction of two 115-kV cables in southwestern Fairfield County. The Council reviewed and approved the plans to construct two new 115-kV underground transmission cables between the Norwalk Substation in Norwalk and the Glenbrook Substation in Stamford. This project was designed to bring the reliability benefits of the new 345-kV transmission loop to the large load center in Stamford. It is currently in service.

While the Bethel-Norwalk, Middletown-Norwalk, and Glenbrook-Norwalk projects relieved transmission congestion in SWCT for the near term, as part of prudent planning, ISO-NE is continually reviewing the New England grid to determine future needs.

Stamford Reliability Cable Project - Docket 435

On January 18, 2013, CL&P submitted an application to the Council, Docket No. 435, for a new 115-kV underground transmission circuit to extend approximately 1.5 miles between CL&P's Glenbrook and South End Substations in Stamford, and for related improvements at both substations. This project is designed to eliminate reliability criteria violations by relieving power flows, and strengthen the 115-kV transmission system serving the Stamford-Greenwich Sub-area, thus ensuring compliance with mandatory national and regional reliability standards. This project would also provide the Stamford-Greenwich Sub-area with a strong electrical connection to the new 345-kV transmission loop through SWCT that was linked to Glenbrook Substation when the Glenbrook-Norwalk Project was completed. See sections on Dockets 217 and 272, 292 above. Finally, the project advances a long-range plan for expanding Connecticut's power grid. Docket 435 was approved by the Council on September 5, 2013.

New Transmission Technologies

Materials and Construction

Within the electric system overall, transmission has been the component slowest to change. In Connecticut, a few innovations have been made, as reported in earlier forecast reviews. Helicopters have been used to install overhead conductors; transmission towers fabricated with new materials are being installed; conductors designed with special-purpose metals and ceramics are being tested elsewhere and could be applied at certain sites in Connecticut; new techniques have been employed for laying cables underground.

Storage

Storage is a hybrid in the electricity sector. Because it can sometimes act as a type of generation (pumped hydro, for instance), and is potentially much cheaper than generation, it is attracting a great deal of basic and engineering research. Building-sized battery "farms" have been developed; storage systems have been devised using cheap electricity at night to make ice that supplies cooling during the day; flywheels have been engineered that take excess electricity from the grid and return it super-efficiently to balance load; compressed-air storage is quite common: the list goes on. Particularly of interest to Connecticut is the form of storage that uses off-peak electricity to charge electric vehicles (EVs): the entire collection of EVs, in this concept, can function as a distributed storage unit. Connecticut is one of the few states to have inaugurated an EV charging station, since CL&P has committed to supporting EVs. See section on Electric Vehicles. Technically, storage is not a transmission technology, but it can be employed in a transmission system to balance electric loads more flexibly and cheaply than conventional methods.

Smart Grid

The technological advances most needed are ones that would improve the working of the grid as a whole. In particular, sweeping improvements are needed in the electronics that control the grid, since, as one expert says "[Today's] switches…operate at a speed that is the equivalent of being 10 days late, relative to the speed of light."[33] A major innovation in control electronics is at hand that will likely change the organization of transmission, even its operating characteristics: this innovation is known as the "Smart Grid."

The Smart Grid is a suite of bundled electronic technologies, some currently available, others only speculative. Many of them apply to electricity distribution, but transmission is importantly involved in the Smart Grid too. Although the Smart Grid can be defined in many different ways, a useful definition here comes from the Energy Security and Independence Act of 2007 (EISA), as reported by ISO-NE: "The goal is to use advanced, information-based technologies to increase power grid efficiency, reliability, and flexibility, and reduce the rate at which electric utility infrastructure needs to be built."[34]

Having anticipated the evolution of the Smart Grid, Connecticut utilities have already taken some steps to implement it. For instance, UI has installed four phasor measurement units (PMUs) in its service area, and CL&P has installed 13. PMUs are extremely precise devices for monitoring power fluctuations on the grid; by providing early detection and warnings of anomalous events, they can help prevent the spread of local outages to neighboring regions. In addition, CL&P has installed digital fault recorders to identify data that can be used to determine what happened during a disturbance in the system.

The driver of the Smart Grid at its inception was reliability; the driver currently is efficiency; the driver going forward will be flexibility—that is, the need to integrate renewable resources, and storage. Given the scale of the Smart Grid effort—thousands of billions of dollars over decades—it is difficult to predict how much of an effect it will have on any Connecticut transmission projects during 2013-2022.

Climate Change Effects on Electric Infrastructure and Mitigation Plans

In accordance with provisions of Public Act 04-252 (AAC Climate Change) the State has taken on various initiatives to study and prepare plans for responding to climate change. At this time, the Council directs the utilities to consult the *Connecticut Climate Preparedness Plan 2011* for adaptation strategies for agricultural, infrastructure (i.e. electric and communications), natural resources and public health climate change vulnerabilities.[35]

The recent increase in storm activity and severity makes flooding a major concern for low-lying substation facilities, given the presence of live electrical equipment. In the event of severe flooding, it may be necessary to shut down and de-energize a substation to protect personnel and equipment, causing an outage for all customers within the substation area. To avoid storm-related outages, the Connecticut utilities have been taking proactive steps to protect their substation facilities.

Specifically, UI has put together an interim plan to ensure that if a storm surge occurred comparable to that of Storm Sandy or even three feet higher, UI would be able to get through the storm without having to de-energize their substations. Six or seven of UI's substations would be part of this plan, three of which had flooding issues during Storm Sandy. UI is also evaluating the longer-term solutions such as raising equipment at substations and even relocating substations.

CL&P did not experience substation flooding during the recent storms. However, one substation – the South End Substation in Stamford – is vulnerable to flooding in future storms. CL&P has taken active measures to mitigate flooding risk at this substation.

The flooding potential for any given location is mapped by the US Geological Service (USGS) and the Federal Emergency Management Agency (FEMA) using two standard flood elevations: the 100-year and the 500-year flood. The 100-year flood elevation, on average, has a one percent chance of being reached or exceeded by a flood in a given year. The 500-year flood elevation, on average, has a 0.2 percent chance of being reached or exceeded in a given year. Whether to design or upgrade a substation to the 100-year or 500-year flood elevation is a judgment call based on the cost and complexity of the upgrades versus the risk. Nevertheless, during its evaluation of new substation applications as well as petitions to modify existing substations the Council has been proactively reviewing flood elevations.

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 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 completed its 2012 review of life-cycle costs of electric transmission lines[36].

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 the 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 sea-change in energy resource planning and policy-making when it merged the Departments of Environmental Protection and Public Utility Control. Various other energy planning groups were also drawn under the DEEP's umbrella, principally the CEAB. In addition, the executive-legislative liaison regarding energy planning was re-designed, involving new DEEP personnel. Perhaps most importantly, the Governor appointed as Commissioner of DEEP—Dan Esty— a person with extensive credentials at the intersection of environmental policy and energy resource planning.

The sweeping changes made by PA 11-80 were necessary because, prior to deregulation, energy resource planning had principally been done by the regulated utilities companies themselves, overseen by the Department of Public Utility Control; after de-regulation, 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)

Through a series of energy bills leading up to PA 11-80, the legislature struggled to make the process of energy planning more rational, and in 2007 gave back to the utility companies the job of drafting an annual Integrated Resource Plan (IRP) first due in 2008, which they duly performed for three years. PA 11-80, however, reclaimed that task for the State once more, assigning it to the newly-formed DEEP.

Currently, an IRP is required in every even-number year. It provides an in-depth assessment of the State's energy and capacity resources. Through an analysis of electric supply and demand, which is informed annually by the Council's forecast report, the IRP outlines a plan for securing resources to meet the State's energy needs in a way that will minimize cost and maximize benefits consistent with the State's environmental goals and standards.

On June 14, 2012, DEEP issued the *2012 Integrated Resource Plan for Connecticut* (2012 IRP).[37] In the "Forecast for Future Electricity Supply and Demand" section, the 2012 IRP found the following:

- Connecticut's electricity consumption declined sharply during the economic recession and is not expected to exceed 2005 levels until 2022.
- Adequate generating resources will likely be available in Connecticut to serve electricity loads reliably through 2022.
- The deliverability of natural gas fuel to electric generators requires monitoring to assure the reliability of electricity supply.
- Connecticut is beginning to experience lower Generation Service Charges and can expect the downward trend to continue over the next five years.
- Between 2017 and 2022, Generation Service Charges are projected to rise by more than three cents per kilowatt-hour in real terms.
- Air pollution in Connecticut has decreased, as low-cost natural gas-fired generation is displacing coal and oil-fired generation.
- A gap between projected available renewable generation and demand mandated by the Connecticut's and other New England states' renewable generation targets is expected to emerge in 2018.

Comprehensive Energy Strategy (CES)

Section 51 of PA 11-80 requires that DEEP, in consultation with the CEAB, prepare a CES every three years beginning in 2012. In accordance with the legislation, on February 19, 2013, DEEP issued the final version of its first CES.[38]

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 and to provide the foundation for better energy choices at every level. It covers all fuels in all sections, with a planning horizon out to 2050. It offers analysis of the State's current energy circumstances and a set of recommendations designed to advance the Governor's agenda of moving Connecticut toward a cheaper, cleaner, and more reliable energy future. Specifically, the CES offers recommendations in five major priority areas: energy efficiency, industrial energy needs, electricity supply (including renewable power), natural gas, and transportation. Of these, the most directly applicable to the Council's work are energy efficiency and electric supply.

Energy efficiency is established by the CES as Connecticut's top policy priority. Fifteen recommendations aim to provide funding for a large range of energy efficiency projects at all levels—state, regional, municipal, and residential—and to ensure building codes or standards foster energy efficiency.

Thirteen recommendations concern energy supply. Many of these overlap with the ones on energy efficiency. Others support strengthening the regional CO_2 cap called for by the RGGI program, emphasize in-state renewable resources with incentives to drive down their costs, and aim to increase electric reliability under emergency conditions through microgrids and other protections called for by the Two Storm Panel.

In general, these two sections of the CES recommendations would continue driving down the capacity needs, consumption and cost of electricity. In terms of siting, the recommendations imply that the Council will likely see applications increasing for smaller, more diversified generation projects using renewable fuels, as well as smaller, more innovative transmission projects emphasizing reliability.

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, the electric generation supply during 2013-2022 will be adequate to meet demand. While possible plant retirements could decrease generation, the NEEWS transmission projects would offset generation losses by increasing import capacity. Any deficits prior to the significant Interstate Reliability Project import upgrade and inclusion of Lake Road in Connecticut could be made up fairly easily by activating the full range of available generation, maximizing the use of active demand response resources, and devising other such operational strategies.

Connecticut's largest recent gain in generating capacity is associated with the new 620 MW Kleen Energy power plant in Middletown.

The Council calls attention to the significant improvements to our transmission system that are complete and/or underway. Several transmission projects in SWCT are up and running. One NEEWS project has been reviewed and approved by the Council and is nearing the completion of construction; another NEEWS project is currently approved by the Council and in the Development and Management Plan review phase. A third NEEWS application is being prepared but has not yet been received. Also, a transmission project to further improve reliability in the Stamford area was recently approved by the Council.

C&LM and DG (including LREC/ZREC) are projected to eliminate Connecticut's increases in energy consumption and reduce the increase in load growth during the forecast period. Specifically, with these measures, annual energy consumption is expected to <u>decrease</u> at a CAGR of 0.35 percent per year. Without such measures, annual energy consumption in Connecticut would <u>increase</u> at a CAGR of 0.91 percent per year. Such measures also reduce the rate of load growth from a CAGR of 1.24 percent to 0.40 percent per year.

Finally, the Council reviewed the accuracy of past forecasting. Specifically, the 2003 utilities' load forecast was compared to the weather-normalized historical data. The utilities' forecasts were, on (weighted) average, accurate to plus or minus 3.15 percent, which is remarkable.

The Council makes the following further observations based on the information presented in this 2013-2022 review.

- Fuel diversity, which is key to Connecticut's policy of energy independence, has been decreasing at the level of power production within the Council's jurisdiction. At the level of DG, however, largely outside the Council's jurisdiction, fuel diversity is markedly increasing.

- Smart Grid improvements offer the potential for significant innovation in transmission, particularly with regard to integrating renewables and storage.

- The deactivation/retirement of older generating facilities is foreseeable during this forecast period, and replacing/repowering these facilities offers opportunities for innovation.

End Notes

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

2. It is anticipated that Wallingford Public Utilities would separate from CMEEC and become its own independent municipal utility in 2014.

3. According to the U.S. Department of Energy, roughly 83 percent of Connecticut homes heat with fossil fuels such as heating oil or natural gas or propane. See http://apps1.eere.energy.gov/states/residential.cfm/state=CT.

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

5. A very small amount of CMEEC 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 1 MW and thus considered negligible relative to the Connecticut load.

6. During the June 12, 2012 hearing, ISO-NE testified that it does not weather-normalize peak data. Thus, the Council is unable to include the ISO-NE 50/50 forecast in this comparison at this time.

7. Plus or minus 5 percent is generally considered a reasonable tolerance for most (rough or preliminary) engineering calculations.

8. For example, a 23-Watt compact fluorescent light bulb consumes electricity at a rate of 23 Watts. If the bulb were on for ten hours, the total energy consumed would be 230 Watt-hours, or 0.23 kWh. A much larger load, for example, a 1,500 Watt electric heater, would only have to run for approximately 9.2 minutes (0.15 hours) to consume 0.23 kWh of energy.

9. For larger accounts, meters also record the instantaneous load or demand.

10. http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3

11. The only emissions are those associated with generating the electricity.

12. Natural gas conservation measures are outside the scope of this report.

13. To put this into perspective, it takes about 8.34 BTUs of heat energy to warm one gallon of water by one degree F.

14. See the PURA Decision in Docket No. 11-12-06. http://www.dpuc.state.ct.us/FINALDEC.NSF/2b40c6ef76b67c438525644800692943/1b95b48c34af2ee285257a3a000bca13?OpenDocument

15. 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.

16. http://ctcleanenergy.com/default.aspx?tabid=97

17. While some of these projects have in-service dates estimated at 2013, the actual in-service dates may be later due to possible extensions of time.

18. http://www.ct.gov/csc/cwp/view.asp?a=2397&q=468692

19. http://www.ct.gov/csc/cwp/view.asp?a=2397&q=469520

20. http://www.ct.gov/csc/cwp/view.asp?a=2397&q=469902

21. http://www.ct.gov/csc/cwp/view.asp?a=2397&q=513338

22. http://www.ct.gov/csc/lib/csc/pendingproceeds/petition_1056/1056decisionpackage.pdf

23. http://www.eia.gov/todayinenergy/detail.cfm?id=2930

24. While the Lake Road power plant does provide electricity to Connecticut under normal operating conditions, it is not considered a Connecticut resource by ISO-NE due to the existing transmission configuration. This is expected to change when the Interstate Reliability Project is constructed. See section titled, "Demand/Supply Balance."

25. This takes into account only passive (non-dispatched) demand reductions such as energy efficiency, to be conservative.

26. This is based on a one-in-ten-years event and assumes conservative import capacity, no load response, and no newly-approved DG.

27. Such retirements are hypothetical based on certain conditions and are difficult to predict with certainty at this time.

28. RGGI Fact Sheet updated 9/28/2012. http://www.rggi.org/docs/Documents/RGGI_Fact_Sheet_2012_09_28.pdf

29. The Connecticut Mirror article "Overhaul is near for Regional Greenhouse Gas Initiative" by Jan Ellen Spiegel and dated December 11, 2012. http://ctmirror.com/story/18431/overhaul-ner-regional-greenhouse-gas-initiative

30. RGGI press release dated September 6, 2013

31. http://www.whitehouse.gov/the-press-office/2013/06/25/presidential-memorandum-power-sector-carbon-pollution-standards

32. Since power is directly proportional to voltage, all else being equal, a 345-kV line can carry three times as much power as a 115-kV line. A typical 345-kV line has two conductors per phase, whereas a typical 115-kV line has one, thus turning the three times power-carrying advantage of a 345-kV line to six times.

33. David Wagman, Power Engineering (March 2011, p. 4).

34. ISO-NE, "Overview of the Smart Grid—Policies, Initiatives, and Needs" (February 17, 2009), p. 1

35. http://www.ct.gov/deep/lib/deep/climatechange/connecticut_climate_preparedness_plan_2011.pdf

36. http://www.ct.gov/csc/cwp/view.asp?a=895&q=246816.

37. See the 2012 Integrated Resource Plan. http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/cb827b1ffa58b2fd85257a1d0060c374?OpenDocument

38. See the 2013 Comprehensive Energy Strategy for Connecticut. http://www.ct.gov/deep/lib/deep/energy/cep/2013_ces_final.pdf

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).

CEAB (Connecticut Energy Advisory Board): The CEAB is a 15-member body responsible for coordinating State energy planning, representing the State in regional energy planning, participating in the Council's annual load forecast proceeding, and reviewing the procurement plans submitted by electric distribution companies.

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: "(A) energy derived from solar power, wind power, a fuel cell, methane gas from landfills, ocean thermal power, wave or tidal power, low emission advanced renewable energy conversion technologies, 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 river flow, and began operation after the effective date of this section, or a biomass facility, including, but not limited to, a biomass gasification plant that utilizes land clearing debris, tree stumps or other biomass that regenerates or the use of which will not result in a depletion of resources, provided such biomass is cultivated and harvested in a sustainable manner and the average emission rate for such facility is 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, provided such biomass is cultivated and harvested in a sustainable manner, or (B) any electrical generation, including distributed generation, generated from a Class I renewable energy source." (Conn. Gen. Stat. § 16-1(a)(26))

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 the effective date of this section." (Conn. Gen. Stat. § 16-1(a)(27))

Class III renewable energy source: "The electricity output from combined heat and power systems with an operating efficiency level of no less than fifty percent 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." (Conn. Gen. Stat. § 16-1(a)(44))

CL&P (The Connecticut Light and Power Company): CL&P is the largest transmission/distribution company in Connecticut.

CMEEC (The Connecticut Municipal Electric Energy Cooperative): An "umbrella" group comprised of all of the municipal electric utilities in Connecticut. It manages coordinated generation and transmission/distribution services on their behalf.

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)(40))

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.

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)(43))

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.

LREC (Low Emissions Renewable Energy Credit): A Class I Renewable Energy Certificate from a low-emissions project as defined in Section 110 of Public Act 11-80. LREC-qualified projects are Connecticut generation projects that are located behind company customer meters, achieve commercial operation on or after July 1, 2011, and have emissions of no more than 0.07 pounds per megawatt-hour (MWh) of nitrogen oxides, 0.10 pounds per MWh of carbon monoxide, 0.02 pounds per MWh of volatile organic compounds, and one grain per 100 standard cubic feet. To qualify for the LREC/ZREC Program, LREC projects may not be larger than 2,000 kilowatts (kW).

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.

Wire: See Conductor.

ZREC (Zero Emissions Renewable Energy Credit): A Class I Renewable Energy Certificate from a zero emissions project as defined in Section 107 of Public Act 11-80. ZREC-qualified projects are Connecticut generation projects that are located behind company customer meters, achieve commercial operation on or after July 1, 2011, and emit no pollutants. To qualify for the LREC/ZREC Program, ZREC projects may not be larger than 1,000 kW.

Appendix A
Existing Electric Generation Facilities
as of December 2013

Facility	Owner	Town	Fuel	Summer Rating	Winter Rating	In-Service Date
Aetna Capitol District (CDECCA)	Capitol District Energy Ctr.	Hartford	Gas	55.25	61.33	11/1/1988
Bantam #1	FirstLight Hydro Generating Co.	Litchfield	Hydro (Run of River)	0.07	0.13	1/1/1905
Branford #10	NRG	Branford	Oil (Jet Fuel)	15.84	20.95	1/1/1969
Bridgeport Energy	Bridgeport Energy LLC	Bridgeport	Gas	451.26	530.51	8/1/1998
Bridgeport Harbor #2	PSEG Power, LLC	Bridgeport	Oil	0.00	0.00	8/1/1961
Bridgeport Harbor #3	PSEG Power, LLC	Bridgeport	Coal/Oil	383.43	384.98	8/1/1968
Bridgeport Harbor #4	PSEG Power, LLC	Bridgeport	Oil (Jet Fuel)	17.02	21.92	10/1/1967
Bridgeport (Wheelabrator)	CRRA	Bridgeport	Wood/Refuse	58.87	59.42	4/1/1988
Bristol Refuse	Ogden Martin Systems-CT	Bristol	Refuse	12.37	12.77	5/1/1988
Bulls Bridge #1- #6	FirstLight Hydro Generating Co.	New Milford	Hydro (Pondage)	3.23	5.00	1/1/1903
Colebrook	MDC	Colebrook	Hydro (Pondage)	0.76	0.58	3/1/1988
Cos Cob #10	NRG	Greenwich	Oil (Jet Fuel)	18.93	23.00	9/1/1969
Cos Cob #11	NRG	Greenwich	Oil (Jet Fuel)	18.72	23.00	1/1/1969
Cos Cob #12	NRG	Greenwich	Oil (Jet Fuel)	19.08	23.00	1/1/1969
Cos Cob #13	NRG	Greenwich	Oil (Jet Fuel)	19.05	22.85	5/29/2008
Cos Cob #14	NRG	Greenwich	Oil (Jet Fuel)	19.21	22.60	5/29/2008
Dayville Pond	Summit Hydro Power	Killingly	Hydro (Run of River)	0.00	0.06	3/1/1995
Derby Dam	McCallum Enterprises	Shelton	Hydro (Run of River)	7.05	7.05	3/1/1989
Devon #10	NRG	Milford	Oil (Jet Fuel)	14.41	19.19	4/1/1988
Devon #11	NRG	Milford	Gas	29.30	38.82	10/1/1996
Devon #12	NRG	Milford	Gas	29.23	38.44	10/1/1996
Devon #13	NRG	Milford	Gas	29.97	38.97	10/1/1996
Devon #14	NRG	Milford	Gas	29.70	40.27	10/1/1996
Devon #15	NRG	Milford	Gas/Oil	46.89	49.19	7/12/2010
Devon #16	NRG	Milford	Gas/Oil	46.90	49.20	6/28/2010
Devon #17	NRG	Milford	Gas/Oil	46.90	49.20	6/15/2010
Devon #18	NRG	Milford	Gas/Oil	46.90	49.20	6/9/2010
Dexter #1- #2	Alstom	Windsor Locks	Gas	42.27	43.20	5/1/1990
East Windsor NORCAP LFG	East Windsor NORCAP	East Windsor	Landfill Gas (Methane)	0.78	0.97	5/7/2007
Exeter	Oxford Energy, Inc.	Sterling	Refuse (Tires)	20.98	19.84	12/1/1991
Falls Village	FirstLight Hydro Generating Co.	Canaan	Hydro (Pondage)	2.38	5.00	1/1/1914
Franklin Drive #10	NRG	Torrington	Oil (Jet Fuel)	15.42	20.53	11/1/1968
Goodwin Dam	MDC	Hartland	Hydro (Run of River)	3.00	3.00	2/1/1986
Hartford Landfill	CRRA	Hartford	Landfill Gas (Methane)	1.25	1.35	8/1/1998
John Street #3	CMEEC	Wallingford	Oil (Diesel)	0.00	2.00	9/26/2007
John Street #4	CMEEC	Wallingford	Oil (Diesel)	0.00	2.00	9/26/2007

Appendix A
Existing Electric Generation Facilities
as of December 2013

Facility	Owner	Town	Fuel	Summer Rating	Winter Rating	In-Service Date
John Street #5	CMEEC	Wallingford	Oil (Diesel)	0.00	2.00	11/1/2007
Kleen Energy	Kleen Energy	Middletown	Gas/Oil	620.00	620.00	7/12/2011
Kimb Rocky River	Kimberly Clark Corporation	New Milford	Gas	13.02	14.44	7/15/2008
Kinneytown A	Kinneytown Hydro Co.	Ansonia	Hydro (Run of River)	0.00	0.00	3/1/1988
Kinneytown B	Kinneytown Hydro Co.	Seymour	Hydro (Run of River)	0.00	0.73	11/1/1986
Lake Road #1	Lake Road Generating Co., L.P.	Killingly	Gas/Oil	245.79	281.42	3/15/2002
Lake Road #2	Lake Road Generating Co., L.P.	Killingly	Gas/Oil	251.21	286.84	3/15/2002
Lake Road #3	Lake Road Generating Co., L.P.	Killingly	Gas/Oil	260.31	289.08	5/22/2002
Lisbon Resource Recovery	Riley Energy Systems	Lisbon	Wood/Refuse	13.52	13.45	1/1/1996
Mechanicsville	Saywatt Hydro Associates	Thompson	Hydro (Run of River)	0.03	0.11	9/1/1995
Middletown #2	NRG	Middletown	Oil/Gas	117.00	120.00	1/1/1958
Middletown #3	NRG	Middletown	Oil/Gas	233.68	244.40	1/1/1964
Middletown #4	NRG	Middletown	Oil	399.92	402.00	6/1/1973
Middletown #10	NRG	Middletown	Oil (Jet Fuel)	15.52	20.02	1/1/1966
Middletown #12	NRG	Middletown	Gas	46.90	49.20	6/24/2011
Middletown #13	NRG	Middletown	Gas	46.90	49.20	6/23/2011
Middletown #14	NRG	Middletown	Gas	46.90	49.20	6/1/2011
Middletown #15	NRG	Middletown	Gas	46.90	49.20	6/1/2011
Milford Power #1	Milford Power Company, LLC	Milford	Gas/Oil	253.61	281.85	2/12/2004
Milford Power #2	Milford Power Company, LLC	Milford	Gas/Oil	253.09	287.63	5/3/2004
Millstone #2	Dominion Nuclear CT, Inc.	Waterford	Nuclear	872.26	875.91	12/1/1975
Millstone #3	Dominion Nuclear CT, Inc.	Waterford	Nuclear	1225.00	1235.00	4/1/1986
Montville #5	NRG	Montville	Oil/Gas	81.00	81.59	1/1/1954
Montville #6	NRG	Montville	Oil	405.05	408.85	7/1/1971
Montville #10 & #11	NRG	Montville	Oil (Diesel)	5.30	5.35	1/1/1967
New Haven Harbor #1	PSEG Power, LLC	New Haven	Oil/Gas	447.89	453.38	8/1/1975
New Haven Harbor #2	PSEG New Haven, LLC	New Haven	Gas/Oil	43.20	48.60	5/30/2012
New Haven Harbor #3	PSEG New Haven, LLC	New Haven	Gas/Oil	43.20	48.60	5/30/2012
New Haven Harbor #4	PSEG New Haven, LLC	New Haven	Gas/Oil	43.20	48.60	5/30/2012
New Milford Landfill	Vermont Electric Power Co.	New Milford	Landfill Gas (Methane)	1.30	1.40	8/1/1991
Norden #1	CMEEC	East Norwalk	Oil	1.79	1.96	2/26/2009
Norden #2	CMEEC	East Norwalk	Oil	1.95	1.95	2/26/2009
Norden #3	CMEEC	East Norwalk	Oil	1.94	1.94	2/26/2009
Norwalk Harbor #1	NRG	Norwalk	Oil	0.00	164.00	1/1/1960
Norwalk Harbor #2	NRG	Norwalk	Oil	0.00	172.00	1/1/1963
Norwalk Harbor #10 (3)	NRG	Norwalk	Oil (Diesel)	0.00	17.06	10/1/1996
Norwich 10th St.	CMEEC	Norwich	Hydro	0.00	0.00	1/1/1966

Appendix A
Existing Electric Generation Facilities
as of December 2013

Facility	Owner	Town	Fuel	Summer Rating	Winter Rating	In-Service Date
Norwich Jet	CMEEC	Norwich	Oil	15.26	18.80	9/1/1972
Norwich Wasterwater Treatment	CMEEC	Norwich	Oil (Diesel)	2.00	2.00	5/29/2008
Pierce	CMEEC	Wallingford	Gas/Oil	74.09	94.59	10/1/2007
Pinchbeck	William Pinchbeck, Inc.	Guilford	Wood/Refuse	0.00	0.00	7/1/1987
Wallingford Unit #1	PPL EnergyPlus, LLC	Wallingford	Gas	43.47	49.18	12/31/2001
Wallingford Unit #2	PPL EnergyPlus, LLC	Wallingford	Gas	43.02	50.00	2/7/2002
Wallingford Unit #3	PPL EnergyPlus, LLC	Wallingford	Gas	43.03	47.93	12/31/2001
Wallingford Unit #4	PPL EnergyPlus, LLC	Wallingford	Gas	42.01	46.90	1/23/2002
Wallingford Unit #5	PPL EnergyPlus, LLC	Wallingford	Gas	44.43	50.00	2/7/2002
Preston RRF	SCRRF	Preston	Wood/Refuse	15.81	16.05	1/1/1992
Putnam	Putnam Hydropower, Inc.	Putnam	Hydro (Run of River)	0.19	0.38	10/1/1987
Quinebaug	Quinebaug Associates LLC	Killingly	Hydro (Run of River)	0.33	0.93	9/1/1990
Rainbow Dam #1- #2	Farmington River Power Co.	Windsor	Hydro (Run of River)	8.20	8.20	1/1/1980
Robertsville #1- #2	FirstLight Hydro Generating Co.	Colebrook	Hydro (Run of River)	0.00	0.00	1/1/1924
Rocky River	FirstLight Hydro Generating Co.	New Milford	Hydro (Pump Storage)	28.85	28.38	1/1/1928
Sandy Hook Hydro	Rocky Glen Hydro LP	Newtown	Hydro (Run of River)	0.00	0.07	4/1/1989
Scotland #1	FirstLight Hydro Generating Co.	Windham	Hydro (Run of River)	0.00	0.24	1/1/1937
Shepaug #1	FirstLight Hydro Generating Co.	Southbury	Hydro (Reservoir)	41.51	42.56	1/1/1955
South Meadow #5	CRRA	Hartford	Refuse	22.00	21.94	11/1/1987
South Meadow #6	CRRA	Hartford	Refuse	18.46	20.50	11/1/1987
South Meadow #11	CRRA	Hartford	Oil (Jet Fuel)	35.78	46.92	8/1/1970
South Meadow #12	CRRA	Hartford	Oil (Jet Fuel)	37.65	47.82	8/1/1970
South Meadow #13	CRRA	Hartford	Oil (Jet Fuel)	38.32	47.92	8/1/1970
South Meadow #14	CRRA	Hartford	Oil (Jet Fuel)	36.75	46.35	8/1/1970
Stevenson	FirstLight Hydro Generating Co.	Monroe	Hydro (Reservoir)	28.31	28.90	1/1/1919
Taftville #1- #5	FirstLight Hydro Generating Co.	Norwich	Hydro (Run of River)	0.00	0.59	1/1/1906
Torrington Terminal #10	NRG	Torrington	Oil (Jet Fuel)	15.64	20.75	8/1/1967
Toutant	Toutant Hydro Power, Inc.	Putnam	Hydro (Run of River)	0.25	0.40	2/1/1994
Tunnel #1- #2	FirstLight Hydro Generating Co.	Preston	Hydro (Run of River)	0.75	1.06	1/1/1919
Tunnel #10	FirstLight Hydro Generating Co.	Preston	Oil (Jet Fuel)	16.59	21.69	1/1/1969
Wallingford Refuse (Covanta)	CRRA	Wallingford	Refuse/Oil	6.57	6.54	3/1/1989
Waterbury Generation	Waterbury Generation	Waterbury	Gas/Oil	96.35	98.75	5/21/2009
Waterside Power	Waterside Power	Stamford	Oil	68.88	70.42	5/1/2004
Willimantic #1	Willimantic Power Corp.	Willimantic	Hydro (Run of River)	0.00	0.00	6/1/1990
Willimantic #2	Willimantic Power Corp.	Willimantic	Hydro (Run of River)	0.00	0.10	6/1/1990
Wyre Wynd	Summit Hydro Power	Griswold	Hydro (Run of River)	0.93	1.32	4/1/1997

Appendix A
Existing Electric Generation Facilities
as of December 2013

Seasonal Claimed Capability of coal fired plants	383.43	384.98	
Seasonal Claimed Capability of natural gas fired plants	2697.89	2972.20	
Seasonal Claimed Capability of oil fired plants	2135.59	2620.21	
Seasonal Claimed Capability of hydroelectric plants	125.84	134.79	
Seasonal Claimed Capability of methane fired plants	3.33	3.72	
Seasonal Claimed Capability of nuclear plants	2097.26	2110.91	
Seasonal Claimed Capability of refuse-fueled plants (inc. wood and tires)	168.58	170.51	
Total Seasonal Claimed Capability available for dispatch to the grid.	7611.92	8397.32	
(Lake Road is excluded from the total.)			

*This data is consistent with the December 2013 ISO-NE Seasonal Claimed Capability Report

Appendix A
Existing Generation
(listed by fuel type)

Facility	Owner	Town	Fuel	Summer Rating	Winter Rating	In-Service Date
Bridgeport Harbor #3	PSEG Power, LLC	Bridgeport	Coal/Oil	383.43	384.98	8/1/1968
Aetna Capitol District (CDECCA)	Capitol District Energy Ctr.	Hartford	Gas	55.25	61.33	11/1/1988
Bridgeport Energy	Bridgeport Energy LLC	Bridgeport	Gas	451.26	530.51	8/1/1998
Devon #11	NRG	Milford	Gas	29.30	38.82	10/1/1996
Devon #12	NRG	Milford	Gas	29.23	38.44	10/1/1996
Devon #13	NRG	Milford	Gas	29.97	38.97	10/1/1996
Devon #14	NRG	Milford	Gas	29.70	40.27	10/1/1996
Devon #15	NRG	Milford	Gas/Oil	46.89	49.19	7/12/2010
Devon #16	NRG	Milford	Gas/Oil	46.90	49.20	6/28/2010
Devon #17	NRG	Milford	Gas/Oil	46.90	49.20	6/15/2010
Devon #18	NRG	Milford	Gas/Oil	46.90	49.20	6/9/2010
Dexter #1- #2	Alstom	Windsor Locks	Gas	42.27	43.20	5/1/1990
Kimb Rocky River	Kimberly Clark Corporation	New Milford	Gas	13.02	14.44	7/15/2008
Kleen Energy	Kleen Energy	Middletown	Gas/Oil	620.00	620.00	7/12/2011
Middletown #12	NRG	Middletown	Gas	46.90	49.20	6/24/2011
Middletown #13	NRG	Middletown	Gas	46.90	49.20	6/23/2011
Middletown #14	NRG	Middletown	Gas	46.90	49.20	6/1/2011
Middletown #15	NRG	Middletown	Gas	46.90	49.20	6/1/2011
Wallingford Unit #1	PPL EnergyPlus, LLC	Wallingford	Gas	43.47	49.18	12/31/2001
Wallingford Unit #2	PPL EnergyPlus, LLC	Wallingford	Gas	43.02	50.00	2/7/2002
Wallingford Unit #3	PPL EnergyPlus, LLC	Wallingford	Gas	43.03	47.93	12/31/2001
Wallingford Unit #4	PPL EnergyPlus, LLC	Wallingford	Gas	42.01	46.90	1/23/2002
Wallingford Unit #5	PPL EnergyPlus, LLC	Wallingford	Gas	44.43	50.00	2/7/2002
Lake Road #1	Lake Road Generating Co., L.P.	Killingly	Gas/Oil	245.79	281.42	3/15/2002
Lake Road #2	Lake Road Generating Co., L.P.	Killingly	Gas/Oil	251.21	286.84	3/15/2002
Lake Road #3	Lake Road Generating Co., L.P.	Killingly	Gas/Oil	260.31	289.08	5/22/2002
Milford Power #1	Milford Power Company, LLC	Milford	Gas/Oil	253.61	281.85	2/12/2004
Milford Power #2	Milford Power Company, LLC	Milford	Gas/Oil	253.09	287.63	5/3/2004
New Haven Harbor #2	PSEG New Haven, LLC	New Haven	Gas/Oil	43.20	48.60	5/30/2012
New Haven Harbor #3	PSEG New Haven, LLC	New Haven	Gas/Oil	43.20	48.60	5/30/2012
New Haven Harbor #4	PSEG New Haven, LLC	New Haven	Gas/Oil	43.20	48.60	5/30/2012
Pierce	CMEEC	Wallingford	Gas/Oil	74.09	94.59	10/1/2007
Waterbury Generation	Waterbury Generation	Waterbury	Gas/Oil	96.35	98.75	5/21/2009
Bantam #1	FirstLight Hydro Generating Co.	Litchfield	Hydro (Run of River)	0.07	0.13	1/1/1905
Bulls Bridge #1- #6	FirstLight Hydro Generating Co.	New Milford	Hydro (Pondage)	3.23	5.00	1/1/1903

Appendix A
Existing Generation
(listed by fuel type)

Facility	Owner	Town	Fuel	Summer Rating	Winter Rating	In-Service Date
Colebrook	MDC	Colebrook	Hydro (Pondage)	0.76	0.58	3/1/1988
Dayville Pond	Summit Hydro Power	Killingly	Hydro (Run of River)	0.00	0.06	3/1/1995
Derby Dam	McCallum Enterprises	Shelton	Hydro (Run of River)	7.05	7.05	3/1/1989
Falls Village	FirstLight Hydro Generating Co.	Canaan	Hydro (Pondage)	2.38	5.00	1/1/1914
Goodwin Dam	MDC	Hartland	Hydro (Run of River)	3.00	3.00	2/1/1986
Kinneytown A	Kinneytown Hydro Co.	Ansonia	Hydro (Run of River)	0.00	0.00	3/1/1988
Kinneytown B	Kinneytown Hydro Co.	Seymour	Hydro (Run of River)	0.00	0.73	11/1/1986
Mechanicsville	Saywatt Hydro Associates	Thompson	Hydro (Run of River)	0.03	0.11	9/1/1995
Norwich 10th St.	CMEEC	Norwich	Hydro	0.00	0.00	1/1/1966
Putnam	Putnam Hydropower, Inc.	Putnam	Hydro (Run of River)	0.19	0.38	10/1/1987
Quinebaug	Quinebaug Associates LLC	Killingly	Hydro (Run of River)	0.33	0.93	9/1/1990
Rainbow Dam #1- #2	Farmington River Power Co.	Windsor	Hydro (Run of River)	8.20	8.20	1/1/1980
Robertsville #1- #2	FirstLight Hydro Generating Co.	Colebrook	Hydro (Run of River)	0.00	0.00	1/1/1924
Sandy Hook Hydro	Rocky Glen Hydro LP	Newtown	Hydro (Run of River)	0.00	0.07	4/1/1989
Rocky River	FirstLight Hydro Generating Co.	New Milford	Hydro (Pump Storage)	28.85	28.38	1/1/1928
Scotland #1	FirstLight Hydro Generating Co.	Windham	Hydro (Run of River)	0.00	0.24	1/1/1937
Shepaug #1	FirstLight Hydro Generating Co.	Southbury	Hydro (Reservoir)	41.51	42.56	1/1/1955
Stevenson	FirstLight Hydro Generating Co.	Monroe	Hydro (Reservoir)	28.31	28.90	1/1/1919
Taftville #1- #5	FirstLight Hydro Generating Co.	Norwich	Hydro (Run of River)	0.00	0.59	1/1/1906
Toutant	Toutant Hydro Power, Inc.	Putnam	Hydro (Run of River)	0.25	0.40	2/1/1994
Tunnel #1- #2	FirstLight Hydro Generating Co.	Preston	Hydro (Run of River)	0.75	1.06	1/1/1919
Willimantic #1	Willimantic Power Corp.	Willimantic	Hydro (Run of River)	0.00	0.00	6/1/1990
Willimantic #2	Willimantic Power Corp.	Willimantic	Hydro (Run of River)	0.00	0.10	6/1/1990
Wyre Wynd	Summit Hydro Power	Griswold	Hydro (Run of River)	0.93	1.32	4/1/1997
Hartford Landfill	CRRA	Hartford	Landfill Gas (Methane)	1.25	1.35	8/1/1998
East Windsor NORCAP LFG	East Windsor NORCAP	East Windsor	Landfill Gas (Methane)	0.78	0.97	5/7/2007
New Milford Landfill	Vermont Electric Power Co.	New Milford	Landfill Gas (Methane)	1.30	1.40	8/1/1991
Millstone #2	Dominion Nuclear CT, Inc.	Waterford	Nuclear	872.26	875.91	12/1/1975
Millstone #3	Dominion Nuclear CT, Inc.	Waterford	Nuclear	1225.00	1235.00	4/1/1986
Branford #10	NRG	Branford	Oil (Jet Fuel)	15.84	20.95	1/1/1969
Bridgeport Harbor #2	PSEG Power, LLC	Bridgeport	Oil	0.00	0.00	8/1/1961
Bridgeport Harbor #4	PSEG Power, LLC	Bridgeport	Oil (Jet Fuel)	17.02	21.92	10/1/1967
Cos Cob #10	NRG	Greenwich	Oil (Jet Fuel)	18.93	23.00	9/1/1969
Cos Cob #11	NRG	Greenwich	Oil (Jet Fuel)	18.72	23.00	1/1/1969
Cos Cob #12	NRG	Greenwich	Oil (Jet Fuel)	19.08	23.00	1/1/1969

Appendix A
Existing Generation
(listed by fuel type)

Facility	Owner	Town	Fuel	Summer Rating	Winter Rating	In-Service Date
Cos Cob #13	NRG	Greenwich	Oil (Jet Fuel)	19.05	22.85	5/29/2008
Cos Cob #14	NRG	Greenwich	Oil (Jet Fuel)	19.21	22.60	5/29/2008
Devon #10	NRG	Milford	Oil (Jet Fuel)	14.41	19.19	4/1/1988
Franklin Drive #10	NRG	Torrington	Oil (Jet Fuel)	15.42	20.53	11/1/1968
John Street #3	CMEEC	Wallingford	Oil (Diesel)	0.00	2.00	9/26/2007
John Street #4	CMEEC	Wallingford	Oil (Diesel)	0.00	2.00	9/26/2007
John Street #5	CMEEC	Wallingford	Oil (Diesel)	0.00	2.00	11/1/2007
Middletown #4	NRG	Middletown	Oil	399.92	402.00	6/1/1973
Middletown #10	NRG	Middletown	Oil (Jet Fuel)	15.52	20.02	1/1/1966
Montville #6	NRG	Montville	Oil	405.05	408.85	7/1/1971
Montville #10 & #11	NRG	Montville	Oil (Diesel)	5.30	5.35	1/1/1967
Norden #1	CMEEC	East Norwalk	Oil	1.79	1.96	2/26/2009
Norden #2	CMEEC	East Norwalk	Oil	1.95	1.95	2/26/2009
Norden #3	CMEEC	East Norwalk	Oil	1.94	1.94	2/26/2009
Norwalk Harbor #1	NRG	Norwalk	Oil	0.00	164.00	1/1/1960
Norwalk Harbor #2	NRG	Norwalk	Oil	0.00	172.00	1/1/1963
Norwalk Harbor #10 (3)	NRG	Norwalk	Oil (Diesel)	0.00	17.06	10/1/1996
Norwich Jet	CMEEC	Norwich	Oil	15.26	18.80	9/1/1972
Norwich Wasterwater Treatment	CMEEC	Norwich	Oil (Diesel)	2.00	2.00	5/29/2008
South Meadow #11	CRRA	Hartford	Oil (Jet Fuel)	35.78	46.92	8/1/1970
South Meadow #12	CRRA	Hartford	Oil (Jet Fuel)	37.65	47.82	8/1/1970
South Meadow #13	CRRA	Hartford	Oil (Jet Fuel)	38.32	47.92	8/1/1970
South Meadow #14	CRRA	Hartford	Oil (Jet Fuel)	36.75	46.35	8/1/1970
Torrington Terminal #10	NRG	Torrington	Oil (Jet Fuel)	15.64	20.75	8/1/1967
Tunnel #10	FirstLight Hydro Generating Co.	Preston	Oil (Jet Fuel)	16.59	21.69	1/1/1969
Waterside Power	Waterside Power	Stamford	Oil	68.88	70.42	5/1/2004
Middletown #2	NRG	Middletown	Oil/Gas	117.00	120.00	1/1/1958
Middletown #3	NRG	Middletown	Oil/Gas	233.68	244.40	1/1/1964
Montville #5	NRG	Montville	Oil/Gas	81.00	81.59	1/1/1954
New Haven Harbor #1	PSEG Power, LLC	New Haven	Oil/Gas	447.89	453.38	8/1/1975
Bristol Refuse	Ogden Martin Systems-CT	Bristol	Refuse	12.37	12.77	5/1/1988
South Meadow #5	CRRA	Hartford	Refuse	22.00	21.94	11/1/1987
South Meadow #6	CRRA	Hartford	Refuse	18.46	20.50	11/1/1987
Wallingford Refuse (Covanta)	CRRA	Wallingford	Refuse/Oil	6.57	6.54	3/1/1989
Exeter	Oxford Energy, Inc.	Sterling	Refuse (Tires)	20.98	19.84	12/1/1991

Appendix A
Existing Generation
(listed by fuel type)

Facility	Owner	Town	Fuel	Summer Rating	Winter Rating	In-Service Date
Bridgeport (Wheelabrator)	CRRA	Bridgeport	Wood/Refuse	58.87	59.42	4/1/1988
Lisbon Resource Recovery	Riley Energy Systems	Lisbon	Wood/Refuse	13.52	13.45	1/1/1996
Preston RRF	SCRRF	Preston	Wood/Refuse	15.81	16.05	1/1/1992
Pinchbeck	William Pinchbeck, Inc.	Guilford	Wood/Refuse	0.00	0.00	7/1/1987
	Seasonal Claimed Capability of coal fired plants			383.43	384.98	
	Seasonal Claimed Capability of natural gas fired plants			2697.89	2972.20	
	Seasonal Claimed Capability of oil fired plants			2135.59	2620.21	
	Seasonal Claimed Capability of hydroelectric plants			125.84	134.79	
	Seasonal Claimed Capability of methane fired plants			3.33	3.72	
	Seasonal Claimed Capability of nuclear plants			2097.26	2110.91	
	Seasonal Claimed Capability of refuse-fueled plants (inc. wood and tires)			168.58	170.51	
	Total Seasonal Claimed Capability disptachable to the grid exc. Lake Road.			7611.92	8397.32	

***This data is consistent with the December 2013 ISO-NE Seasonal Claimed Capability Report**

Appendix B
Planned Transmission Lines in Connecticut

Planned/Proposed Transmission Lines in Connecticut	Voltage (kV)	Estimated In-Service Date	Length (miles)	Utility	Status
North Bloomfield S/S, Bloomfield - Northeast Simsbury S/S, Simsbury (reconductor)	115	2013	2.4	CL&P	Planned
Frost Bridge S/S, Watertown - Stevenson S/S, Monroe (replace structures and reconductor)	115	2014	20.5	CL&P	Proposed
Glenbrook S/S, Stamford - South End S/S, Stamford (new underground cables)	115	2014	1.5	CL&P	Planned
Congress S/S, Bridgeport - Baird Substation, Stratford (increase thermal capability)	115	2015	2.4	UI	Proposed
Glen Lake Junction, Woodbridge - Mix Avenue, Hamden (reconductor)	115	2015	2.9	UI	Proposed
Milvon S/S, Milford - Devon Tie Switching Station, Milford (increase thermal capability)	115	2015	1.4	UI	Proposed
North Haven S/S, North Haven - Walrec Junction, Wallingford (reconductor)	115	2015	1.7	UI	Proposed
Southington S/S, Southington - Cook Hill Junction, Cheshire (reconductor)	115	2015	10.6	CL&P	Proposed
Wallingford S/S, Wallingford - Walrec Junction, Wallingford (reconductor/rebuild)	115	2015	0.2	CL&P	Proposed
Naugatuck Valley Reliability Improvement Project	115	2016	TBD	UI	Concept
Cos Cob S/S, Greenwich - Greenwich S/S, Greenwich (new transmission)	115	2017	TBD	CL&P	Concept
Manchester S/S, Manchester - East Hartford S/S, East Hartford (new transmission)	115	TBD	3.2	CL&P	Concept
North Bloomfield S/S, Bloomfield - CT/MA Border, Suffield (1)	345	2013	12.0	CL&P	Under Construction
Card S/S, Lebanon - Lake Road S/S, Killingly (2)	345	2015	29.3	CL&P	Planned
Lake Road S/S, Killingly - CT/RI Border, Thompson (2)	345	2015	7.6	CL&P	Planned
Frost Bridge S/S, Watertown - North Bloomfield, Bloomfield (3)	345	2017	35.4	CL&P	Planned
(1) Related to Greater Springfield Reliability NEEWS Project					
(2) Related to Interstate Reliability NEEWS Project					
(3) Related to Central Connecticut Reliability NEEWS project					

Appendix C
Planned Substations

Appendix C: Planned Substation and Switching Station Projects	Voltage (kV)	Est. In-Service Date	Utility	Status	Project
Modify the existing South End Substation in Stamford	115	2014	CL&P	Planned	Add a distribution transformer
Modify the Beseck Substation in Wallingford	115	2013	CL&P	Under Construction	Add a variable shunt reactor
Modify the existing East Shore Substation in New Haven	115	2013	UI	Under Construction	Substation Capacity Upgrade and Modernization
Modify the North Bloomfield Substation in Bloomfield	115	2013	CL&P	Under Construction	Replace series reactor
Modify the existing North Bloomfield Substation in Bloomfield (3)	345	2013	CL&P	Under Construction	NEEWS GSRP
Modify the existing South Meadow Substation in Hartford	115	2013	CL&P	Under Construction	Upgrade to Bulk Power System requirements
Modify the East Devon Substation in Milford (Devon)	345	2013	CL&P	Planned	Add a series breaker
Install a new Subsation in Norwalk (Third Taxing District)	115	2014	CMEEC	Under Construction	Install a new substation
Install the new South Norwalk (SoNo) Substation in Norwalk	115	2014	CMEEC	Under Construction	Install a new substation
Install a new Substation in Shelton	115	2014	UI	Under Construction	Install a new substation
Modify the existing Norwalk Substation in Norwalk	115	2014	CL&P	Concept	Add a distribution transformer
Modify the Scitico Substation in Enfield	115	2014	CL&P	Planned	Substation work associated with new Hampden Project (NGRID)
Modify the existing Bulls Bridge Substation in New Milford	115	2015	CL&P	Proposed	Replace a transformer
Modify the existing Grand Avenue Switching Station in New Haven	115	2015	UI	Concept	Install a new 115 kV capacitor bank.
Modify the existing Hawthorne Substation in Fairfield	115	2015	UI	Concept	Install two 115 kV capacitor banks.
Modify the Mix Avenue Substation in Hamden	115	2015	UI	Concept	Addition of two 115 kV capacitor banks, a 115 kV series reactor, and upgrades to 115 kV terminal
Modify the existing Pequonnock Substation in Bridgeport	115	2016	UI	Concept	Fault Duty Mitigation - Upgrades to 115 kV disconnect switches and bus, as well as a new control house with modern microprocessor relaying.
Modify the existing Sackett Substation in North Haven	115	2015	UI	Concept	Addition of one 115 kV capacitor bank, upgrades to 115 kV terminals, and removal of existing capacitor bank and phase angle regulator
Modify the existing Canal Substation in Southington	115	2016	CL&P	Concept	Add a distribution transformer
Modify the Uncasville Substation in Montville	115	2016	CL&P	Concept	Replace both transformers with larger capacity transformers
Modify the existing Card Substation in Lebanon (1)	345	2015	CL&P	Planned	NEEWS Interstate
Modify the existing Lake Road Substation in Killingly (1)	345	2015	CL&P	Planned	NEEWS Interstate
Modify the Beseck Substation in Wallingford	115	2017	CL&P	Planned	Add a second variable shunt reactor
Modify the existing Frost Bridge Substation in Watertown (2)	345	2017	CL&P	Planned	NEEWS/CCRP
Install the new Greenwich Substation in Greenwich	115	2017	CL&P	Concept	Install a new substation
Modify the existing North Bloomfield Substation in Bloomfield	115	2017	CL&P	Concept	Add a distribution transformer
Modify the existing North Bloomfield Substation in Bloomfield (2)	345	2017	CL&P	Planned	NEEWS/CCRP
Install a new Substation in Fairfield	115	2019	UI	Concept	Install a new substation
Modify the existing Haddam Neck Substation in Haddam	345	TBD	CL&P	Concept	Add a variable shunt reactor
Modify the existing Northeast Simsbury Substation in Simsbury	115	TBD	CL&P	Planned	Add a circuit breaker
Install the new Burrville Substation in Torrington	115	TBD	CL&P	Concept	Install a new substation
(1) Related to Interstate Reliability NEEWS project					
(2) Related to Central Connecticut Reliability NEEWS project					
(3) Related to the Greater Springfield Reliability NEEWS project					