

## **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 110 generating units whose output 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 finally direct electricity to individual users via the distribution system.

This network of electric connections must be highly reliable, reflecting its importance not only for our State, but for our region. Reliability is a special challenge, given current global circumstances, with its volatile fuel prices, new energy technologies, and climate change concerns. Daily operations of the grid, including both power flows and transactions within the wholesale market for electricity, are managed by the Independent Systems 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. With the same aim, ISO-NE also directs annual forward planning for electric transmission needs in our region. The main participants in the planning process are regional ones: generators, suppliers (including suppliers of 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 and 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 our State's electricity needs and resources, looking ahead ten years. As is to be expected, the utility companies themselves provide 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 corporate 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.

CL&P and UI were mandated by the Public Act 07-242 to create an Integrated Resource Plan (IRP) that they could agree to jointly and present as a planning tool for the State. The IRP focuses on resource procurement. Its most important features, to be discussed below in more detail, are its coordinated approach to procurement and its emphasis on energy reliability and efficiency. In the end, all of Connecticut's and New England's plans for the future of the electric system are designed to make changes in the system happen more smoothly, so electric service will not be disrupted, and more efficiently, so electric service will be worth its price.

## **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 electric 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”; however, since utility companies serve loads on a much larger scale, forecasts typically use the unit of a megawatt (MW), or one million watts<sup>1</sup>.

Loads increase with any increase in the number of electrical devices being used at the same time. Demand also depends on the type of loads and how much work is being performed by those devices. Generally, the higher the loads, the more the stress on the electrical infrastructure. Higher loads result in more generators having to run, and run at higher outputs. Transmission lines must carry more current to transformers located at the various substations. The transformers in turn must carry more 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 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 a 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.

## **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 most of the energy for heating is supplied directly by fossil fuels, not by electricity. While natural gas or oil furnaces do typically require electricity for blowers/fans, pumps, and control systems, this electrical load is small compared with the load from air conditioning, which runs entirely on electricity. (There are some natural gas-fueled air conditioning systems, but they are not common.) Conversely, in areas where electric heat is common and there is less demand for air conditioning, such as the Canadian province of Quebec, a winter peak load can result.

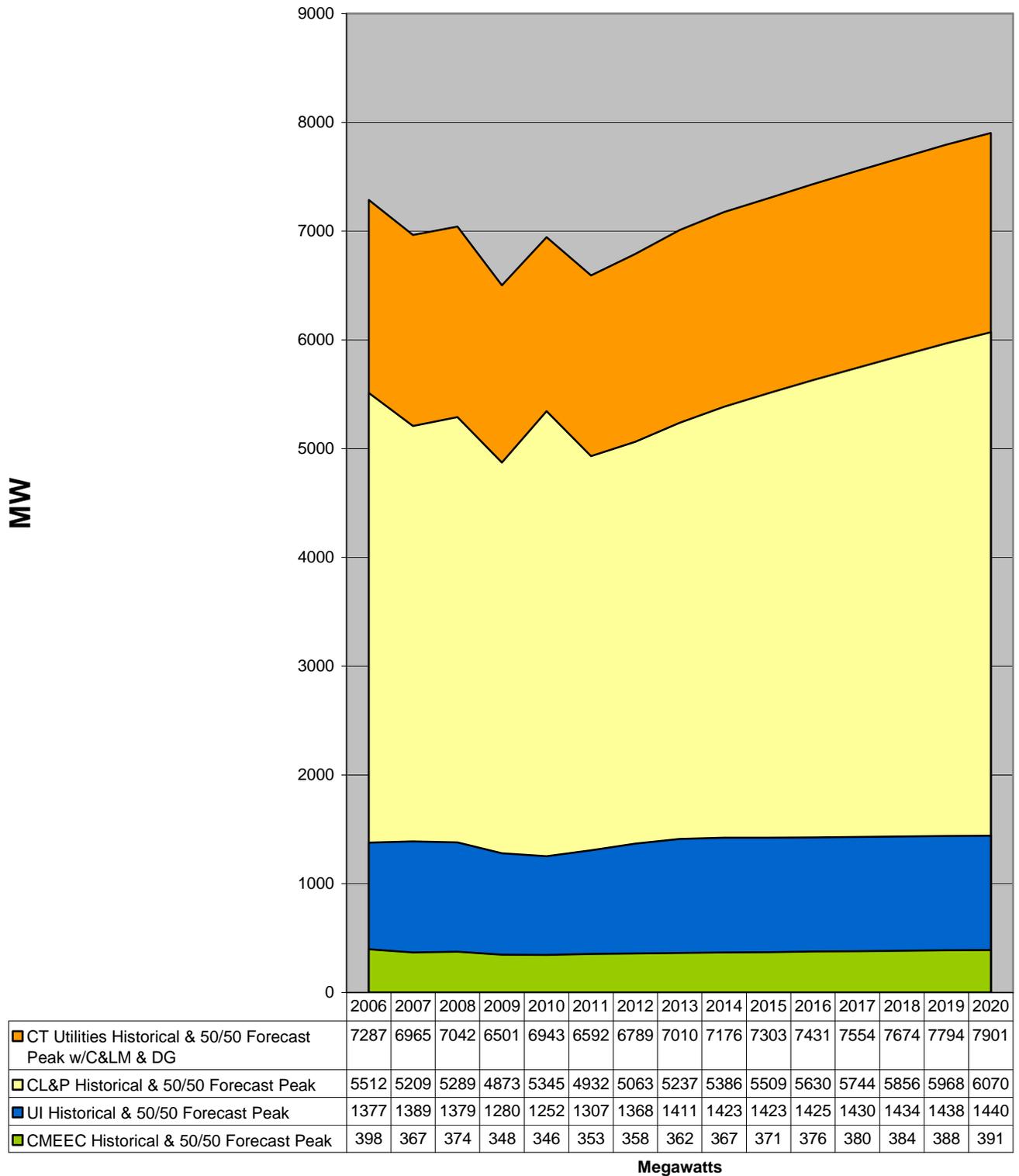
While a detailed discussion of peak loads would have to include additional factors such as customer usage, demographics, conservation efforts, economic conditions, and others, the most important factor is weather—specifically the temperature and humidity. Higher temperatures result in more frequent use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

In its normal weather (50/50) forecast, CL&P predicted a peak load of 4932 MW for its service area during 2011. This load is expected to grow during the forecast period at an annual compound growth rate (ACGR) of 2.33 percent, reaching 6070 MW in 2020. UI predicted, in its normal weather (50/50) forecast, a peak load of 1307 MW for its service area during 2011. This load is expected to grow during the forecast period at an ACGR

of 1.08 percent, reaching 1440 MW in 2020. CMEEC predicted, in its normal weather (50/50) forecast, a peak load of 353 MW for its service area during 2011. This load is expected to grow during the forecast period at an ACGR of 1.14 percent, reaching 391 MW in 2020<sup>2</sup>. All three of the State utilities' 50/50 summer peak loads are depicted in Figure 1a.

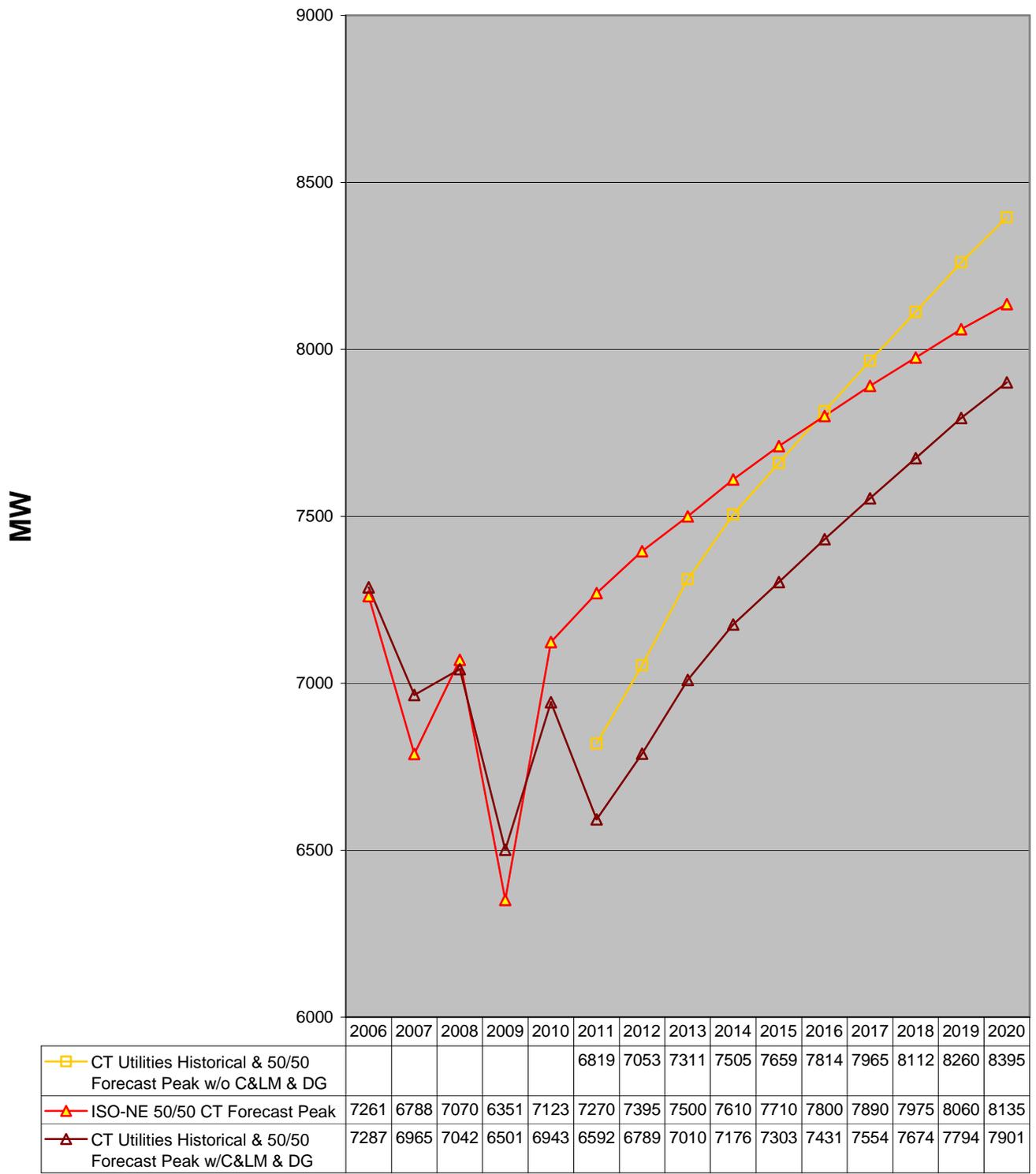
**Figure 1a: Utility Adjusted Historical & 50/50 Peak Load Forecast in MW**



The sum of the three utilities' forecasts resulted in a projected statewide peak load of 6592 MW during 2011. This load is expected to grow at an ACGR of 2.03 percent and reach 7901 MW by year 2020. The statewide ACGR is a weighted average of the three utilities' ACGRs. 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 ACGR of 2.03 percent is comparable to CL&P's ACGR of 2.33 percent. The statewide ACGR is lower than CL&P's due to the effect of slower projected growth rates in UI and CMEEC territories. (See Figure 1a.) The Council notes 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.

ISO-NE predicted, in its 50/50 forecast for Connecticut, a peak load of 7270 MW during 2011. This peak load is expected to grow at an ACGR of 1.26 percent and reach 8135 MW by year 2020. Note that the ISO-NE 50/50 forecast exceeds the sum of the utilities' forecasts each year by an average of 412 MW. This is due to a difference in how 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. See ISO-NE and the State utilities' forecasts in Figure 1b.

**Figure 1b: 50/50 Forecasts in MW**



Megawatts

The ISO-NE 50/50 forecast is depicted in yellow in Figure 1b. The Connecticut utilities peak including the effects of C&LM and DG is depicted in dark red. The Connecticut utilities peak excluding the effects of C&LM and DG are depicted in orange. The orange curve more closely matches the ISO-NE projections and provides an approximately “apples to apples” comparison. This is evident as the curves intersect at approximately year 2016.

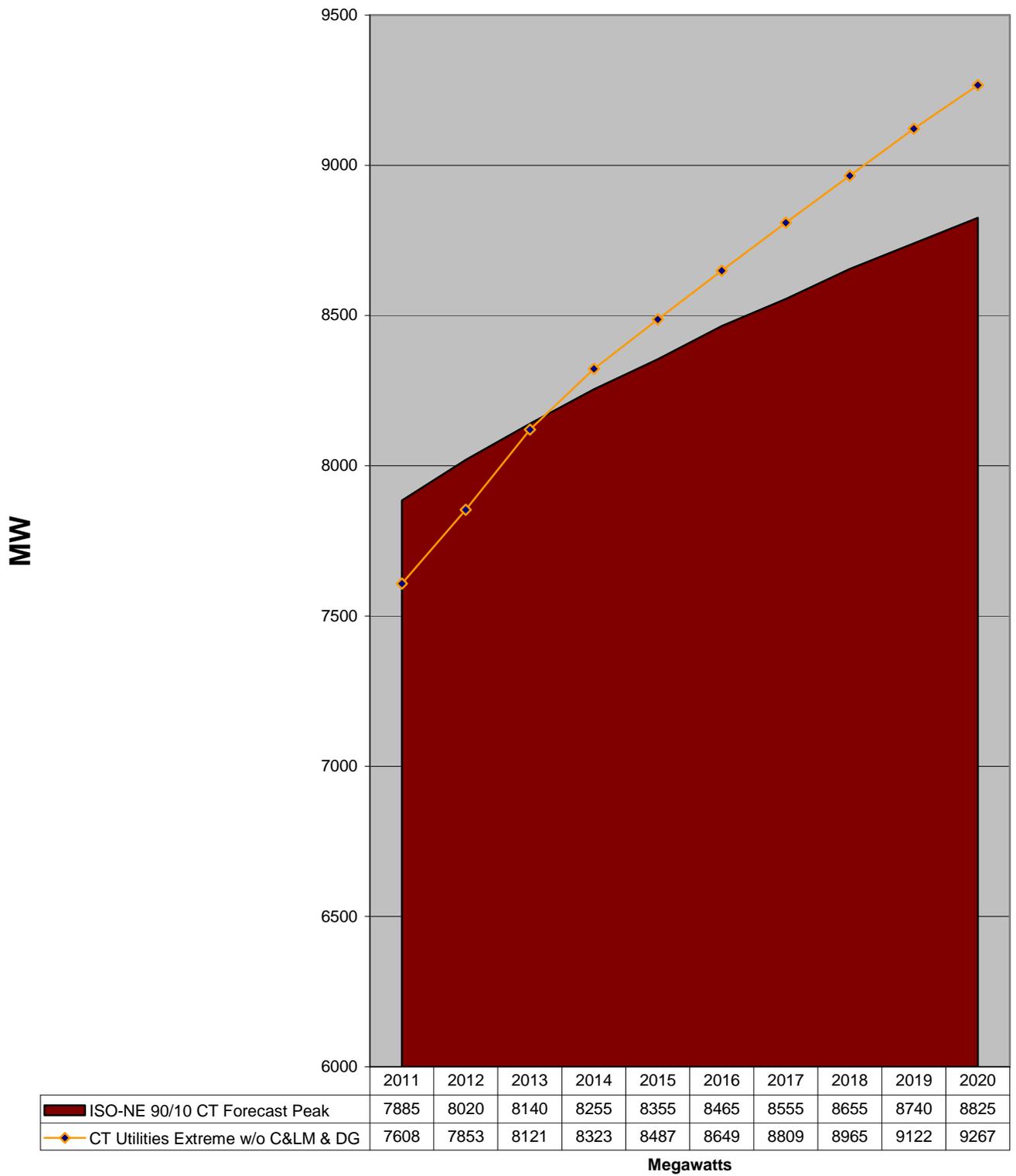
The more significant forecast to be discussed in this review is the one produced by ISO-NE. Called the “90/10” forecast, it is separate from the normal weather (50/50) forecasts offered by the Connecticut utilities. However, it is the one used by both ISO-NE and by the Connecticut utilities for utility 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, ISO-NE’s 90/10 forecast has a projected (worst-case) peak load for Connecticut of 7885 MW in 2011. This load is expected to grow at an ACGR of 1.26 percent and reach 8825 MW by 2020. See Figure 1c.

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



## **Forecasting Electric Energy Consumption**

Energy 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. Energy can be thought of as the total number of gallons of water that accumulate in the sink or gallons per minute times the number of minutes.

Accordingly, 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) for energy. 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), energy is the total work done by the electricity over time. 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 (0.153 hours) to consume 0.23 kWh of energy. 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. For larger accounts, meters also record the instantaneous load (i.e. demand).

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, like the sum of their loads, only approximates the electric energy consumption in Connecticut, because some suppliers serve their own needs independently, but this marginal supply is tiny.

CL&P predicted that the total electric energy consumption<sup>3</sup> in its service area would be 23406 GWh during 2011. The calculated ACGR is 1.03 percent. This means the energy consumption is forecast to increase over time. Thus, energy consumption is expected to increase to 25677 GWh by 2020.

UI predicted that the total electric energy consumption in its service area would be 5769 GWh during 2011. UI's projections also result in an ACGR of 0.63 percent. That is, UI's electric energy consumption is expected to slowly increase over the forecast period to reach 6107 GWh by 2020.

CMEEC predicted that the total electric energy consumption in its service area would be 1832 GWh during 2011. This number is expected to grow slowly at an ACGR of 0.62 percent, reaching 1936 GWh by 2020.

Taken together, these data result in a projected statewide electric energy consumption of approximately 31007 GWh for 2011. This number is expected to increase at a (weighted) ACGR of 0.94 percent and reach 33720 GWh by 2020.

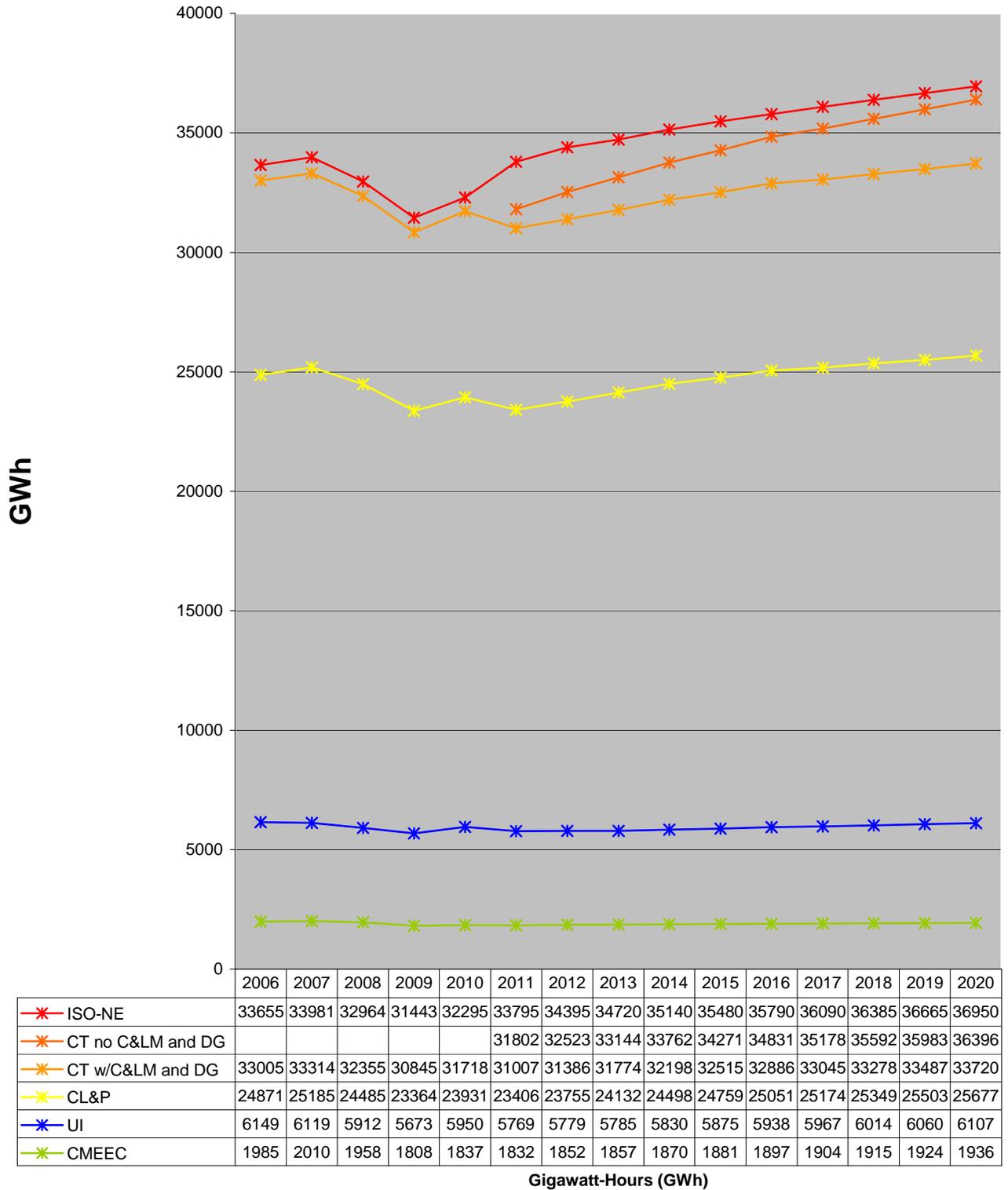
On the surface, the energy consumption ACGR of 0.94 may seem inconsistent with the more than double 2.03 percent ACGR of peak electric load in the State. Actually, it is not. The discrepancy can be explained in terms of changing customer behavior in response to higher electric rates, to technological change, and to various efficiency efforts encouraged by the utilities and the State.

It appears that customers are conserving electricity wherever possible to reduce their electric bills, thus mitigating the average increases in electric energy consumption. On the other hand, demand for air conditioning during the hottest days (and hours) of the year appears to remain strong, and energy consumption during peak periods continues to grow. Since the short peak periods when people tend not to conserve are offset by the much longer periods when people do conserve, the overall trend for electric energy consumption increases more slowly than the growth in peak load.

As is the case with electric load, ISO-NE also provides electric energy consumption data for Connecticut. Specifically, ISO-NE predicts electric energy consumption in Connecticut to be 33795 GWh in 2011. This number is expected to grow at an ACGR of 1.00 percent and reach 36950 GWh by 2020. Figure 2 depicts the four requirement forecasts.

Figure 2 also includes two curves showing Connecticut both with and without Conservation and Load Management (C&LM) and Distributed Generation (DG) (See next section). The curve for Connecticut without 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, as explained in the next section.

**Figure 2: State and Utility Energy Requirements in GWh**



## **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 to a local distribution system, as opposed to transmission.

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 of energy efficiency can be considered a reduction in demand or an increase in supply. As mentioned earlier, the Connecticut utilities consider C&LM, 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 and need for fuels, particularly fossil fuels. C&LM, DG 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.

The Connecticut Energy Conservation Management Board (ECMB) was created by the Legislature in 1998 to advise and assist the State's utility companies in developing and implementing cost-effective conservation programs to meet Connecticut's changing and growing energy needs. With the approval of the Public Utility Regulatory Authority (PURA), formerly known as the Department of Public Utility Control (DPUC), the ECMB also guides the distribution of the Connecticut Energy Efficiency Fund (CEEF), which finances energy efficiency programs of various kinds all over the State. CEEF's money comes from a surcharge on customer electric bills. Effective July 1, 2011, the CEEF became part of the newly created Clean Energy Finance and Investment Authority (CEFIA).<sup>4</sup>

Most of the CEFIA programs are implemented and administered by CL&P and UI, who are also accountable for attaining State-approved performance goals—goals that include reducing both energy consumption and peak load. CMEEC has a separate program for energy efficiency, but with the same goals.

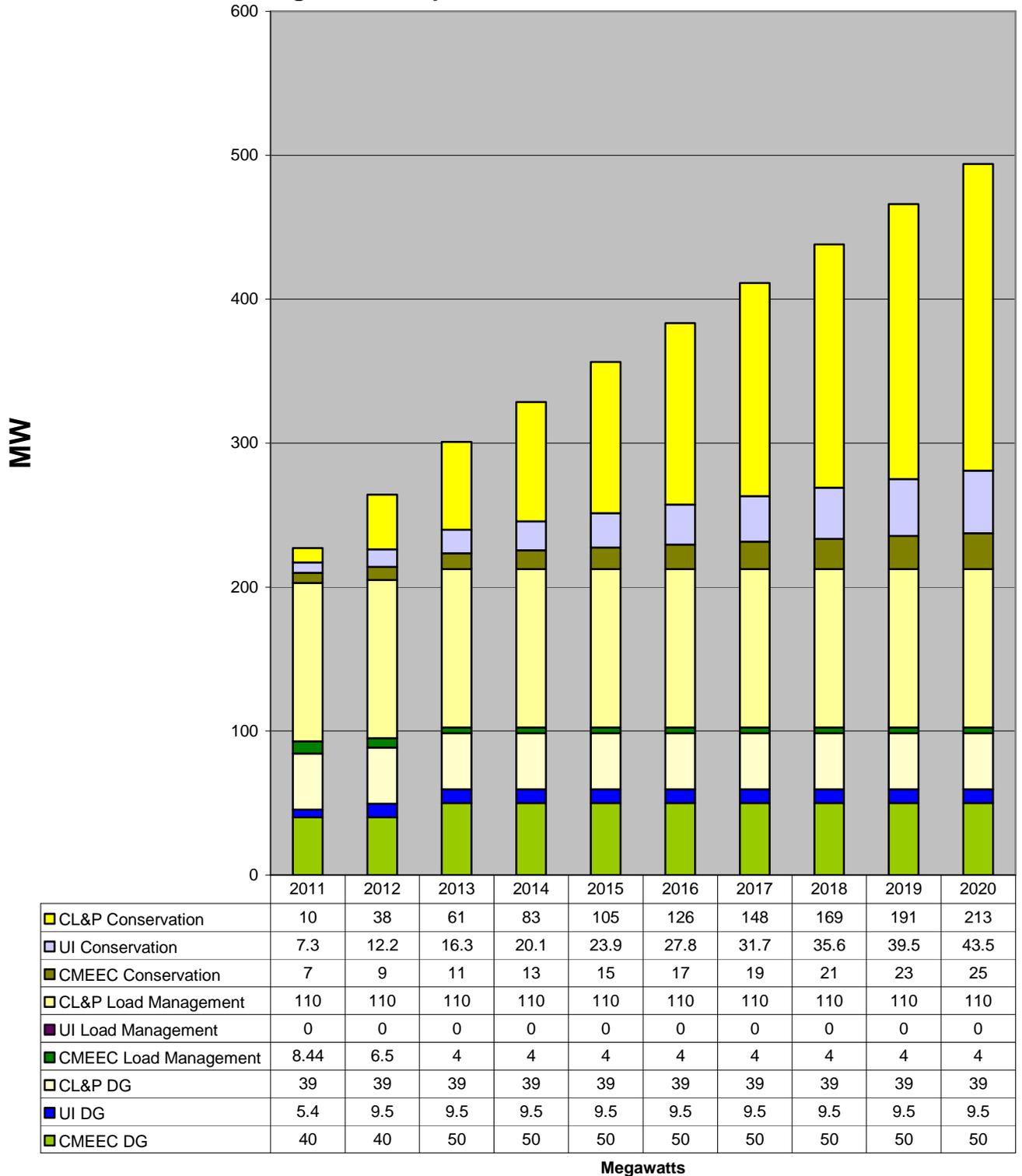
The ECMB submits an annual report to the legislature regarding energy efficiency programs in Connecticut. In the ECMB report dated March 1, 2010, the ECMB notes that the CEFIA programs (for CL&P, UI, and CMEEC) resulted in annual energy savings

of 423 GWh or 1.33 percent of the State's 2010 energy consumption, and lifetime savings of 3700 GWh.

UI projected a load reduction<sup>5</sup> (excluding DG) of 7.3 MW in 2011. This number is expected to increase to 43.5 MW by 2020. Load management has been assumed to be zero by UI for the forecast period. This is a conservative assumption given that participation in the load management program is voluntary and difficult to accurately predict. However, CL&P and CMEEC have included their load management projections in their total forecast load reductions. Specifically, CL&P projected a load reduction<sup>6</sup> (excluding DG) of 120 MW in 2011 due to C&LM. This number is expected to grow to 323 MW by 2020. Finally, CMEEC reported a projected load reduction (excluding DG) of 15.4 MW for 2011. This number is expected to grow to 29 MW by 2020.

Collectively, this results in a statewide peak load reduction due to C&LM (and excluding DG) of 142.7 MW in 2011<sup>7</sup>. This cumulative load reduction is projected to increase annually with a substantial ACGR of 12.0 percent and reach 395.5 MW by 2020, the end of the forecast period. By the end of the forecast period, the magnitude of this reduction in load is nearly on the order of the output of the Bridgeport Harbor #3 facility in Bridgeport. Figure 3 depicts the projected annual peak load reduction by utility throughout the forecast period.

**Figure 3: Load Reductions Due to Conservation, Load Management/Response, and Distributed Generation**



The Council believes that energy efficiency and programs like CEFIA 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 tends to hold down utility costs. Electric energy efficiency also reduces federal congestion costs and the costs of new generation.

In recent forecast years, Connecticut has been among the states leading the country on energy efficiency. It was third in the national rankings put out by the American Council for an Energy-Efficient Economy during 2008, but is now eighth, on account of the poor economy. (See annual scorecard at [www.aceee.org](http://www.aceee.org).) Long-term national projections by the U.S. Department of Energy (DOE) show that employing the most energy-efficient technologies over the next 25 years could decrease energy consumption by 27 percent. Thus, the upside for Connecticut would be considerable if the State were to resume the investment targets in place just three years ago.

## **ELECTRIC SUPPLY**

While peak loads occur during the summer, the electric system is further challenged by the fact that generation output 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.) Connecticut's August 2011 ISO-NE dispatched generation output is 8141.65 MW in the summer, with a higher total of 8273.29 MW during the winter.

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. Neglecting retirements, going forward, Connecticut has a surplus of generation during the forecast period. Plant retirements would decrease generation; however, the New England East West Solution (NEEWS) transmission projects, to the extent they are approved, would offset generation losses by increasing import capacity. See Table 2, and also the section on Transmission.

## **New Generation**

The largest addition to Connecticut's generation resources is the Kleen Energy facility. The 620 MW Kleen Energy facility in Middletown is a natural gas-fired (with oil backup) combined-cycle generating facility. The plant was approved by the Council in Docket No. 225. Kleen was later selected in a request for proposal (RFP) as a project that would significantly reduce federally mandated congestion charges. It went into service in June,

2011. Accordingly, the Kleen Energy plant is reflected in the load/resource balance table (Table 2) based on in-service availability for summer 2011.

Public Act 07-242, An Act Concerning Electricity and Energy Efficiency, created an expedited Council review and approval process to facilitate the siting of certain new power plants. 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 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 quality standards of the Department of Environmental Protection;
- the siting of temporary generation solicited by DPUC pursuant to section 16-19ss of this act.

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 ruling under this provision. Several Project 150 proposals (see below) were in this category.

### **Project 150**

Project 150 is a program funded by the CEFIA. The aim of this program is to stimulate Class I renewable energy generation. Applicants that are approved by the Council receive secure funding via long-term power purchase agreements with CL&P and UI. Table 1 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 the 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/arrangements.

<b>Table 1:</b>	<b>Renewable</b>	<b>Generation</b>	<b>Projects</b>	<b>Selected in</b>	<b>Project 150</b>
					<i>Council</i>
<i>Project</i>	<i>Location</i>	<i>Project MW</i>	<i>Contract MW</i>	<i>Est. In-service Date</i>	<i>Review Status</i>
DFC-ERG Bloomfield	Bloomfield	3.65	3.65	2011*	Approved
DFC-ERG Glastonbury	Glastonbury	3.4	3.4	2011*	Approved
DFC-ERG Milford Project	Milford	9	9	2011*	Approved
Bridgeport Fuel Cell Park	Bridgeport	14.93	14.93	2012	Approved
Watertown Renewable Power, LLC	Watertown	27.3	15	2013	Approved
Plainfield Renewable Energy	Plainfield	37.5	30	2014	Approved
<b>Total Capacity Approved by Council</b>		95.78	75.98		
<i>Project</i>	<i>Location</i>	<i>Project MW</i>	<i>Contract MW</i>	<i>Est. In-service Date</i>	<i>Review Status</i>
Clearview East Canaan Energy, LLC	North Canaan	3	3	2011*	Not Rec'd
Clearview Renewable Energy, LLC	Bozrah	30	30	2011*	Withdrawn
DFC-ERG Trumbull	Trumbull	3.4	3.4	2011*	Not Rec'd
Stamford Hospital Fuel Cell CHP	Stamford	4.8	4.8	2011*	Not Rec'd
Waterbury Hospital Fuel Cell CHP	Waterbury	2.8	2.8	2011*	Not Rec'd
Cube Fuel Cell	Danbury	3.36	3.36	2012	Not Rec'd
South Norwalk Electric Works	South Norwalk	35.5	30	2012	Not Rec'd
<b>Other Project Capacity</b>		82.86	77.36		
*Construction has not yet commenced.					
<i>Source: CL&amp;P Forecast dated March 1, 2011</i>					

### **Bridgeport Energy II LLC - Bridgeport**

On June 5, 2008, the Council approved another large fossil-fuel generation project: the Bridgeport Energy II (BEII) facility. This is a 350 MW single cycle natural gas-fired generating plant with ultra low sulfur fuel oil as the backup fuel. It was the subject of Petition No. 841. The plant would be located at the site of the existing 442 MW (summer rating) Bridgeport Energy facility. The BEII project was also selected as an expedited peaking facility. However, the current economic conditions make it unlikely that the project will go forward soon, or at all. Accordingly, at this time, it is not included in the load/resource balance in Table 2 to be conservative.

### **Montville Power LLC – Montville**

On June 22, 2009, Montville Power LLC (MP) submitted a petition (Petition No. 907) for a declaratory ruling that no Certificate is required for the proposed construction, maintenance, and operation of a 40 MW wood biomass-fueled generating facility. Such a facility would replace Montville Unit 5, which is an 81 MW (summer rating) oil and natural gas-fired steam electric generator. The repowered facility could generate up to 40 MW of electricity using wood fuel, and up to 82 MW using natural gas or ultra-low sulfur distillate fuel during high demand periods. The project was approved by the Council on February 25, 2010 and has all its permits. With a power purchase contract, the project could be commercially available in 2012. Since this is a repowering of nearly equal peak megawatts, the project is not reflected in Table 2.

### **PSEG Power LLC – New Haven**

On November 23, 2009, PSEG Power Connecticut LLC (PSEG) submitted a petition (Petition No. 925) for a declaratory ruling that no Certificate is required for the proposed construction, maintenance, and operation of three 48.4 MW electric generating peaking units. The units would be dual-fuel (natural gas/oil) and would be able to commence operations within ten minutes of being dispatched by ISO-NE. Black start capability (the ability to start without outside grid power) is also included to improve the reliability of Connecticut's power system.

While the original petition included an overhead electrical connection, PSEG subsequently filed another petition (Petition No. 976) on November 2, 2010 for an underground connection, after that was found to be feasible and of comparable cost to the overhead connection. Petition Nos. 925 and 976 were approved on January 7, 2010 and December 16, 2010, respectively. This project is expected to go into service approximately during June 2012.

### **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 was denied by the Council on May 12, 2011.

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 was approved by the Council on June 2, 2011.

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 was approved by the Council on June 9, 2011.

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. Accordingly, to be conservative, the wind projects have not been included in the current Council forecast.

## **Demand/Supply Balance**

Table 2 contains a tabulation of generation capacity vs. 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.

Assumed unavailable generation estimates a typical number of power plants off-line for maintenance purposes. Existing generation supply resources are based on the total existing generation in Connecticut listed in Appendix A. Appendix A contains data from ISO-NE's August 2011 Seasonal Claimed Capability report. Approved generation projects (not yet constructed and/or complete) are also included in Table 2. As indicated in Table 1, 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. While NRG Energy Inc. (the owner of several older fossil-fueled steam facilities) testified at the Council's 2011 hearing that it has no plans at this time to retire facilities during the forecast period, the 2010 IRP has several retirement assumptions in its base case. To maintain consistency, the Council adopts these retirement assumptions, but cautions that they are very tentative and subject to change.

Specifically, the 2010 IRP assumes that Bridgeport Harbor (130 MW summer), Middletown No. 3 (236 MW summer), Norwalk Harbor No. 1 (162 MW summer), and Norwalk Harbor 2 (168 MW summer) would retire in 2013. Accordingly, Table 2 includes the loss of 696 MW (total) beginning in 2013. The 2010 IRP also assumes that the following facilities would retire in approximately 2016: Middletown No. 4 (400 MW summer), Montville 6 (407 MW summer). Thus, Table 2 also includes the incremental loss of 807 MW beginning in 2016.

Table 2: MW Balance

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
90/10 Load	7885	8020	8140	8255	8355	8465	8555	8655	8740	8825
Reserve (Equiv. Millstone 3)	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225
Load + Reserve	9110	9245	9365	9480	9580	9690	9780	9880	9965	10050
Existing Generation	7345	7345	7345	7345	7345	7345	7345	7345	7345	7345
Est.Unavail. Generation	576	576	576	576	576	576	576	576	576	576
Available Generation	8142	8142	8142	8142	8142	8142	8142	8142	8142	8142
Normal Import <sup>1</sup>	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Energy Efficiency <sup>2</sup> per Fig. 3	24	59	88	116	144	171	199	226	254	282
Total Avail. Resources	10166	10201	10230	10258	10286	10312	10340	10367	10395	10423
<b>Surplus/Deficiency<sup>3</sup></b>	<b>1056</b>	<b>956</b>	<b>865</b>	<b>778</b>	<b>706</b>	<b>622</b>	<b>560</b>	<b>487</b>	<b>430</b>	<b>373</b>
<b>Approved Generation Projects</b>										
Ameresco	5	5	5	5	5	5	5	5	5	5
Project 150 <sup>4</sup>	16	31	58	96	96	96	96	96	96	96
PSEG Power New Haven		130	130	130	130	130	130	130	130	130
CMEEC DG	38	38	38	38	38	38	38	38	38	38
Ansonia		58	58	58	58	58	58	58	58	58
<b>Surplus/Deficiency</b>	<b>1115</b>	<b>1218</b>	<b>1154</b>	<b>1105</b>	<b>1033</b>	<b>949</b>	<b>887</b>	<b>814</b>	<b>757</b>	<b>700</b>
<b>Possible Generation Retirements Per 2010 IRP<sup>5</sup></b>										
			-696	-696	-696	-1503	-1503	-1503	-1503	-1503
<b>Surplus/Deficiency</b>	<b>1115</b>	<b>1218</b>	<b>458</b>	<b>409</b>	<b>337</b>	<b>-554</b>	<b>-616</b>	<b>-689</b>	<b>-746</b>	<b>-803</b>
<b>Future Projects Under Council Review</b>										
NEEWS <sup>6,7,8</sup>	0	0	300	300	700	1100	1100	1100	1100	1100
<b>Future Projects Not Yet Filed<sup>9</sup></b>										
South Norwalk Renewable Generation (Proj. 1		36	36	36	36	36	36	36	36	36
Stamford Hospital Fuel Cell CHP (Proj. 150)		5	5	5	5	5	5	5	5	5
Clearview East Canaan Energy, LLC (Proj. 15		3	3	3	3	3	3	3	3	3
Waterbury Hospital Fuel Cell CHP (Proj. 150)		3	3	3	3	3	3	3	3	3
Cube Fuel Cell (Proj. 150)		3	3	3	3	3	3	3	3	3
DFC-ERG Trumbull (Proj. 150)		3	3	3	3	3	3	3	3	3
CMEEC DG		12	12	12	12	12	12	12	12	12
<b>Total Net Surplus/Deficiency</b>	<b>1115</b>	<b>1283</b>	<b>823</b>	<b>774</b>	<b>1102</b>	<b>611</b>	<b>549</b>	<b>476</b>	<b>419</b>	<b>362</b>

<sup>1</sup>This is an average value. The actual import capacity can range between 1,500 MW to 2,500 MW.

<sup>2</sup>This takes into account only passive (non-dispatched) demand reductions such as energy efficiency, to be conservative.

<sup>3</sup>This is based on a one-in-ten years event and assumes conservative import capacity, no load response, and no newly-approved generation.

<sup>4</sup>Only the Council-approved projects associated with Project 150 are listed in this row.

<sup>5</sup>Such retirements are hypothetical based on certain conditions, and are difficult to predict with certainty at this time, especially since they require ISO-NE approval.

<sup>6</sup>NEEWS is a group of transmission projects, three of which are in Connecticut. The Council has already approved one: the Greater Springfield Reliability Project.

<sup>7</sup>The other NEEWS applications are expected to be received in the future.

<sup>8</sup>The effect of NEEWS on import capacity will ultimately depend on which of the projects are approved and their final configuration(s).

<sup>9</sup>It is not known when these projects will be filed with the Council or whether they would be approved.

## **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 (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), mercury, and carbon monoxide. (SO<sub>x</sub> and NO<sub>x</sub> contribute to acid rain and smog.) Nuclear plants also do not emit carbon dioxide, 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 2100 MW of summer capacity, approximately 25.8 percent of the State's generating capacity. The Millstone facility is the largest generating facility in Connecticut by power output.

The former Millstone 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.

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.

On October 29, 2010, the Council received a petition from Dominion for a declaratory ruling that no Certificate is required for the proposed replacement of the Reserve Station Service Transformer and Normal Station Service Transformer for the Millstone Unit 2 facility. On December 2, 2010, the Council approved the petition. This project is expected to maintain reliability at the Millstone facility.

### **Coal Powered Generation**

Connecticut has two coal-fired electric generating facilities contributing 566 MW, or approximately 7.0 percent of the State's current capacity. The AES Thames facility, located in Montville, burns domestic coal and generates approximately 182.65 MW. The AES Thames facility is technically a cogeneration facility because, besides generating electricity for the grid, it also provides process steam to the Jefferson Smurfit-Stone Container Corporation.

The other coal-fired generating facility in Connecticut is the Bridgeport Harbor #3 facility located in Bridgeport. This facility burns imported coal and has a summer power output of approximately 383.43 MW.

While both of these facilities are listed as coal/oil in Appendix A, the Council notes that the AES Thames facility is not a dual-fuel facility and cannot operate on oil alone. Oil is only used to help ignite the coal initially to start the plant. However, the Bridgeport Harbor #3 unit is a dual-fuel facility capable of operating on oil only.

In general, using coal as fuel has the advantages of an abundant domestic supply (US reserves are projected to last more than 250 years), and an existing rail infrastructure to transport the coal. However, despite the advantages of domestic coal, generators sometimes find imported coal more economical to use. With very low sulfur content, imported coal does not require as much cost for emissions control.

In conventional coal-fired plants, coal is pulverized into a dust and burned to heat steam for operating the turbines. However, burning coal to make electricity causes air pollution. Pollutants emitted include sulfur dioxide, carbon dioxide, and mercury. Coal-fired power plants have high carbon dioxide emissions relative to plants using other fuels; thus, they are considered particularly significant contributors to global warming.

### **Petroleum Powered Generation**

Connecticut currently has 43 oil-fired electric generating facilities contributing 2983 MW, or 36.6 percent of the State's current capacity.

Additional oil-fired generation is not likely in the near future, due to market volatility and mounting oil prices. (However, replacement and/or repowering of existing aging units may occur.) In particular, the price of crude oil currently exceeds \$80 per barrel.

Moreover, oil-fired generation presents environmental problems, particularly related to the sulfur content of the oil, and may face tighter air-emissions standards in the near-term, such as regulation of carbon dioxide emissions. Some of the oil-fired generating facilities in Connecticut are dual-fueled, meaning that they can switch to natural gas if necessary. Currently, six generating units in Connecticut (Middletown #2 and #3; Montville #5; New Haven Harbor #1; Pierce; and Waterbury Generation), totaling approximately 1055 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**

Connecticut currently has 20 natural gas-fired generating units (not including Lake Road<sup>8</sup> which is electrically more a part of Rhode Island than Connecticut) contributing a total of 1,384 MW, or 19.3 percent of the State's generating capacity. This includes additions

such as Waterbury Generation, Kleen Energy, and Middletown #12-15 with summer ratings of 98 MW, 620 MW, and 188 MW, respectively.

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 generating facilities also have the advantage of being linked directly to their domestic or North American fuel source via a pipeline.

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.

Two combined-cycle gas plants—the Towantic power plant in Oxford and the NRG facility in Meriden—have been approved by the Council, but remain pending due to market conditions. The estimated completion dates are not known at this time. Accordingly, to be conservative, they are not included in Table 2.

### **Hydroelectric Power Generation**

Connecticut's hydroelectric generation consists of 28 facilities contributing approximately 118 MW, or 1.4 percent of the State's current generating capacity. 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. The main obstacle to the development of additional hydroelectric generation in Connecticut is a lack of suitable sites.

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.

### **Solid Waste Power Generation**

Connecticut currently has approximately 180 MW of solid waste-fueled generation, or approximately 2.5 percent of the State's generation capacity. The Exeter generating plant in Sterling burns used tires, and has a summer rating of approximately 24 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 4.

**Table 4**

<b>Solid Waste-fueled Generation</b>	<b>MW</b>
Bridgeport (Wheelabrator)	59.25
Bristol Resource Recovery Facility	12.86
Lisbon Resource Recovery Facility	13.73
Preston Resource Recovery Facility	16.45
Wallingford Resource Recovery (Covanta) Facility	4.40
Connecticut Resource Recovery Agency - South Meadows Unit #5	24.26
Connecticut Resource Recovery Agency - South Meadows Unit #6	24.43
Exeter Tire-burning Facility	24.01
Total	179.39

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.

Recently passed energy legislation encourages the development and expansion of waste-to-energy facilities. Trash-to-energy plants are considered a Class II renewable resource, which could count toward the Renewable Portfolio Standards. (See later section titled "Renewable Portfolio Standards.")

### **Miscellaneous Distributed Generation**

Approximately 134 MW of electricity is generated by 67 independent entities in Connecticut such as schools, businesses, and homes. This portion of generation is not credited to the State's capability to meet demand because ISO-NE does not control its dispatch. However, these privately-owned units do serve to reduce the net load on the grid, particularly during periods of peak demand. 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. The newest significant addition to this category is the 24.9 MW cogeneration facility at the University of Connecticut. This unit was put into service in August 2005.

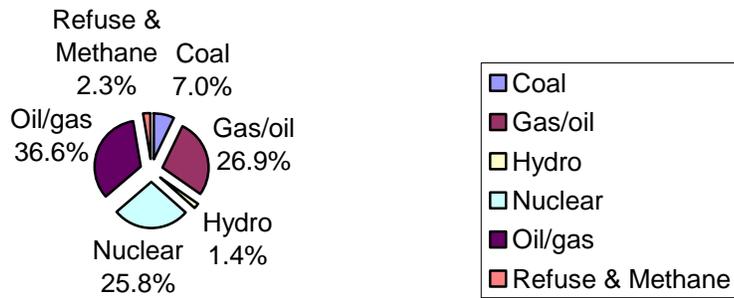
The applications for distributed-connected fuel cell have been quite steady, and thus the Council has approved seven projects totaling 4,100 kW or 4.1 MW in 2011 so far. These have not been included in Table 1 because they are not ISO-NE dispatched.

A significant portion of the small generation category is supported by programs for clean energy, which include small wind and solar PV. Finally, several unreported units may be in service in Connecticut. Therefore, the total amount of miscellaneous small generation is an approximation at best.

## Fuel Mix

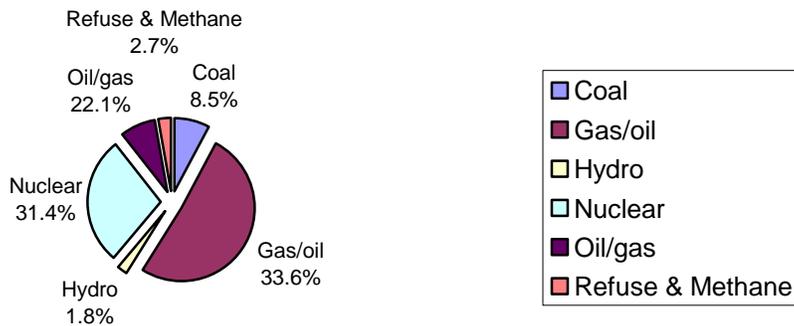
Based on existing generation and future (approved) generation projected in Table 1, the estimated fuel mix (by MW) is provided below for 2011 and also 2020, the end of the forecast period. The retirement assumptions of the 2010 IRP are included in the 2020 Fuel Mix chart. See Figure 4a and 4b below.

**Figure 4a: 2010 Fuel Mix (Capacity)**



\*Lake Road plant (~745 MW) is not included in the fuel mix charts because it is electrically more a part of Rhode Island than Connecticut.

**Figure 4b: 2020 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.

Connecticut has one 345-kV tie with each bordering state. The 345-kV tie from New York can carry 18 percent of our import capacity. The 345-kV tie from Rhode Island can carry 31 percent. The 345-kV tie from Massachusetts can carry about 32 percent. This results in 81 percent of our imports being carried on high-capacity lines. The remaining power is carried via 115-kV interstate connections.

While the previous imports mentioned have all been on the alternating current (AC) transmission system, there is one direct current (DC) tie between New Haven and Long Island called the Cross Sound Cable. The Cross Sound Cable is 150-kV DC and has a capacity of approximately 330 MW in either direction.

The 2500 MW import capability only represents about 30 percent of the State's peak demand. Looking ahead, CL&P is developing a transmission upgrade plan that would increase the State's import capacity to approximately 45 percent of peak demand. This plan would significantly increase the reliability of Connecticut's supply system and allow for greater import of economical supply. This plan is known as NEEWS. (See Transmission section.)

## **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 five FCM auction results are listed below.

<b>Results of the First Five Forward Capacity Auctions</b>									
Auction	Total Qualified	Acquired Generation	Acquired Demand Resources	Acquired Imports	Total Capacity Acquired	Projected Capacity Need	Floor Price	Excess Supply	Prorated Price
	MW	MW	MW	MW	MW	MW	\$	MW	\$
2010/11	39165	30865	2279	933	34077	32305	4.5	1772	4.25
2011/12	42777	32207	2778	2298	37283	32528	3.6	4755	3.12
2012/13	42745	32228	2867	1901	36996	31965	2.95	5031	2.54
2013/14	40412	32247	3261	1993	37501	32127	2.95	5374	2.52
2014/15	40077	31439	3468	2011	36918	33200	3.21	3718	2.86
Source: ISO-NE Press Release dated June 27, 2011									

### **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](http://www.iso-ne.com/markets/mkt_anlys_rpts/annl_mkt_rpts/index.html).

## **Legislation Affecting Supply**

### **Renewable Portfolio Standards**

Connecticut, like most other states, has adopted Renewable Portfolio Standards (RPS), which require a certain percentage of the electricity used in our State to be generated from renewable fuels. The types of fuels that can be considered renewable differ somewhat from state to state, but in Connecticut they are divided into three different classes. Class I renewable fuels include: solar power, wind power, fuel cells, methane gas from landfills, low-emission energy conservation technologies, run-of-river hydropower,

and sustainable biomass. Class II renewable fuels include: municipal solid waste burned to generate electricity, certain kinds of biomass, and run-of-river hydropower. (The difference between Class I and Class II run-of-river hydropower is the date by which a hydropower generating facility began operations. Facilities operating before July 1, 2003 are considered Class II.) Those which began operating after this date are considered Class I. Class III renewable fuels include heat and power systems with an efficiency of at least 50 percent, electricity generated by capturing waste heat from industrial or commercial processes, and electricity saved through conservation and load management programs.

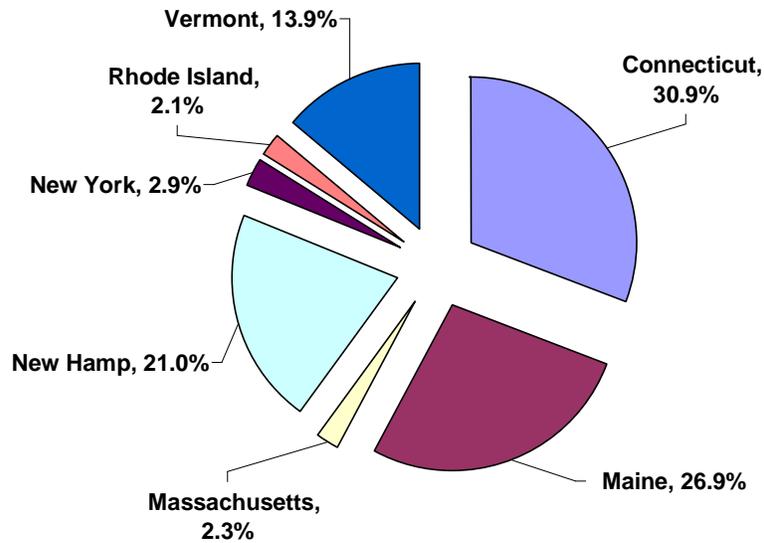
The percentage of electricity used in the State that must be generated from renewable sources escalates through the year 2020. Connecticut’s escalating RPS is shown in the following table.

<b>Year</b>	<b>Class I %</b>	<b>Class II %</b>	<b>Class III %</b>	<b>Total %</b>
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

Every year, PURA collects information from Connecticut’s electricity generators and the utilities that provide electricity to State customers to determine if they were able to meet the RPS for that year. (CMEEC is exempt from the RPS requirements, although some of its electricity is generated from renewable fuels.) The most recent year for which this information is available is 2009. The information gathered by PURA for this year indicates that Connecticut was able to meet its RPS, which were 6 percent for Class I fuels, 3 percent for Class II fuels, and 3 percent for Class III fuels, for a total requirement of 12 percent.

Sixty-nine percent of the megawatt-hours (MWh) produced by renewable fuels and consumed in our State were generated in the other New England states, with a small percentage originating in New York, although the largest single portion was generated in Connecticut: 31 percent. The following chart depicts the geographic origin of the renewable megawatt hours consumed in Connecticut in 2009.

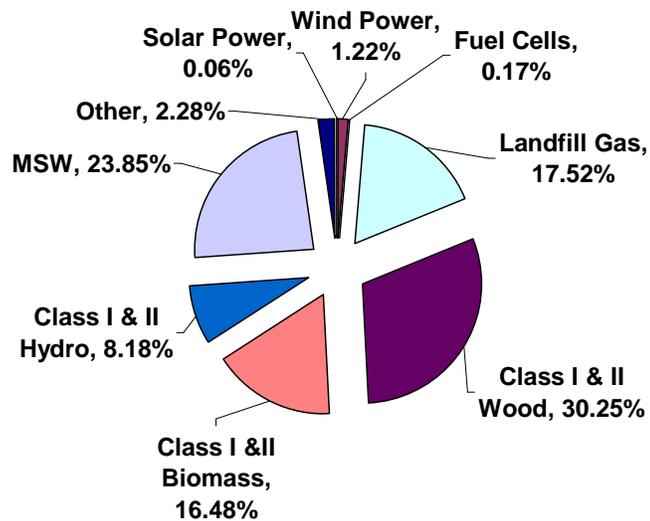
### 2009 - Origin of Renewable MWh Generated, by %



Source: Dept. of Public Utility Control Docket #10-09-06 – Annual Review of Connecticut Electric Suppliers’ and Electric Distribution Companies’ Compliance with Connecticut’s Renewable Energy Portfolio Standards in the year 2009.

In 2009, Class I and II wood-fired generators accounted for the largest proportion of electricity produced by the different types of renewable fuel, followed closely by municipal solid waste. The respective percentages of electricity produced by the different renewable fuels (from the above states combined) are shown in the following chart.

### 2009 Renewable Class I & II Fuels, by %



Source: Dept. of Public Utility Control Docket #10-09-06 – Annual Review of Connecticut Electric Suppliers’ and Electric Distribution Companies’ Compliance with Connecticut’s Renewable Energy Portfolio Standards in the year 2009.

During the ten-year forecast period, Connecticut will have to produce or import increasing amounts of electricity generated from renewable fuels. From 2010 to 2020, ISO-NE forecasts that the State’s annual usage of electricity will increase 14.4 percent from 32295 GWh to 36950 GWh. Applying Connecticut’s escalating RPS to these numbers means that, in this same time period, the State’s requirement for electricity generated by renewable fuels will more than double from 4521 GWh to 9,977 GWh. The following table summarizes Connecticut’s forecasted annual demand for electricity and electricity to be generated by renewable fuels.

<b>Year</b>	<b>ISO Forecasted GWh</b>	<b>RPS %</b>	<b>RPS Required GWh</b>
2010	32,295	14.0	4,521
2011	33,795	15.0	5,069
2012	34,395	16.0	5,503
2013	34,720	17.0	5,902
2014	35,140	18.0	6,325
2015	35,480	19.5	6,919
2016	35,790	21.0	7,516
2017	36,090	22.5	8,120
2018	36,385	24.0	8,732
2019	36,665	26.5	9,716
2020	36,950	27.0	9,977

(Source: ISO-NE CA and States History: Annual Energy, Coincident & Own Seasonal Peak Load and Load Factor, and 2011 CELT & RSP Forecast Detail: ISO-NE Control Area, New England States, RSP Sub-areas, and SMD Load Zones)

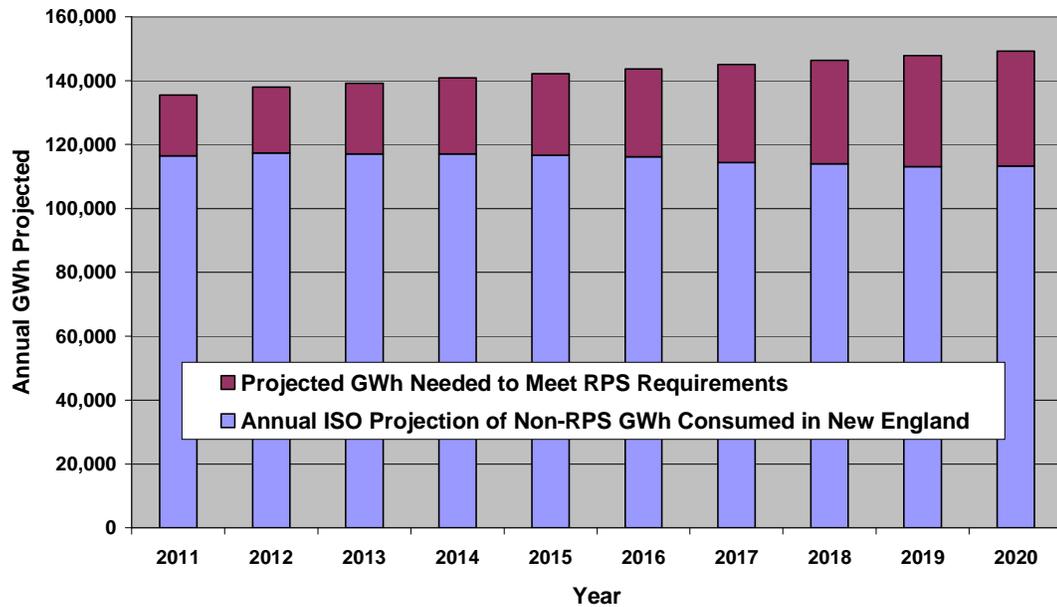
Connecticut is not the only state that will require greater amounts of electricity generated from renewable fuels. Each of the other New England states, with the exception of Vermont (which has similar requirements although they are not strictly considered RPS), has also mandated escalating RPS. Based upon ISO-NE forecasts for the years 2010 through 2020, New England's annual electricity usage is expected to increase by approximately 14 percent, from 130,330 to 149,145 GWh. In order to meet all of the New England states' various renewable requirements, the amount of electricity generated by renewable fuels will have to double, going from 17,311 GWh in 2010 to 35,921 GWh in 2020. The percentage that renewable hours must comprise of the total amount of electricity consumed in New England will have to increase from 13 percent in 2010 to 24 percent in 2020. The following table summarizes the New England state's renewable requirements as calculated per ISO-NE's yearly forecasts.

<b>Year</b>	<b>ISO Forecasted GWh for NE</b>	<b>NE RPS %</b>	<b>RPS Required GWh for NE</b>
2010	130,770	13.2	17,311
2011	135,455	14.0	18,984
2012	137,955	15.0	20,653
2013	139,230	15.9	22,161
2014	140,830	16.9	23,758
2015	142,215	18.0	25,561
2016	143,585	19.1	27,394
2017	144,980	21.1	30,639
2018	146,390	22.1	32,422
2019	147,760	23.4	34,594
2020	149,145	24.1	35,921

(Source: ISO-NE CA and States History: Annual Energy, Coincident & Own Seasonal Peak Load and Load Factor, and 2011 CELT & RSP Forecast Detail: ISO-NE Control Area, New England States, RSP Sub-areas, and SMD Load Zones; ISO-New England Regional System Plan, Section 8.5 – Renewable Portfolio Standards)

The following chart is a graphic depiction of the information contained in the above table. It shows how the renewable requirements of New England's states will require an increasing proportion of the electricity our region consumes to be generated by renewable fuels.

### Projected Growth in New England GWh Consumed and RPS GWh Required, 2011 - 2020



(Source: ISO-NE CA and States History: Annual Energy, Coincident & Own Seasonal Peak Load and Load Factor, and 2011 CELT & RSP Forecast Detail: ISO-NE Control Area, New England States, RSP Sub-areas, and SMD Load Zones; ISO-New England Regional System Plan, Section 8.5 – Renewable Portfolio Standards)

Although Connecticut has been able to meet its RPS up to now, will we, and the other New England states, be able to continue to do so as the requirements for renewable electric generation escalate over the forecast period?

As of April 1, 2010, ISO-NE had a total of 52 renewable energy projects in its generator interconnection queue. These projects had an aggregate nameplate capacity of 3,515 MW and included facilities that used hydro, landfill gas, biomass, onshore and offshore wind, and fuel cells as fuel. ISO assumed that these projects would have an average capacity factor of 40 percent. At this capacity factor, the projects in ISO's queue would be able to generate approximately 12,443 GWh per year. This amount of generation would not allow New England to meet the demand for an additional, approximately 18,000 GWh of renewable electricity needed to meet the region's adopted requirements for the use of renewable fuels by 2020.

RPS requirements will undoubtedly drive the development of additional renewable energy projects during the coming years. These projects may include small, onsite and behind-the-meter facilities such as the fuel cells that are being increasingly installed at industrial and commercial facilities, as well as new, larger projects. Tax subsidies and other forms of government assistance may also spur development of renewable projects.

There is also the potential to import electricity generated from renewable fuels from outside the US—Canada, for example.

Complicating these dynamics are moves by New England states to re-classify certain fuels considered renewable. Connecticut, for instance, views an upgrade for hydropower from dams as a chance to meet its RPS with imports from Hydro Quebec, while Massachusetts has down-graded biomass as a renewable, on account of new debate among scientists about the net pollution and carbon emissions from biomass compared with rates from natural gas, oil, and coal.

In the end, Renewable Portfolio Standards are not the only factor driving the development of increasing numbers of renewable fuel electricity generation projects. Concern over climate change and the contribution of carbon fuel emissions, a societal movement toward a more sustainable economy, and the need to lessen the nation's reliance on imported energy resources will conjoin to ensure that renewables will have a growing share in the mix of fuels used to generate Connecticut's electricity.

#### Regional Greenhouse Gas Initiative (RGGI)

RGGI grew out of a compact originally agreed to in 2001 by the governors of the New England states and eastern Canadian provinces to reduce greenhouse gas emissions. The first cap-and-trade program in the U.S., it is modeled after a federal program to curb acid rain started by G.H.W. Bush. A series of steps were taken toward implementation: an inventory of greenhouse gases in the region: a Memo of Understanding signed by member governors (2005); legislative approvals in all member states (2007 in Connecticut). Finally, RGGI began regular quarterly auctions of CO<sub>2</sub> allowances in January 2009. Allowances are essentially emissions permits, with one allowance offered per emission of one ton of CO<sub>2</sub>. Power producers pay for the allowances they buy with a surcharge on ratepayers, but RGGI, in turn, pays out the auction proceeds to all ten of its current member states, pro rata, for programs supporting clean energy. In Connecticut, after 12 auctions, \$35 million has been repaid into energy-efficiency programs, \$12 million to CCEF, and \$4 million to other energy programs and administration.

RGGI's first compliance period is up at the end of this year, and the program is being evaluated. It has operated as planned. It has benefited energy efficiency in Connecticut with \$51 million. It has demonstrated to the country that cap-and-trade programs can work. What is debatable is its cost-effectiveness in reducing greenhouse gases. Even at the start of RGGI auctions, the "cap", or pool of allowances, was significantly higher than actual emissions. Since then, the steep economic decline, a general electricity sector shift to natural gas, which is lower than other fossil fuels in CO<sub>2</sub> emissions, milder weather (on average), and public acceptance of energy efficiency have mitigated demand for electricity to such an extent that the supply of allowances substantially exceeds demand. In the June 2011 auction about one-third of the allowances went unsold at the floor price. Suggested changes to RGGI include retiring unsold allowances and lowering the cap in 2012, two years earlier than the cap was originally planned to ratchet down.

A continuing uncertainty is how RGGI will relate to new standards for carbon emissions set by the U.S. Environmental Protection Agency (EPA). Although RGGI states have asked EPA to give their power producers flexibility on the basis of RGGI allowances, the EPA has been silent. Also, the lack of a national cap-and-trade bill has isolated RGGI. On account of these and other uncertainties, RGGI's impacts to Connecticut's electric loads and resources cannot be quantified for 2011-2020.

## **TRANSMISSION SYSTEM**

Transmission is often referred to as the "backbone" of the electric system, since it transports large amounts of electricity over long distances efficiently 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.

The State's electric transmission system contains approximately: 413.1 circuit miles of 345-kV transmission; 1,300 circuit miles of 115-kV transmission; 5.8 circuit miles of 138-kV transmission; and 99.5 circuit miles of 69-kV transmission. (These figures refer to AC transmission. The Cross Sound Cable is not counted because it is DC.) Appendix B shows planned new transmission, reconductoring, or upgrading of existing lines to meet load growth and/or system operability needs.

Large generating units are typically connected to the 345-kV transmission system because they are higher capacity lines<sup>9</sup>. Older, smaller units are connected to the 115-kV system.

## **Substations and Switching Stations**

A substation is a grouping of electrical equipment including 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 four as new substations are planned for the next nine 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 2006, National Grid, a utility company that provides service in various parts of New England outside of Connecticut, CL&P, 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 would build 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, at the location of an existing connection point with Rhode Island. When combined with the three other projects within NEEWS, this one would increase the east-west power transfer capability across New England in general.

**The Greater Springfield Reliability Project** improves connections between Connecticut and Massachusetts to address particular problems in the Springfield, Massachusetts area. New 345-kV facilities would be built to tie the WMECO Ludlow Substation with Agawam Substation and also connect Agawam Substation with CL&P's North Bloomfield Substation in Bloomfield. The 345-kV connections from the north to Manchester Substation would also be improved.

**The Central Connecticut Reliability Project** is proposed to increase the reliability of power transfers from eastern Connecticut to western and southwest 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.

**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. Connecticut would be only minimally involved in this project.

Overall, the aggregate of the southern New England transmission reinforcements provided by NEEWS is expected to increase Connecticut's import capacity significantly. The Council has already reviewed and approved The Greater Springfield Reliability Project (GSRP), which is currently under construction. The other applications are expected to be filed with the Council within the forecast period.

### **Transmission associated with RPS**

As has been mentioned in an earlier sub-section on RPS, Connecticut will have to use imports significantly to meet its targets. 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 these transmission projects would come directly to Connecticut. All would have to pass a technical evaluation by ISO-NE and siting processes in multiple states. None are at a stage likely to result in an application to the Council during the forecast period.

## **Electric Transmission in Southwest Connecticut**

### **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" through 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. Construction is complete, and the line was activated in October 2006.

The third phase of the upgrade plan was the subject of Council Docket No. 272. This proposal was to construct a 345-kV transmission line from Middletown to Norwalk Substation. 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**

Within SWCT, a critical sub-area is called the Norwalk-Stamford Sub-Area. Historically, Norwalk and Stamford have relied on local generation. Since generation has become less economical, given electric restructuring, and given the age of generating plants around Norwalk and Stamford, the Norwalk-Stamford Sub-Area had to look at an additional 115-kV transmission line, rather than generation, to meet its increasing needs.

To address these needs, the Council reviewed and approved the construction of two new 115-kV underground transmission cables between the Norwalk Substation in Norwalk and the Glenbrook Substation in Stamford. This project, proposed by CL&P, will effectively 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. SWCT is currently being reviewed again by ISO-NE to determine if any further upgrades would be needed to ensure continued reliability going forward.

## **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—so-called “superconductors”—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, which can sometimes act as a type of generation (pumped hydro, for instance). Regardless, storage is an area where basic and

engineering research is concentrating. 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 medium of storage. Connecticut is one of the few states to have inaugurated an EV charging station, since CL&P has committed to supporting EVs.

### **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.”<sup>10</sup> 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.”<sup>11</sup>

Having anticipated the evolution of the Smart Grid, ISO-NE has already taken some steps to implement it. For instance, ISO-NE has installed phasor measurement equipment at its Eastern Interconnect to smooth inter-regional power flows. Within the distribution system, Connecticut’s utilities have been piloting smart meters. Other steps, however, such as a federal effort to establish standards for interoperability among regional transmission systems, have been aborted. In Connecticut, although an aspect of the Smart Grid called a “microgrid” has expressly been authorized by statute, with microgrids initially encouraged in a handful of municipalities, none have been established.

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 2011-2020.

## **RESOURCE PLANNING**

Since deregulation in 1998, energy resource planning in Connecticut has been distributed among the utilities and various groups within the executive and legislative branches of State government, resulting in problems with coherence and authority. Frequent calls to streamline the system of energy planning were met with well-intentioned fixes that gradually made the process more diffuse, not less. A diagram produced in 2008 by the Connecticut Academy of Science and Engineering (CASE) showed a collection of some 26 groups with direct or indirect roles in planning and their relationships to each other: the picture looked redundant and tangled<sup>12</sup>. As the energy planning process in State government became more fragmented, ISO-NE began to assume the role of principal planner. The Council has described this evolution in earlier forecasts. However, in 2007 the Connecticut legislature did pass a bill that streamlined energy resource planning, sharpening the State's priorities. In 2011, an even more sweeping change was made.

### **Connecticut Advisory Board (CEAB) and the Integrated Resource Plan (IRP)**

PA 07-242 restructured the CEAB, and required that it conduct studies on how to integrate and coordinate the State's energy entities to achieve the State's greenhouse gas goals, as well as evaluate the efficacy of the State's efficiency program delivery. Under this broad mandate, one of the CEAB's most important new duties was to review and approve an electric resource assessment and procurement plan—a plan to be submitted for approval by UI and CL&P. While the original statute specified that the plan should be annual, in 2009 the statute was revised to require the plan every even-numbered year.

On January 1, 2010, as required, the two utilities, along with their consultant, The Brattle Group, submitted their integrated resource plan (IRP). Per mandate, the IRP was reviewed and modified by the CEAB, and then re-drafted in the form of the CEAB's 2010 *Comprehensive Plan for the Procurement of Energy Resources*. The document was then submitted to the DPUC for final review and approval.

Both the CEAB and DPUC reviews invited public comment, which was vigorous. After this open year-long process, the CEAB's 2010 *Comprehensive Plan* announced the State's findings and priorities, primarily as listed below:

- Overall, the resource needs over the coming decade are defined by economic and environmental factors. A number of factors lead to the conclusion that the overall cost of power supply is likely to go up, including transmission costs, RPS costs, fuel prices, and, potentially the cost to meet carbon reduction goals. Demand-side resources best meet the combination of economic and environmental objectives;

- The State and the region are likely to have ample installed capacity to meet resource adequacy for the coming decade, assuming current load projections, aggressive regional demand-side programs, development of renewable resources to meet regional RPS targets, and limited retirements of existing fossil steam generation. Reference Case demand-side resources and build-out of renewables to meet the RPS will, if implemented, add significant capacity resources to the State and regional supply over this period;
- Reliability issues, if any, are most likely to arise as a result of the ISO-NE study of the remaining NEEWS projects and the four area studies underway in Connecticut;
- Economic analysis of energy efficiency potential shows the economic benefits of an aggressive demand-side program to be significant under a broad range of scenarios and assumptions over the longer-term;
- The estimated cost of renewable energy projects needed to meet Connecticut and regional RPS requirements are high, due to both the amount of supply called for in the RPS and the expected costs of the resources. The scale of the RPS requirement over the next decade could require transmission expansion to integrate those resources into the regional grid;
- The environmental performance of the Connecticut power system must meet more stringent NO<sub>x</sub> emissions in the coming years. Demand-side resources help meet these requirements, along with some assumed retirements and added emissions controls; and
- Under Waxman/Markey-like carbon cap-and-trade regimes, carbon emissions in the region decline somewhat over the planning horizon, due to the addition of RPS renewables and the significant reduction in coal-fired power production when carbon allowance costs approach \$30/ton.

### **Department of Energy and Environmental Protection (DEEP)**

PA 11-80 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, with new DEEP personnel. Perhaps most importantly, the Governor appointed as Commissioner of DEEP a person—Dan Esty—with extensive credentials at the intersection of environmental policy and energy resource planning.

PA 11-80 fulfilled one of Governor Malloy's campaign promises, intended to spur new jobs, decrease the cost of electricity, and generally boost entrepreneurship around all aspects of the energy sector. But DEEP has officially existed only since July 1, 2011, and many large and small issues of consolidation are unresolved. The Council cannot say, at this point, exactly how the steps of energy resource planning might change, how the

CEAB might function under these circumstances, what new directions the 2012 IRP might take, or whether Connecticut, even with a reformed planning process, will be able to reconcile State prerogatives with regional ones. Nonetheless, the Council welcomes any decisions to rationalize energy resource planning, as these will enable administrative agencies like ours to work more effectively, benefiting both the environment and the economy.

## CONCLUSION

This Council has considered Connecticut's electric energy future and finds that even taking into account the most conservative forecast, the ISO-NE 90/10 forecast, the electric generation supply during 2011-2020 will be adequate to meet demand. Neglecting retirements, going forward, Connecticut has a surplus of generation during the forecast period. When possible retirements are taken into account, the NEEWS projects, to the extent they are approved, would provide additional import capacity to offset such losses.

Connecticut's most significant 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. The transmission projects of SWCT are up and running. One NEEWS project has been reviewed and approved by the Council and is under construction, and applications for the remaining projects are anticipated in the future.

The Council makes the following further observations based on the information presented in this 2011-2020 review.

- A uniform forecasting methodology would be useful for the transmission/distribution companies to consider, consistent with the ISO-NE 90/10 forecast, which is considered the lead forecast.
- Energy efficiency and demand response programs have successfully reduced State load and are commanding a significant share in the ISO-NE forward capacity market. This justifies additional support for them, as recommended in the 2010 IRP.
- 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.
- Additional interstate transmission resources would allow greater transfer capability into Connecticut, increasing reliability and, of particular importance, helping meet the State's renewable portfolio requirements.

- 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. 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.
3. Electric energy consumption, as used in this report, includes losses. See "Losses" in Glossary.
4. This year, PA 11-80, the same act that formed DEEP, effectively transformed CCEF into a full-scale energy finance authority. It is empowered to leverage both public and private funds for expanded investment.
5. UI's C&LM projections include PA 10-179 reductions which were supposed to occur beginning in 2012. Accordingly, UI's projections are conservative, i.e. on the lower side.
6. The C&LM forecasts were developed in March of 2011 and reflect reduced energy efficiency funding as a result of PA 10-179.
7. Peak load reduction due to C&LM includes Energy Independence Act initiatives, excluding third party contracts.
8. 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. As such, it is not included in this forecast.
9. 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.

10. David Wagman, Power Engineering (March 2011, p. 4).
11. ISO-NE, “Overview of the Smart Grid—Policies, Initiatives, and Needs” (February 17, 2009), p. 1
12. “Preparing for Connecticut’s Energy Future” (December, 2008), p. vi.

### 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).

Annual Compound Growth Rate (ACGR): 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 nine 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,  $ACGR = (100\% * (((Final\ Value / Initial\ Value)^{(1/9))} - 1))$ .

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.

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.

**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, busbar, 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 contrasted 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.

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

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.

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.