Estimating the Potential for Cost Effective Electric Energy and Peak Demand Savings in Connecticut

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ABSTRACT

This paper presents estimates of the maximum achievable cost effective potential for electric energy and peak demand savings from energy efficiency measures in the geographic region of Connecticut served by United Illuminating (UI) and Connecticut Light and Power Company (CL&P) for the ten year period from 2003 through 2012. The results of the study showed that there is a significant savings potential in Connecticut for the implementation of additional and long-lasting cost effective energy efficiency measures. The net present value savings to ratepayers in Connecticut is ***$1.8 billion*** if the maximum achievable cost effective potential is captured by CL&P's and UI's programs over the next decade. In addition, there are significant reductions in emissions from power plants in the State and there are other significant non-energy benefits.

This paper presents the detailed sector-level results of the study, including: 1) energy efficiency supply curves; 2) energy savings potential broken down by measure type (i.e., early replacement, retrofit, and replace-on-burnout) and end-use category; and 3) benefit/cost ratios. In addition, the paper describes, in step-by-step fashion, the methodologies used in estimating technical potential, maximum achievable potential and maximum achievable cost effective potential for each sector (residential, commercial, industrial). Finally, the paper discusses the valuable lessons learned through the process of completing this study, including insights for others considering similar efforts. The paper also provides suggestions for preliminary assessments and data collection to be conducted prior to embarking on energy efficiency potential studies. One unique aspect of this study which confounded an already challenging project was the re-allocation of the State's energy efficiency funds by the Governor and State legislature in order to address statewide funding deficits, which resulted in immediate layoffs of utility personnel who were critical to the project. The paper will conclude with comparisons of Connecticut efficiency potential to results of recent studies for other states.

Introduction

This paper presents the results of an independent assessment of the conservation and energy efficiency potential for Connecticut and the Southwest Connecticut Region. This assessment was prepared for the Connecticut Energy Conservation Management Board (ECMB) by GDS Associates, Inc. with support from Quantum Consulting and the Lawrence Berkeley National Laboratory (LBNL). Critical to this effort was the input and technical support from Connecticut Light & Power Company (CL&P), United Illuminating (UI), and the ECMB's consultants.

The study which is the subject of this paper estimated the maximum achievable cost effective potential for electric energy and peak demand savings from electric energy efficiency measures in the geographic region of Connecticut served by United Illuminating and Connecticut Light and Power Company. Energy efficiency opportunities typically are physical, long-lasting changes to buildings and equipment that result in decreased energy use while maintaining the same or improved levels of energy service. The study showed that there is significant savings potential in Connecticut for implementation of additional and long-lasting energy efficiency measures. Capturing the maximum achievable cost effective potential for energy efficiency in Connecticut will reduce peak demand by 12.5% (908 MW) and electric energy use by 13.4% (4,466 GWh) by 2012, resulting in zero growth in electric load from 2003 through 2012. Load reductions from load management and load response measures, which were not analyzed in this study, would be in addition to the energy efficiency savings.

The overall objective of the study was to estimate the maximum achievable cost effective potential for energy conservation and energy efficiency resources over the ten-year period from 2003 through 2012 in three geographic areas: 1) Connecticut statewide[1]; 2) the 52 towns in the constrained area of Southwest Connecticut; and, the 16 critical constrained area towns in Southwest Connecticut (the Norwalk-Stamford area). The breakout of the Southwest Connecticut areas for the study was due to serious electrical transmission constraints in those areas. The study offered detailed load reduction and energy saving estimates for these areas but this paper will focus on the statewide results.

The definitions used in the study, and discussed throughout this paper, for energy efficiency potential estimates were defined as follows:

- **Technical potential** was defined as the complete penetration of all measures analyzed in applications where they were deemed technically feasible from an engineering perspective. For all sectors, the analysis only included measures that are commercially available, no emerging technologies were addressed.
- **Maximum achievable potential** was defined as the maximum penetration of an efficient measure that would be adopted given unlimited funding, and by determining the maximum market penetration that can be achieved with a concerted, sustained campaign involving highly aggressive programs and market intervention. The term "maximum" refers to efficiency measure penetration, and meant that the GDS Team had based their estimates of efficiency potential on the maximum realistic penetration that could be achieved by 2012. The term "maximum" does not apply to other factors used in developing these estimates, such as measures energy savings or measure lives.
- **Maximum achievable cost effective potential** was defined as the potential for maximum penetration of energy efficient measures that are cost effective according to the Total Resource Cost test, and would be adopted given unlimited funding, and by determining the maximum market penetration that can be achieved with a concerted, sustained campaign involving highly aggressive programs and market interventions.

[1] For the purposes of this paper, Connecticut statewide refers to the areas served by CL&P and UI.

Methodologies for Estimating Efficiency Potential in Each Sector

This section describes the methodologies that were used to estimate the levels of load reduction (MW) and energy savings (GWh) for the State of Connecticut.

The maximum achievable potential estimate provides a measure of the maximum amount of energy that could be saved if most households and businesses in Connecticut replaced their standard efficient equipment with energy efficient technologies over the ten-year forecast period of the study. The estimation of the cost effective maximum achievable potential is based on the assumption that energy efficiency measures or bundles of measures would only be included in statewide efficiency programs when it was cost effective to do so.

The methodology used in the determination of the potential for electricity efficiency improvement in all sectors followed similar steps, as follows:

1. Identification of data sources to be used in the study;
2. Identification of measures to be included in the assessment;
3. Determination of the characteristics of each measure including its incremental cost, energy savings, operations and maintenance savings, useful life, and peak demand impacts;
4. Calculation of initial cost-effectiveness screening metrics (e.g., levelized $ per kWh saved and the total resource cost (TRC) benefit cost ratio) and sorting of measures from least cost to highest cost;
5. Collection and analysis of the baseline and forecasted characteristics of the market including equipment saturation levels and consumption and peak demand, by market segment and end use over the forecast period;
6. Integration of measure characteristics and baseline data to produce estimates of cumulative costs and savings across all measures (supply curves);
7. Determination of the cumulative technical and maximum achievable potentials using supply curves; and,
8. Determination of the annual maximum achievable potential over the ten-year forecast period.

Energy Efficiency Supply Curves

A key element in the approach used in this study was the use of energy efficiency supply curves. Supply curves are a common tool in economics. In the 1970s, conservation supply curves were developed by energy analysts as a means of ranking energy conservation investments alongside investments in energy supply in order to assess the least cost approach to meeting energy service needs.

The advantage of using an energy-efficiency supply curve is that it provides a clear, easy-to-understand framework for summarizing a variety of complex information about energy efficiency technologies, their costs, and the potential for energy savings. Properly constructed, an energy-efficiency supply curve avoids the double counting of energy savings across measures by accounting for interactions between measures, is independent of prices, and also provides a simplified framework to compare the costs of efficiency with the costs of energy supply technologies.

The conservation supply curve approach also has certain limitations. In particular, the potential energy savings for a particular sector are dependent on the underlying load forecast for the sector as well as the measures that are listed and/or analyzed at a particular point in time. There may be additional energy efficiency measures or technologies that do not get included in an analysis, or the fraction of the market to which a measure applies may be miss-stated, so savings may be underestimated or overestimated. In addition, the costs of efficiency improvements (initial investment costs plus operation and maintenance costs) do not include all of the transaction costs for acquiring all of the appropriate information needed to evaluate and choose an investment and there may be additional investment barriers as well that are not accounted for in the analysis. There are a number of other advantages and limitations of energy efficiency supply curves that are discussed in the paper entitled Developing Greenhouse Mitigation Supply Curves for In-State Sources (Rufo 2003).

Residential Sector – Bottom-Up Approach

The approach for estimating efficiency potential in the residential sector was to estimate the saturation of the energy efficiency equipment and practices in Connecticut homes and then determine the impact of addressing what remains. The term "bottom-up" refers to the method of determining efficiency potential by estimating the amount of inefficient equipment, or similarly inefficient building practices, that remains in the region and the corresponding savings from replacing it.

The core equation used to calculate the energy efficiency technical potential for each individual efficiency measure is shown in Table 1 and followed by definitions of each of the equation components. In addition, Table 1 illustrates an example calculation for residential efficient lighting using the core equation. This example involves the case of a typical 75-Watt incandescent lamp which is replaced by a 19-Watt CFL in the residential sector in Connecticut. Technical potential for peak demand reduction is calculated analogously.

Table 1. Core Equation – Residential

Technical Potential of Efficient Measure	=	Total Number of Residential Households in State of Connecticut	*	Base Case Equipment End Use Intensity (kWh per home)	*	Base Case Factor	*	Remaining Factor	*	Convertible Factor	*	Savings Factor
1,634 GWH	=	1,335,698	*	1,942	*	100%	*	84%	*	100%	*	75%

Definitions of core equation components are as follows:

- **Number of Households** is the number of residential electric customers in the market segment.
- **Base-case equipment EUI** is the electric energy used per customer per year by each base-case technology in each market segment. This is the consumption of the energy-using equipment that the efficient technology replaces or affects. For example, if the efficient measure were a CFL, the base EUI would be the annual kWh per household associated with all equivalent incandescent lamps in the home.

- **Base Case factor** is the fraction of the end use energy that is applicable for the efficient technology in a given market segment. For example, for a residential high-efficiency lighting technology, this would be the fraction of the energy use that is for incandescent lighting.
- **Remaining factor** is the fraction of applicable dwelling units or floor space that has not yet been converted to the efficient measure; that is, one minus the fraction of households or floor space that already have the energy efficient measure installed.
- **Convertible factor** is the fraction of the applicable dwelling units or floor space that is technically feasible for conversion to the efficient technology from an *engineering* perspective (e.g., due to accessibility issues and other technical constraints).
- **Savings factor** is the percentage reduction in energy consumption resulting from application of the efficient technology.

Commercial and Industrial Sectors – Top-Down Approach

A "top-down" approach was used to develop the technical potential estimates for the commercial and industrial sectors. The main difference from using a bottom-up method is that data is displayed in terms of energy rather than square feet or number of homes. It is important to note that square-foot based saturation assumptions cannot be applied to energy use values without taking into account differences in energy intensity, (e.g., incandescent fixtures that represent 2 percent of floor space may represent 5 percent of lighting energy because they are several-fold less efficient than the rest of the lighting stock).

In the top-down method, the core equation used to calculate the energy technical potential for each individual efficiency measure is calculated as shown in Table 2. In addition, Table 2 illustrates an example of how the core equation was used in the commercial sector for the case of a prototypical four-lamp, T8 fixture with an electronic ballast system, which is replaced by a Super T8 fixture in the office segment.

Table 2. Core Equation – Commercial and Industrial Sectors – Top Down Method

Technical Potential of Efficient Measure	=	Total End Use GWh (by segment)	*	Base Case Factor	*	Remaining Factor	*	Convertible Factor	*	Savings Factor
130.1 GWH	=	1,747	*	56%	*	95%	*	70%	*	20.0%

(Convertible factor of 70% reflects that 70% of market has already moved to T8 lighting.)

Total measure costs in the top-down method can be calculated as a function of savings using costs per first-year kWh saved as the basis. For the example above, if the incremental cost of the Super T-8 fixture is $12 and there are 3,000 full-load operation hours, the cost per first-year kWh saved is simply:

$12 ÷ [(0.12 kW/unit – 0.096 kW/unit) X 3,000 hours] = $0.167/first-year kWh

The total measure cost associated with the technical potential savings of 130.1 GWh can then calculated as:

130,100,000 first-year kWh X \$0.167/first-year kWh = \$21.7 million

Levelized costs are then adjusted through the supply curve method to account for reductions in savings that occur through the measure stacking process.

As noted above, a top-down approach was also used in the industrial sector to determine the technical and maximum achievable potential in Connecticut. As with the commercial sector, this results in data displayed in terms of energy rather than square feet. For the industrial sector, the core equation is identical to that described previously for the commercial sector. Table 3 illustrates an example of the core equation for the case of standard 1-5 horsepower motors being replaced by energy efficient motors in buildings within SIC Code 20 – Food.

Table 3. Industrial Core Equation Example – Efficient Motors

Replace a Standard Efficiency 1-5 HP Motor with a NEMA Premium Efficient Motor for SIC Code 20 – Food										
Technical Potential of Efficient Measure	=	Total End Use GWh (by segment)	*	Base Case Factor	*	Remaining Factor	*	Convertible Factor	*	Savings Factor
0.239 GWH	=	296.9	*	1.6%	*	87%	*	100%	*	5.7%

(Savings factor is expressed as share of electricity use.)

To determine the level of peak savings, the core equation is analogous with Total End Use kW (by segment) replacing Total End Use kWh (by segment). One item of note that was unique to the Industrial Sector was the inclusion of significant operation and maintenance (O&M) savings. For many measures, a savings on the O&M of the affected equipment was included in the economic analysis. This O&M savings was estimated on a cost per kWh basis and included in the calculation of the Cost of Conserved Energy (CCE) for each measure. In some cases, this resulted in a measure with a negative CCE. Table 4 illustrates the calculation of a negative CCE for the optimization of a compressed air system for SIC Code 20.

Table 4. Example of Cost of Conserved Energy Calculation

Measure	O&M Savings (\$/kWh)	CCE w/out O&M (\$/kWh)	Supply Curve CCE (\$/kWh)
Optimization of Compressed Air System	-0.02	0.007	-0.013

Estimating Maximum Achievable Potential Over the Ten Year Period

To estimate the maximum achievable potential for each year of the forecast period, we first separated the forecasts of energy and peak demand in Connecticut into existing and new construction. Existing construction is defined as the entire stock of buildings in place today. New construction is defined as the stock of buildings that is constructed over the 10 years of the forecast period. For new construction, energy-efficiency measures can be implemented when each new building is constructed, thus the rate of availability is a direct function of the rate of new construction. For existing building, determining the annual rate of availability of savings is more complex.

Energy-efficiency potential in the existing stock of buildings can be captured over time through two principal processes: 1) as equipment replacements are made normally in the market when a piece of equipment is at the end of its useful life ("market-driven" case) and 2) at any time in the life of the equipment or building ("retrofit" case). Market-driven measures are generally characterized by *incremental* measure costs and savings; whereas retrofit measures are generally characterized by full costs and savings. A specialized retrofit case is often referred to as "early replacement". This refers to a piece of equipment whose replacement is accelerated by several years, as compared to the market-driven assumption, for the purpose of capturing energy and peak demand savings earlier than they would otherwise occur. The rates of ramp-in used in this study for each of these types of measures are included in Table 5.

For certain energy efficiency measures, estimates of potential include both market-driven and early replacement-based savings. Examples of measures that are addressed using both approaches include residential refrigerators, residential air conditioning, commercial chillers and packaged AC units and early replacement of lighting fixtures in commercial buildings. Due to electrical capacity constraints, the accelerated replacement of air conditioning measures was particularly relevant to the Southwest Connecticut analysis.

For the "market driven" maximum achievable potential, we calculate the rate at which savings are available as a function of the useful life of each piece of equipment. A simplified form of this function is the inverse of the useful life; thus, if the average life of air conditioners is 20 years, their replacement is estimated to occur in the market-driven case at the rate of 1/20 per year. Retrofit measures are available for implementation by the entire eligible stock at any time; however, there are practical limits to reaching the entire stock of buildings over a short period of time. For retrofit measures, it was assumed that installations over time would be faster than those done through the market-driven approach. After a short ramp-up period early, it was assumed that retrofit measures would be implemented aggressively in early-to-mid years of the next decade. The annual ramp-in rates shown in Table 5 were applied to the cumulative annual maximum achievable cost effective potential available in the year 2012 to obtain the year-by-year energy savings potential for the period 2003 to 2012. By 2012, 100% of the available maximum achievable potential has been ramped-in.

Table 5. Annual Ramp-In Rates for Individual Energy Efficiency Measures

Year	Market Driven	Retrofit	Early Retirement
2003	10%	5%	5%
2004	10%	15%	10%
2005	10%	20%	20%
2006	10%	20%	30%
2007	10%	10%	35%
2008	10%	10%	0%
2009	10%	5%	0%
2010	10%	5%	0%
2011	10%	5%	0%
2012	10%	5%	0%

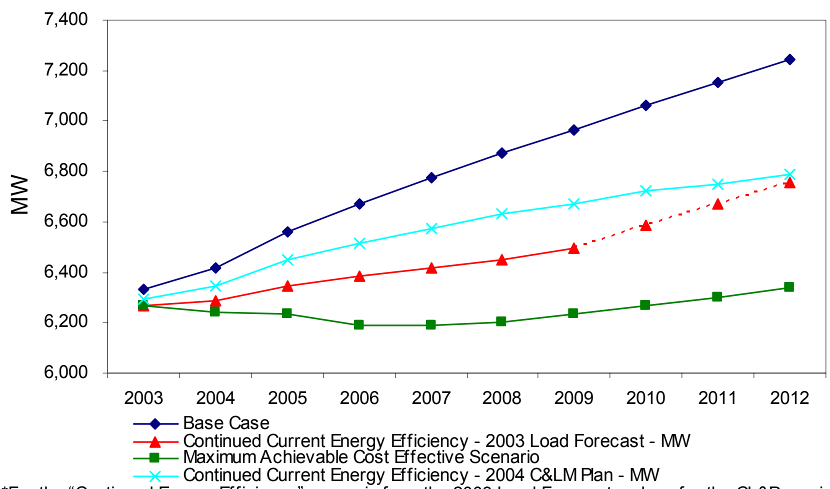
Findings: Estimated Maximum Achievable Cost-Effective Potential for Connecticut

This section includes the results of the study, including; the estimated values for reduced load (MW) and energy savings (GWh), the sector benefit/cost ratios, and the resulting supply curves.

If all energy efficiency measures analyzed in the study were implemented immediately where technically feasible, it was estimated that overall peak demand savings (technical potential) would be 1,748 megawatts (MW) on a statewide basis (a 24.1% reduction) and corresponding energy savings would be 8,021 GWh (a 24.2% reduction). The forecasted peak load in 2012 for the CL&P and UI service areas without energy efficiency programs is 7,243 MW. If all measures that are cost effective were implemented, and consumer acceptance trends and the timing of equipment replacements in the market were factored in, the maximum achievable cost effective potential peak demand savings amount to 908 MW in 2012 (a 12.5% reduction) and corresponding energy savings would be 4,466 GWh (a 13.4% reduction). It is important to note that the 908 MW potential reduction in the projected 2012 peak load did not include impacts of any load management or load response programs.

Figure 1 compares (1) a peak load (MW) forecast for the State of Connecticut assuming complete implementation of the maximum achievable cost effective potential scenario for energy efficiency, to (2) a "Base Case" scenario (the Base Case is the load forecast for the State of Connecticut that includes naturally occurring energy efficiency, but no "Public Benefits" funded conservation and load management programs), to (3) Connecticut's continued current level of energy efficiency efforts as stated in the utilities' 2003 load forecasts (equivalent to annual energy efficiency program funding of $72.5 million) and to (4) Connecticut's continued current level of energy efficiency efforts as stated in the utilities' 2004 C&LM Plans. A similar comparison was conducted for energy (GWh) forecasts for the State but is not shown in this paper due to space constraints.

Figure 1 Connecticut Summer Peak Load Forecast (MW): Base Case, Continued Current Energy Efficiency, and Maximum Achievable Cost Effective Potential



*For the "Continued Energy Efficiency" scenario from the 2003 Load Forecast, values for the CL&P service territor 2009 to 2012 are estimates based on the average of prior year values.

Table 6 provides information on the sources of the maximum achievable energy efficiency potential from early replacement, retrofit and replace-on-burnout markets. The majority (55%) of the statewide savings of 908 MW in 2012 come from retrofit measures (499 MW). The second largest contributor to savings is from replace-on-burnout measures (339 MW). Early replacement measures provide the remaining 69 MW of savings by 2012.

Table 6. Maximum Achievable Cost Effective Energy Efficiency Potential Load Reductions (MW) and Energy Savings (GWh) By Measure Type

Region	Maximum Achievable Cost-Effective Potential Savings (MW) in 2012			
	Commercial	Residential	Industrial	All Sectors
Statewide	575	240	93	908
Early Replacements	69	0	0	69
Retrofit Measures	327	99	74	499
Replace-On-Burnout (Cycle) Measures	179	141	19	339

Region	Maximum Achievable Cost-Effective Potential Savings (GWh) in 2012			
	Commercial	Residential	Industrial	All Sectors
Statewide	2,088	1,655	723	4,466
Early Replacements	242	0	0	242
Retrofit Measures	1,199	1,150	611	2,960
Replace-On-Burnout (Cycle) Measures	647	504	112	1,264

Present Value of Costs and Savings

The results of the study demonstrated that energy-efficiency resources could play a significantly expanded role in Connecticut's electricity resource mix over the next decade. Table 7 shows the present value of benefits and costs associated with implementing the maximum achievable potential energy savings in the State of Connecticut. The net present savings to citizens of the State for statewide implementation of programs are over $1.8 billion[2].

Table 7. Sector Level Benefit/Cost Ratios

	Total Resource Benefits, Costs, and Net Benefits			
State of Connecticut	Present Value Benefit	Present Value Cost	PV of Net Benefits	Benefit-Cost Ratio
Commercial Sector	$1,411,460,062	$358,414,779	$1,053,045,283	3.94
Residential Sector	$1,062,432,855	$390,141,582	$672,291,273	2.72
Industrial Sector	$341,431,615	$79,413,671	$262,017,944	4.30
All Sectors	$2,815,324,532	$827,970,032	$1,987,354,500	3.40
O&M Benefits (inc. avoided inc. bulb purchases)		$(80,156,204)		
Other Program Costs (25%)*		$206,992,508		
All Sectors	$2,815,324,532	$954,806,336	$1,780,361,992	2.95

**Other program costs estimated as 25% of total incremental measure costs, net of any O&M savings.*

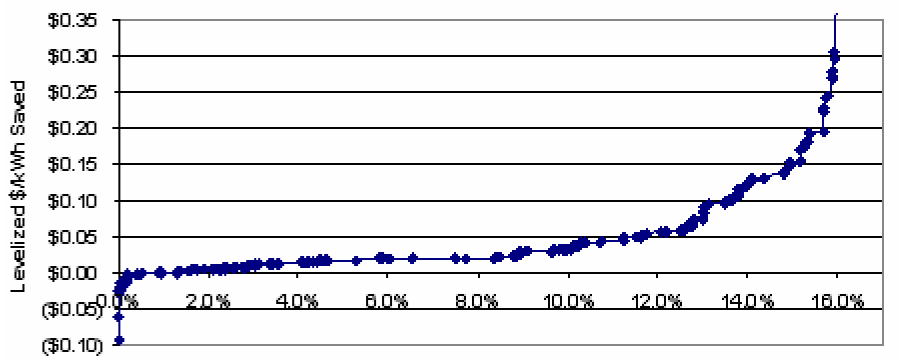
Values were calculated using version 9 of the "NSTAR" model, with CL&P avoided cost estimates..

[2] For this analysis, the following economic factors were used: Real Discount Rate of 5.61%, Inflation Rate of 2.45%, and Nominal Discount Rate of 8.20%.

Energy Efficiency Supply Curves

The maximum achievable potential supply curve for the State of Connecticut for all sectors (residential, commercial and industrial) is shown in Figure 2. The y-axis of this curve represents the levelized cost per kWh for each point (measure) on the curve. The x-axis represents the savings as a percent of total electricity sales. This curve is particularly useful because it allows for a simple comparison of the characteristics of energy efficiency with the characteristics of energy supply technologies. For example, the avoided cost for electricity can be drawn in at the appropriate point on the y-axis, indicating which measures would be fall below the cost of supply options. In a typical energy efficiency supply curve, the base-case end-use consumption is reduced with each unit of energy efficiency that is acquired and adjustments for measures that interact need to be performed where necessary.

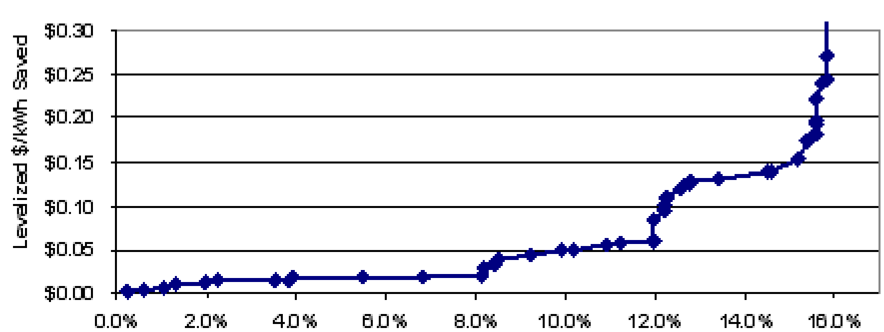
Figure 2. Maximum Achievable Potential for Energy Efficiency CT 2012 - All Sectors



Maximum Achievable Savings Potential as Percent of Total Electricity Sales

Residential sector. The residential sector maximum achievable potential supply curve for the state of Connecticut is shown in Figure 3. In the residential sector for existing homes, the major electricity savings opportunities are in the areas of lighting, electric heat, and electric water heating. Substantial electricity savings also will occur when older refrigerators and freezers are replaced with new models, and as older home appliances are replaced with ENERGY STAR® labeled models.

Figure 3. Maximum Achievable Savings Potential Residential Sector – State of Connecticut



Maximum Achievable Savings Potential as Percent of Total Electricity Sales

Key findings from the residential analysis included the following:

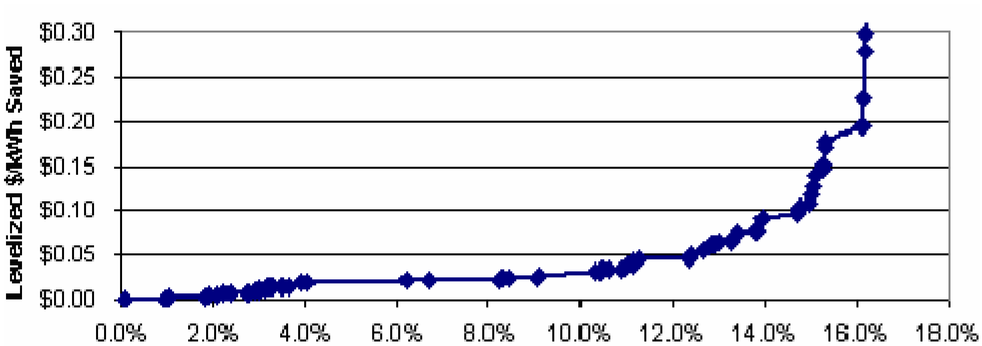
1. CFLs produce the most significant energy savings potential.
2. The measure with the lowest cost of conserved energy is the water heater pipe wrap (CCE of only $.00226 per kWh saved).
3. CFL and electric water heater measures have the lowest CCE values.

Commercial sector. Figure 4 illustrates the maximum achievable potential supply curve for the commercial sector for the State of Connecticut. There were 100 measures that were found to be applicable to the commercial sector (including measures that were attributed to both existing stock and new construction), and as shown on the supply curve, more than half of these measures have levelized cost per kWh values of $0.10 or less.

Following are a few key data points based upon the supply curve developed for the commercial sector in Connecticut:

1. Retrofitting T-12, 34 watt lighting with Super T-8 fixtures was found to be the measure with the most potential kWh (assuming 30% of the existing market has not yet converted to standard T-8 fixtures)
2. Nighttime shutdown of desktop computers was the measure with the lowest Cost of Conserved Energy (CCE) at $0.0005/kWh
3. The median CCE for this sector is $0.046/kWh[3]

Figure 4. Maximum Achievable Savings Potential
Commercial Sector – State of Connecticut



Industrial sector. Figure 5 illustrates the maximum achievable potential supply curve for the industrial sector in Connecticut. This graph includes data from 107 energy efficiency measures that were found to be applicable to the industrial sector.

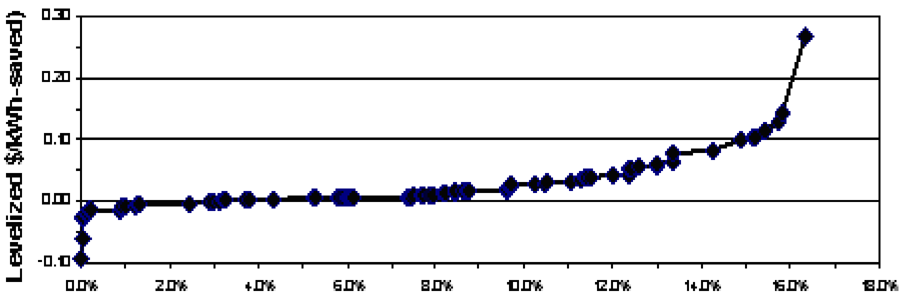
Following are a few key data points that came out of the supply curve development for the industrial sector.

1. Pump controls in the paper manufacturing industrial sector was found to be the measure with the most potential kWh savings

[3] The median value shown is for all measures in the supply curve. The median CCE for the cost effective measures only is $0.0266.

2. Near Net Shape Casting in the metal manufacturing industry was the measure with the lowest CCE at -$0.09/kWh (the negative value is a result of a large savings due to productivity benefits associated with this measure)
3. The median CCE for the Industrial sector is $0.01/kWh

Figure 5. Maximum Achievable Savings Potential
Industrial Sector – State of Connecticut



Maximum Achievable Savings Potential as Percent of Total Electricity

Comparisons to Other Recently Conducted Potential Studies

Table 8 provides a comparison of the Connecticut saving potential with other recent potential studies.

Table 8. Comparison of Technical and Achievable Potential Savings Percent of Total Energy (GWh) Sales

Sector	**Connecticut 2012**	**California 2011** (Rufo 2002; Coito 2003)	**Vermont 2012**[1] (Optimal 2002)	**Mass. 2007**[1] (RLW 2001)	**New York 2012**[2] (Optimal 2003)	**Southwest 2020**[3] (SWEEP 2002)
Technical Potential						
Residential	21%	22%			39%	26%(6)
Commercial	25%	18%			42%	37%(6)
Industrial	20%	15%			22%	33%(6)
Total	***24%***	***18%***			***38%***	***33%***(6)
Maximum Achievable Potential						
Residential	17%		30%			
Commercial	17%		32%			
Industrial	15%		32%			
Total	***17%***		***31%***			
Maximum Achievable Cost Effective Potential						
Residential	13%	10%		31%	28%	
Commercial	14%	10%		21%	40%	
Industrial	13%	9%		21%	20%	
Total	***13%***	***10%***		***24%***	***33%.***	

1. Vermont and Massachusetts studies reported commercial and industrial sectors together.
2. NY Maximum Achievable Cost Effective Potential values are Economic Potential Under High Avoided Costs.
3. Southwest values represent technical cost effective potential.

Lessons Learned

This section includes a few lessons learned and insights gained through the process of conducting this study.

A key area of uncertainty due to limited data was the current saturations of energy efficient equipment and practices in Connecticut. Although the Connecticut utilities have been delivering energy efficiency programs for many years, there was very limited information on the saturation of energy efficient equipment in all sectors. It is recommended that prior to commissioning a technical potential study, or in conjunction with the study, a baseline study of current practices or purchasing behaviors be conducted. Although this type of assessment can become expensive when several sectors and end-uses are involved, a baseline assessment should be considered even at a cursory level because region-specific information is invaluable in establishing accurate estimates of remaining potential.

Extensive research on measure-level data for energy efficient equipment and practices yielded solid data for 278 measures across the residential, commercial and industrial sectors. This data included kWh and kW savings, life of measure, and incremental or full cost (as appropriate). As described in the methodology section, this data was then applied to develop the potential for energy savings, and the related costs, in Connecticut. The one area that was not included at the measure-level was the costs associated with energy efficiency programs designed to deliver the estimated penetrations of high efficiency equipment. These costs are more difficult to accurately estimate and offer an area of uncertainty in the study. Conflicting theories on estimating these costs involve the idea that economies of scale with such large programs will drive down the program costs on a per kWh basis versus the thought that marginal savings will be increasingly difficult to achieve as more of the market is transformed and only the "late majority" and "laggards" are left.

As noted in the introduction, the input and technical support from CL&P and UI was not only helpful in estimating savings estimates but essential in obtaining load forecasts and other related data. Although the individuals from the utilities were active participants in this study and responsive with data requests, there was a looming cloud of uncertainty hovering over much of this study's timeframe as the Governor and State legislature were in the process of re-allocating the energy efficiency program funding reserves in order to address statewide funding deficits. This proved to confound an already complex and data-intensive effort and culminated in one of the key players being laid off in the middle of the study. Establishing a working relationship with the local utilities can be extremely helpful, and often critical, in conducting an efficiency potential study. It is also helpful if existing funding for energy efficiency programs is not on the chopping block while conducting the study.

How the Study Findings May Be Used

The findings in this study identify the amount of energy efficiency potential that remains in the State of Connecticut and pinpoints markets and cost effective efficiency measures that can provide the most savings at the lowest cost. The study will be useful to legislators in helping them to understand the return on investment they can achieve for every "public benefits" dollar invested in energy efficiency in Connecticut. Moreover, the data in the study relating to costs, energy savings and environmental benefits of energy efficiency measures are very useful for making decisions on which programs should be done first, which energy efficiency technologies offer the most savings, which technologies are most cost effective, and how the environment can benefit from aggressive programs. Finally, the study provides well-documented evidence of the large magnitude of net present value savings to the State available from energy efficiency over the next decade – almost 2 billion dollars.

This study did not seek to answer the larger resource-planning question of exactly how much energy efficiency ought to be purchased as part of an overall portfolio of electric resources for the State. However, the study is a critical source of information for policy-makers and decision-makers in Connecticut who are participating in funding decisions for existing and future energy efficiency programs in the State funded with public benefits dollars.

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