Version Date : 09/25/2009

UI and CL&P Program Savings Documentation
for
2010 Program Year

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INTRODUCTION

1.1 BACKGROUND

Introduction

In 1999, the State Legislature created the Energy Conservation Management Board (ECMB) to guide and assist the State's electric and gas distribution companies in the development and implementation of cost-effective energy conservation programs and market transformation initiatives (CGS § 16-245m). The Connecticut Energy Efficiency Fund (CEEF) created by this legislation provides the financial support for ECMB-guided programs and initiatives. The Department of Public Utility Control (DPUC) is responsible for final approval of all CEEF programs. The State's energy conservation efforts, as administered by Connecticut Light & Power and United Illuminating, with guidance from the ECMB, focus on realizing the following primary objectives:

1. **Advancing the Efficient Use of Energy**

Conservation and Load Management (C&LM) programs are critical in reducing overall energy consumption and reducing load during periods of high electric demand. These programs alleviate potential electricity shortages and reduce stress on transmission lines in the State, especially in southwestern Connecticut (SWCT).

2. **Reduce Air Pollution and Negative Environmental Impacts**

C&LM programs produce environmental benefits by slowing the electricity demand growth rate, thereby avoiding emissions that would otherwise be produced by increased power generation activities. The Environmental Protection Agency regulates criteria air pollutants under the Clean Air Act's National Ambient Air Quality Standards (NAAQSs). Connecticut's conservation programs have significantly reduced two NAAQS criteria pollutants emitted in the process of generating electricity: sulfur dioxide and nitrogen oxides. Carbon dioxide and other "greenhouse gases", such as methane, are also emitted during the process. Greenhouse gases have been linked to global warming and climate change. With decreased power production resulting from declining electrical demand as a result of conservation efforts, C&LM programs reduce carbon dioxide emissions. The programs also produce environmental benefits through reductions in consumption of natural gas and oil. C&LM programs, guided by the ECMB, support the State's environmental initiatives to reduce these air pollutants as well as fine particulate emissions and ozone.

3. **Promote Economic Development and Energy Security**

Energy efficiency programs generate considerable benefits for Connecticut customers. Conservation programs are tailored to meet the particular needs of all customer classes, thereby benefiting all State residents. Energy efficiency measures assist low-income customers in reducing their energy costs, which typically comprise a significant percentage of their household income. Other groups that benefit from energy conservation programs include educational institutions, manufacturers, non-profit organizations, residential customers and small businesses. Conservation programs made possible by the CEEF lower operating costs and improve efficiency, which increases the productivity of manufacturing processes for small and large businesses. By reducing operating costs and enhancing productivity, Connecticut businesses remain competitive in the dynamic global economy, avoiding unnecessary outsourcing of jobs and services. The retention of Connecticut businesses enhances the perception among potential businesses and investors that Connecticut's economy is healthy and productive.

Information regarding Connecticut's energy conservation programs is available at:

The Connecticut Light and Power Company:	www.cl-p.com
The United Illuminating Company:	www.uinet.com

Connecticut Natural Gas Corporation: www.cngcorp.com
Southern Connecticut Gas Company: www.soconngas.com
Yankee Gas Company: www.yankeegas.com
Conservation Program hot line (CL&P and UI): 1-877-WISE USE
The Energy Conservation Management Board:
http://www.state.ct.us/dpuc/ecmb/boardprocess.html

Purpose

This manual provides detailed, comprehensive documentation of all claimed resource costs and savings corresponding to individual C&LM technologies. This Program Savings Documentation (PSD) manual fulfills the Department's requirement to develop a Technical Reference Manual (Docket NO. 03-11-01PH02, DPUC Review of CL&P and UI Conservation and Load Management Plan for Year 2004 – Phase II, July 28, 2004).

Public Act 05-01, June (2005) Special Session, "An Act Concerning Energy Independence" (the "Act") established a class III requirement for electric suppliers and electric distribution companies. Following the passage of the Act, the DPUC held a proceeding to develop class III standards (Docket NO. 05-07-19, DPUC Proceeding to Develop a New Distributed Resource Portfolio Standard (Class III)). Based on the DPUC Final Decision in that Docket, the C&LM fund program's technical reference manual must be used as the basis to calculate energy efficiency for both C&LM and non-C&LM measures that qualify for Class III credits. As a result, C&LM and non-C&LM measures will be measured using the same baseline and parameters. The exception is that non-C&LM funded projects shall not incorporate free-ridership and spillover because these factors are specific to C&LM program savings, however, other impact factors (i.e. other realization rates) that are part of the energy savings calculations and methodologies must be incorporated into Class III savings calculations.

In June 2006, FERC approved a settlement that establishes a redesigned wholesale electric capacity market in New England designed to encourage the maintenance of current power plants and construction of new generation facilities. The settlement established a Forward Capacity Market ("FCM"). ISO New England, Inc., operator of the region's bulk power system and wholesale electricity markets, will project the energy needs of the region three years in advance and then hold an annual auction to purchase power resources to satisfy the region's future needs.

In response to ISO-NE solicitation for proposals for the first forward capacity auction, ("FCA1"), CL&P and UI submitted new demand-response resource/energy efficiency projects that will decrease electricity use. Per ISO-NE requirements, detailed Project Qualification Packages that include Measurement and Verification Plans ("M&V") were submitted. The purpose of ISO-NE's required M&V activity is to verify that energy conservation measures promoted by the programs were actually installed; are still in place and functioning as intended; and to measure the reduction in electrical demand compared to some baseline pattern of use. The CL&P and UI Program Savings Documentation ("PSD"), serves as the underpinning of the demand reduction value calculations that will be submitted in the FCM.

CL&P and UI have worked together over the past several years to develop common assumptions regarding measured savings for all types of energy efficient measures. This manual is a compilation of those efforts. C&LM savings claims will be traceable through cross-references to this manual. The manual will be reviewed annually (or as needed) and updated to reflect changes in technology, baselines, measured savings, evaluation work, and impact factors.

The C&LM savings calculations in this manual represent typical measures and prescriptive calculations used for those measures. In some cases, projects are more comprehensive and prescriptive measure calculations are not appropriate. To accurately calculate the savings related to these types of projects, more detailed spreadsheets or computer simulation models (DOE-2, Trace, HAP) must be used. Third-party engineering consultants may be contracted to run simulations and create many of these more detailed spreadsheets; all are reviewed for reasonableness.

Organization

C&LM measures in this manual are grouped by primary sector and reflect how programs and measures are organized within C&LM. Commercial and Industrial (C&I) measures are also categorized as either "Lost Opportunity" or "Retrofit". The main sections of the manual are as follows:

- Introduction
- Section 2: C&I Lost Opportunity
- Section 3: C&I Retrofit
- Section 4: Small Business
- Section 5: Residential
- Section 6: Low Income
- Appendices

Savings Calculations

Savings results presented in this manual (both electric and non-electric) are assumed to be the savings that would be measured at the point of use. Electric savings (both kWh and kW) and natural gas savings (ccf) are assumed to be the savings that would occur at the customer's meter. Line losses are not included in the savings values presented here; their effects are captured within the screening model that the companies use to evaluate the benefits of conservation programs. In addition, the annual electric savings from measures has a specified load shape (i.e. the time of day and seasonal patterns at which savings occur). See Table 1.2 for load shapes for various end-use savings. The load shapes are used to properly assign the value of energy savings resulting from the implementation of C&LM measures to the corresponding time of day when those savings are realized.

The values for electric demand savings (for both winter and summer) in this manual are given based on the following definition:

- A "Seasonal Peak" reduction is based on the average peak reduction for a measure during the ISO New England definition for a Seasonal Peak Demand Resource – when the real-time system hourly load is equal to or greater than 90% of the most recent "50/50" system peak load forecast for the applicable summer or winter season. The summer season is defined as non-holiday weekdays during the months of June, July and August; the winter season is defined as non-holiday weekdays during December and January. Typically, these peaks are weather driven and occur in the mid afternoon on hot summer weekdays, or for winter, in the early evening.

Peak demand savings can be calculated either on a measure-by-measure basis; or, on a default basis, coincidence factors can be used to calculate demand savings based on the annual savings and load shape of the measure. Coincidence factors are multiplied by the connected load savings of the measure in order to obtain the peak demand savings. See Table 1.1 for a list of default coincidence factors that are used to calculate the peak demand savings.

In addition to electric and natural gas benefits, some measures have other non-electric benefits. Where appropriate, these benefits (or "impacts" since they can also be negative) are defined in this manual. Non-electric, non-natural gas impacts may include quantifiable changes in other fossil fuel consumption, water use, maintenance costs, productivity improvements, replacement costs, etc. Non-electric benefits are not included in the Electric System test; they are captured in the Total Resource Cost Test.

The savings for the measures defined in this manual are gross savings. Impact factors are applied to the gross savings to calculate the net (final) savings. Gross energy savings estimates (based on known technical parameters) represents the first step in calculating energy savings. Gross savings calculations are based on engineering algorithms or modeling that take into account technically important factors such as hours of use, differences in efficiency, differences in power consumption, etc.

When calculating the total impact of energy saving measures, there are also some other factors beyond the engineering parameters that need to be considered, such as the market effects of free-ridership, spillover or installation rate. The equation for net savings is as follows:

Net Savings = Gross Savings x (1 + spillover – free-ridership) x Installation Rate

In some cases, evaluation work may uncover differences between calculated savings and actual (metered) savings that may not be (completely) attributable to the impact factors above. These differences may arise when the savings calculations do not accurately capture the real savings attributable to a measure. In addition to the impact factors above, savings differences can happen for a variety of reasons such as non-standard usage patterns or operating conditions. In these cases, overall net-to-gross ratios (realization rates) may be used in addition to (or instead of) the aforementioned impact factors to bring the observed savings values more in line with the original savings calculations.

For instance, a billing analysis may show observed savings from a refrigerator removal program to be 60% of the gross (calculated) savings. In this case, the differences may be attributable to a combination of factors including refrigerators that are not being used, free-ridership, units being improperly used (e.g. the refrigerator door left open for long periods of time), and units that exhibit lower energy use because they are operating in cooler basement environments. In such a case, a 60% realization rate would be applied to the gross (calculated) energy savings to correct it.

Realization rates can be applied to specific measures or across programs depending on their source. Since commercial and industrial (C&I) programs typically offer a wide range of diverse measures, defining specific impact factors for Commercial and Industrial (C&I) programs can be difficult, and therefore program specific realization rates are usually limited to C&I programs. Table 1.3 contains a list of program specific realization rates. These rates have been updated from 2009 based on recent studies. Realization rates are no longer included in the description of each individual measure.

Other Major Changes from 2009

The following changes have been made:

- 2.6.1 Computer Power Supply was deleted.
- Separated general service (common) from non-general service (specialty) CFL’s.

1.2 GLOSSARY

The glossary provides definitions of the energy conservation terms used in this Program Savings Document. Note that some of these terms may have alternative or multiple definitions some of which may be outside the context of the manual. Only definitions pertaining to this manual are included in the glossary.

Baseline Efficiency: C&LM program savings are calculated from this efficiency value. It represents the value of efficiency of the equipment that would have been installed without any influence from the program. *Contrast compliance efficiency.*

Baseline Standard: The source or document that provides the Baseline Efficiency values, or a means to calculate these values. In many cases, the baseline efficiency is the minimum efficiency required by codes and standards, such as the Connecticut Energy Code.

Coincident Demand: Demand of a measure that occurs at the same time as some other peak (building peak, system peak, etc). In the context of this document, coincident demand is a measure of demand savings that is coincident with electric system peak demand.

Coincidence Factor: Coincidence factors represent the fraction of connected load expected to occur at the same time as a particular system peak period, on a diversified basis. Coincidence factors are normally expressed as a percent (of connected load). Also referred to as Diversity Factor.

Compliance Efficiency: This efficiency value must be achieved in order to qualify for a C&LM program incentive. *Contrast baseline efficiency.*

Compliance Standard: The source or document that provides the Compliance Efficiency values, or a means to calculate these values. In many cases the compliance efficiency is based on standards from recognized programs such as Energy Star.

Connected Load: This is the maximum power required by the equipment, usually expressed as kW.

Demand: The average electric power requirement (load) during a time period. Demand is measured in kW and the time period is usually one hour. If the time period is different than one hour, the time period is usually stated, such as “15-minute demand.” Demand can refer to an individual customer’s load or to the load of an entire electric system. *See Peak Demand.*

Demand Reduction, Demand Savings: The reduction in demand due to installation of an energy efficiency measure, usually expressed as kW and measured at the customer’s meter. *See discussion under Peak Demand Savings.*

Diversity Factor – See Coincidence Factor.

Electric System (benefit-cost ratio) Test: A ratio used to assess the effectiveness of energy efficiency efforts on the electric system. The electric system test is defined as the present value of the avoided electric system costs (including energy, capacity, transmission and distribution) divided by the program related costs of achieving the savings. The electric system test is the primary evaluation tool used to screen measures and programs in Connecticut. Energy efficiency efforts are cost-effective if the benefit-cost ratio is greater than 1.0.

End Use: Refers to a category of measures with similar load shapes. There are several different acceptable industry standards for defining end-use categories. For the purpose of this manual, end uses are cooling, heating, lighting, refrigeration, water heating, motors, process, and other.

Equivalent Full Load Hours (EFLH): This is the number of hours per year that the equipment would need to draw power at its connected load rating in order to consume its estimated annual kWh. It is calculated as annual kWh/connected kW. EFLH is the same as operating hours for technologies that are either on or off, such as light bulbs; EFLH is less than operating hours for technologies that operate at part load for some of the time, such as air conditioners and motors.

Evaluation Study: A study that is used to assess the true impacts of a program including but not limited to: energy and demand savings, non-electric benefits, market effects, program performance, or program cost-effectiveness.

Free-Rider: A program participant who would have installed or implemented an energy efficiency measure even in absence of program marketing or incentives.

Free-ridership: The fraction (usually expressed as a percent) of gross program savings that would have occurred even in the absence of a C&LM program.

Gross Savings: A saving estimate, calculated from objective technical factors. The gross savings do not include impact factors.

High Efficiency: The efficiency of the energy-saving equipment installed because of a conservation program. High efficiency equipment uses less energy than standard equipment.

Impact Evaluation: A study that assesses the energy, demand, nor non-electric benefits associated with energy efficiency measures or programs.

Impact Factor: A number (usually expressed as a percent) used to adjust the gross savings in order to reflect the savings observed by an impact study. Examples of impact factors include free-ridership, spillover and installation rate.

Installation Rate: The fraction of the recorded products that are installed. For example, some screw-in compact fluorescent lights are bought as spares, and will not be installed until another burns out.

Lighting Power Density: The amount of electrical power required for the installed lighting in a building space or in an entire building, expressed as watts per square foot.

Load Factor: The average fractional load at which the equipment runs. It is calculated as average load/connected load.

Load Shape: The time-of-use pattern of a customer's energy consumption or measure. Load shape can be defined as hourly and/or seasonally (winter/summer).

Lost Opportunity: Refers to the new installation of an enduring unit of equipment (in the case of new construction) or the replacement of an enduring unit of equipment at the end of its useful life. An enduring unit of equipment is one that would normally be maintained, not replaced, until the end of its life. *Contrast "retrofit"*

LPD: Lighting power density.

Market Effect: A change in the behavior of a market because of conservation efforts. "Market Effect savings" is the savings that results changes in market behaviors.

MBtu: Millions of Btu.

Measure: A product (a piece of equipment) or a process that is designed to provide energy or demand savings. Measure can also refer to a service or a practice that provides savings.

Measure Cost: For new construction or measures that are installed at their natural time of replacement (replace upon burn-out), measure cost is defined as the incremental cost of upgrading to high efficiency. For retrofit measures, measure cost is defined as the full cost of the measure. Measure cost refers to the true cost of the measure regardless of whether an incentive was paid for that measure.

Measure lifetimes: This is the average number of years (or hours) that a group of new high efficiency equipment will continue to produce energy savings or the average number of years that a service or practice will provide savings. Lifetimes are generally based on experience or studies.

Measure type: Refers to a category of similar measures. There are several different acceptable industry standards for defining end-use categories. For the purpose of this manual, end use categories are Lighting, HVAC, Motors, VFD (variable frequency drives), Refrigeration, Products & Services, Envelope, Renewable, and Other.

Net Savings: The final value of savings that is attributable to a program or measure. Net savings differs from "gross savings" because it includes adjustments from impact factors such as free-ridership or spillover. Net savings is sometimes referred to as "verified savings" or "final savings."

Net-to-gross: The ratio of net savings to the gross savings (for a measure or program). Net-to-gross is usually expressed as a percent.

Non-electric benefits: Quantifiable benefits (beyond electric savings) that are the result of the installation of a measure. Fossil fuel, water and maintenance are examples of non-electric benefits. Non-electric benefits can be negative (i.e. increased maintenance or increased fossil fuel usage which results from a measure) and therefore are sometimes referred to as non-electric impacts.

Non-Participant: A customer who is eligible to participate in a program, but does not. A non-participant may install a measure because of a program, but the installation of the measure is not through regular program channels; as a result, their actions are normally only detected through evaluations (see spillover).

Operating Hours: The annual amount of time, in hours, that the equipment is expected to operate. *Contrast Equivalent Full Load Hours.*

Participant: A customer who installs a measure through regular program channels and receives any benefit (i.e. incentive) that is available through the program because of his participation. Free-riders are a subset of this group.

Peak Day Demand, Natural Gas: The one day (24 hours) of maximum system deliveries of natural gas during a year.

Peak Demand: The highest demand.

Peak Demand Savings: The kW demand reduction that occurs in the peak hours. There is both a summer peak and a winter peak. Two peak periods are used:

- Seasonal peak, which consists of the highest demand hours in either summer or winter. Seasonal Peak hours are those in which the projected hourly load in the ISO next day forecast is equal to or greater than 90% of the ISO 50/50 peak forecast, for summer or winter. There are typically 25 to 75 such hours in a year.
- On peak, which consists of the entire summer or winter peak period. On-Peak Hours are each non-holiday weekday summer afternoon from 1 pm through 5 pm in June, July, and August; and winter evenings 5 pm through 7 pm in Dec. and Jan.

The peak demand savings is usually determined by multiplying the demand reduction attributed to the measure by the appropriate Seasonal or On-Peak coincidence factor. Coincidence factors for different measures for each peak are shown in Table 1.1.1.

The Seasonal Peak Demand savings are used in the C&LM programs. The On-Peak savings are used in ISO programs.

See also Coincidence Factor, Demand Savings.

Peak Period: The annual time periods that experience the times of peak electrical demand. The Summer Peak Period consists of the non-holiday weekday hours from 1pm to 5pm in June through August. The Winter Peak Period consists of the non-holiday weekday hours from 5pm to 7pm in December and January.

Realization of Savings: The ratio of actual measure savings to gross measure savings (sometimes referred to as the "realization rate"). This ratio takes into account impact factors that can influence the actual savings of a program such as spillover, free-ridership, etc.

Retrofit: The replacement of a piece of equipment or device before the end of its useful or planned life for the purpose of achieving energy savings. "Retrofit" measures are sometimes referred to as "early retirement" when the removal of the old equipment is aggressively pursued. *Contrast "lost opportunity."*

Sector: A system for grouping customers with similar characteristics. For the purpose of this manual, the sectors are Commercial and Industrial (C&I), Small Business, Residential, and Low Income.

SMB: Small Business

Spillover: Savings attributable to the program, but additional to the gross (tracked savings) of a program. Spillover include the effects of : (a) participants in the program who install additional energy efficient measures outside of the program as a result of hearing about the program; or (b) non-participants who install or influence the installation of energy efficient measures as a result of being aware of the program.

Summer Demand Savings: Refers to the demand savings that occur during the summer peak period. *See discussion under peak demand savings.*

Summer System Peak: *See discussion under peak demand savings.*

Summer Peak Period: The non-holiday weekday hours from 1pm to 5pm in June through August.

Total Resource (Benefit/Cost) Test: A test used to assess the net benefit of energy efficiency resources to society. The total resource test is different from the electric system test in that the total resource benefit consists of the avoided costs of all conserved energy (electric *and* other fuels) plus other non-energy resource impacts that may have occurred because of efficiency efforts such as reduced maintenance or higher productivity. The cost for the total resource benefit consists of all program-related costs and any costs incurred by the customer related to the installation of measures.

Winter Demand Savings: Refers to average demand savings that occurs during the winter peak period. *See discussion under peak demand savings.*

Winter Peak Period: The non-holiday weekday hours from 5 pm to 7 pm in December and January.

C&I LOST OPPORTUNITY

2.1.1 C&I LO STANDARD LIGHTING

Description of Measure

Encourage and reward lighting power levels that are better than the standards.

Method for Calculating Energy Savings

KWh savings, $S = S_p + S_o + S_h + S_c$

S_p, kWh = savings due to lower lighting power density
S_o, kWh = savings from use of occupancy sensors, if applicable
S_h, kWh = savings from installation of hard-wired fluorescent fixtures in residential areas
S_c, kWh = savings from reduced cooling

$\boldsymbol{S_p}$ Calculation of savings due to lower lighting power density

*S_p, kWh = (Allowable LPD - Actual LPD)*H*A*

Allowable LPD, in kW/ft^2, is the value of Watts per ft^2 from Ashrae 90.1-2004 Tables 9.6.1 or 9.6.2 for the facility type divided by 1000. The Ashrae tables are reproduced in PSD tables 2.1.1C and 2.1.1D respectively. (When using the space-by space method to calculate the LPD, an increase in the spaces' power allowances can be used, in accordance with Section 9.6.2 of Ashrae 90.1-2004.)

Actual LPD, in kW/ft^2, is calculated by dividing the total *Fixture Wattage* by the *Lighted Area, ft^2*

Fixture Wattage is the sum of the power consumed by each fixture's ballast, kW

A = Lighted Area, ft^2, is calculated for each project, either from architectural drawings or by physical measurement.

H = Facility Lighting Hours, per year, and is described in Table 2.0.0.

$\boldsymbol{S_o}$ Calculation of kWh savings due to occupancy sensors

S_o = Additional savings due to occupancy sensors

If the *Actual LPD* is less than or equal to the *Allowable LPD*, then S_o will be calculated as follows; otherwise, $S_o = 0$.

$$S_O = \frac{0.3H}{1000}\sum_{n=1}^{N} O_n W_n$$

H = Facility hours

N = Number of different fixture types with occupancy sensors

n = Fixture number

O_n = Quantity of fixtures of type n that have occupancy sensors

W_n = Input watts for fixture type n

Explanation of numerical constants:
- 0.3 is the generally accepted average energy reduction due to the use of occupancy sensors (see ref.)
- 1000 converts watts to kW

S_h Calculation of savings from hard-wired fluorescent fixtures in residential areas, kWh.

Refer to PSD Section 5.1.2 “CFL Fixtures (New Homes)” for this calculation. Normally the total number and type of fixtures in living areas is not known at the time of construction, so the LPD method cannot be used to calculate these savings. Where hard-wired fixtures are installed as part of new construction, they are usually shown on the building plans. Their savings are calculated per fixture according to the residential methodology.

S_c Calculation of lighting kWh savings due to the reduced cooling required to remove excess heat produced by the lighting fixtures

S_c = Additional savings due to the reduced cooling energy required to remove the energy from lighting

$$S_C = \frac{(S_P + S_O + S_H) \bullet F}{COP}$$

F = Fraction of annual kWh energy savings that must be removed by the cooling system

If the HVAC system includes an economizer,
Then F = 0.35
Otherwise, use the table below

Building Area, A, Sq ft	F
< 2,000	0.48
2,000 – 20,000	$0.48 + \frac{0.195(A - 2{,}000)}{18{,}000}$
>20,000	0.675

COP = 2.4

This methodology may understate the savings from residential hard-wired fixtures. Residential areas are sometimes cooled by their own dedicated units, and their cooling efficiency can be less than that for the commercial areas.

The source of the equation for S_c and the derivation of the values for F and COP is from “Calculating Lighting and HVAC Interactions,” Ashrae Journal 11-93 as used by KCPL.

Method for Calculating Demand Savings

$$KW = \frac{1}{H}\left(C_L * S_P + C_o * \frac{S_o}{.3} + C_H * S_H \right)(1 + \frac{G}{COP})$$

C_L is the lighting coincidence factor taken from Table 1.1.1 of Section 7.1.1.

C_o is the occupancy-sensor coincidence factor from Table 1.1.1 Section 7.1.1.

S_0/0.3 converts the occupancy sensor savings back to occupancy sensor connected load.

C_H is the residential lighting coincidence factor from Table 1.1.3 of Section 7.1.1.

G = 0.73, and is the estimated lighting energy heat to space, based on modeling results.

Facility Lighting Hours are defined in Appendix Table 2.0.0.

Baseline Efficiencies from which savings are calculated

The baseline allowable Lighting Power Densities are those shown in Ashrae 90.1-2004 Tables 9.5.1 and 9.6.1. These tables are reproduced in the Appendix as Tables 2.1.1.C and 2.1.1.D, respectively.

Compliance Efficiency from which incentives are calculated

10% below the baseline LPD

Operating Hours

Default Facility Lighting Hours are taken from Table 2.0.0.

Non-Electric Benefits - Annual Fossil Fuel Savings

Space heating increase from reduced lighting load. Annual Fossil fuel Savings = -0.00079 MBTU's per annual kWh saved.
Based on August 22, 2003 Memorandum from Optimal energy, Inc.

Non-Electric Benefits - Annual O&M Cost Adjustments

O&M savings due to the reduction of lighting hours from installation of occupancy sensors. Annual O&M Savings = $0.014917 per annual kWh saved from the installation of occupancy sensors.
Based on August 22, 2003 Memorandum from Optimal energy, Inc..

Notes & References

Occupancy sensor savings reference:
1. D. Maniccia B. Von Neida, and A. Tweed.
An analysis of the energy and cost savings potential of occupancy sensors for commercial lighting systems

Illuminating Engineering Society of North America 2000 Annual Conference: Proceedings. IESNA: New York, NY. Pp. 433-459.

2. RLW Study "2005 Coincidence Factor Study With 1-5 Summer Peak Window", 7-20-06.

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2.2.1 C&I LO COOLING - CHILLERS

Description of Measure

This measure encourages the installation of efficient water-cooled and air-cooled water chilling packages (chillers). Chillers must use an environmentally friendly refrigerant in order to qualify for the program.

Method for Calculating Energy Savings

Energy savings are custom-calculated for each chiller installation based on the specific equipment, operational staging, operating profile, and load profile.

Equipment

Each chiller plant is characterized by its:

- Number of chillers,
- Sizes, in tons (the chillers may be of different sizes),
- Type, which may be:
  - Centrifugal,
    - R123 refrigerant,
    - R134a refrigerant
  - Water-cooled screw and scroll, or
  - Air-cooled
- Speed, constant or variable
- Auxiliary equipment
  - Chilled water pumps
  - Cooling tower pumps
  - Cooling tower fans
  - Other

Operational Staging

If more than one chiller is used, their operational relationship can be defined. When the load is high enough to permit two chillers to operate, they can be designated to operate together at the same loading, or, alternatively, either one can be operated at full output while the other follows the cooling load profile.

Operating Profile

The customer's cooling load profile, for each of 12 months, is characterized by:

- On-peak occupied hours the chiller is operated each week,
- Off-peak occupied hours the chiller is operated each week,
- On-peak un-occupied hours the chiller is operated each week,
- Off-peak un-occupied hours the chiller is operated each week.

Load Profile

The customer's load profile is estimated by determining the load at the peak outdoor conditions and the load at the minimum conditions. For systems with an air-side or water-side economizer, the minimum conditions are those just above the set point of the economizer. If the customer's load profile is not known, a default load profile will be developed; in this case it is also necessary to determine the value of any process loads.

Savings Calculation

With the above information, a calculation is made for each time period of the year based on the appropriate temperature bin data. The calculation is performed once for the chillers meeting the baseline efficiencies and again for the proposed chillers, and the difference determines the kWh and the kW savings for each period. These are summed to yield the total savings.

Method for Calculating Demand Savings

The demand savings calculation is described in the previous paragraph.

Baseline Efficiencies from which savings are calculated

The baseline efficiencies are those required by the Ct Building Code. These efficiencies are shown in Table 2.2.1.A in the Appendix.

Compliance Efficiency from which incentives are calculated

The chiller rating at ARI conditions must meet a minimum efficiency to qualify for an incentive. The minimum is set at an efficiency somewhat better than what Ashrae 90.1 requires. These minimum efficiency levels for the various sizes and types of chillers are shown in Table 2.2.1.A in the Appendix. The ARI conditions are shown in Table 2.2.1.B in the Appendix
The part-load efficiencies that are used to compute the savings are shown in Table 2.2.1.C. These values are not part of Ashrae 90.1-2001. They are based on reported part-load efficiencies of chillers.

Operating Hours

A single value for operating hours is not used. As described above, custom hourly calculations are made for each customer.

Non-Electric Benefits - Annual Fossil Fuel Savings

The realization of savings is based on program. Refer to table 7.1.3

Revision Number

09

2.2.2 C&I LO COOLING - UNITARY AC & HEAT PUMPS

Description of Measure

This measure encourages the installation of efficient Direct-Expansion (DX) cooling systems for C&I customers.

Method for Calculating Energy Savings

Cooling (A/C units and Air Source Heat Pumps)

Annual kWh savings = $$Cap * \left(\frac{1}{EER_B} - \frac{1}{EER_I} \right) * \frac{1}{1000} * EFLH_C$$

$EFLH_c$ = Refer to Table 2.0.0

Heating (Air source heat pumps only)

Annual kWh savings = $$Cap * \frac{13{,}900}{12{,}000} * \left(\frac{1}{HSPF_B} - \frac{1}{HSPF_I} \right) * \frac{1}{1000} * EFLH_H$$

EFLHh = Refer to Table 2.0.0

Cap = Unit's rated cooling capacity in Btu/h
EER_i = Installed unit's rated energy efficiency ratio
EER_b = Baseline energy efficiency ratio from Table 2.3
(Note: $SEER_p$ and $SEER_b$ are used for units < 5.4 tons)
$HSPF_b$ = Baseline Heating seasonal performance factor, watt-hours per MBtu heat input, from ASHRAE 90.1-2004, Table 6.8.1B.
$HSPF_i$ = installed Heating seasonal performance factor
$EFLH_c$ = equivalent full load hours cooling
$EFLH_h$ = equivalent full load hours heating
1000 = converts Wh to kWh
Ratio 13900/12000 = ratio of heat produced in the heating mode divided by cooling produced in the cooling mode.

Method for Calculating Demand Savings

Summer kW savings = D* Cap * (1/(EER_b)-1/(EER_i)) /1000

Winter kW savings = 0,
Cooling only units have no winter demand savings since they do not operate during the winter.
Air source heat pumps have no winter demand savings because they use resistance back up at low outside air temperatures.

D = Peak Factor from Table 1.1.1

Baseline Efficiencies from which savings are calculated

The baseline efficiencies are shown in Table 2.3.

Compliance Efficiency from which incentives are calculated

The compliance efficiencies are shown in Table 2.3.

Operating Hours

The operating hours are shown in Table 2.0.0.

Incremental Cost

Incremental Costs

Size		
Tons	MBtu/H	$/ton
Less than 5.4	Less than 65	TBD
5.4 to under 11.25	65 to under 135	TBD
11.25 to under 20	135 to under 240	TBD
20 to under 30	240 to under 375	TBD
30 to under 63	375 to under 756	TBD
63 and over	756 and over	TBD

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

10

2.2.3 C&I LO COOLING - WATER AND GROUND SOURCE HP

Description of Measure

The measure is to encourage efficiency upgrades of water-source, ground water source, and ground-coupled heat pump units at the time of their replacement or new construction.

Method for Calculating Energy Savings

Cooling

Annual cooling kWh savings = $$Cap * \left(\frac{1}{EER_B} - \frac{1}{EER_I} \right) * \frac{EFLH_C}{1000}$$

Cap = Unit's rated cooling capacity in Btu/h
EER_b = Baseline energy efficiency ratio (see table below)
EER_i = Installed unit's rated energy efficiency ratio
$EFLH_c$ = equivalent full load hours cooling, refer to Table 2.0.0

Heating

Annual heating kWh savings = $$Cap * \frac{COP_I}{EER_I} * \left(\frac{1}{COP_B} - \frac{1}{COP_I} \right) * \frac{1}{1000} * EFLH_H$$

COP_i / EER_i = converts the rated cooling output to the rated heating output.
COP_b = Baseline Heating Coefficient of performance
COP_i = Installed Heating Coefficient of performance
$EFLH_h$ = equivalent full load hours heating, refer to Table 2.0.0
1/1000 = converts W to kW

Method for Calculating Demand Savings

Summer kW savings = $$CF * Cap * \left(\frac{1}{EER_B} - \frac{1}{EER_I} \right) * \frac{1}{1000}$$

Winter kW savings = $$CF * Cap * \frac{COP_I}{EER_I} * \left(\frac{1}{COP_B} - \frac{1}{COP_I} \right) * \frac{1}{1000}$$

CF = The coincidence factor from Table 7.1.1
The other units in the kW formulas are the same as those in the kWh formulas.

Baseline Efficiencies from which savings are calculated

The baseline efficiencies are shown below. They are the same as required by the Ct Bldg code.

Water Source Heat Pump		
(Closed loop within a building, served by boiler and cooling tower)		
Cooling Btu/h	**Baseline**	**Minimum Compliance**
< 17,000	11.2 EER, 4.2 COP	14 EER, 4.2 COP
≥ 17,000 <65,000	12 EER, 4.2 COP	14 EER, 4.2 COP
≥65,000 <135,000	12 EER, 4.2 COP	***To Be Determined***
≥135,000 <240,000	11 EER	***To Be Determined***
Ground Water Heat Pump		
(The water used by the heat pump is in contact with the ground)		
Cooling Btu/h	**Baseline**	**Minimum Compliance**
All	16.2 EER, 3.6 COP	18.0 EER, 3.6 COP
Ground Loop Heat Pump		
(The water used by the heat pump is isolated from contact with the ground)		
Cooling Btu/h	**Baseline**	**Minimum Compliance**
All	13.4 EER, 3.1 COP	15.0 EER, 3.1 COP

Compliance Efficiency from which incentives are calculated

The compliance efficiencies are shown in the above table.

Operating Hours

The operating hours are shown in Table 2.0.0.

Incremental Cost

Incremental cost = $81 per ton.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

10

2.2.4 C&I LO COOLING - DUAL ENTHALPY CONTROLS

Description of Measure

The measure is to upgrade the outside-air dry-bulb economizer to a dual enthalpy economizer. The system will continuously monitor the enthalpy of both the outside air and return air. The system will control the system dampers adjust the outside quantity based on the two readings.

Method for Calculating Energy Savings

Annual cooling kWh savings = Tons * 276 kWh / Ton

Tons = Unit's rated cooling capacity in Tons

The 276 kWh / ton average savings is based on DOE-2 simulation results of modeling a broad cross section of building types and sizes.

Method for Calculating Demand Savings

Summer kW savings = 0

Demand savings are zero since the measure reduces energy when outside temperatures are low.

Baseline Efficiencies from which savings are calculated

HVAC operating with fixed dry-bulb economizer.

Operating Hours

The operating hours are not used in the calculation.

Incremental Cost

$250 per unit controlled

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

03

2.2.5 C&I LO VENTILATION CO2 CONTROLS

Description of Measure

The measure is to upgrade CO2 control of outside air to an air handling system. The proposed systems monitor the CO2 in the spaces or return air and reduce the outside air when possible to save energy while meeting indoor air quality standards.

Method for Calculating Energy Savings

Cooling
The electrical savings are custom-calculated for all projects. Savings are based on hours of operation, return air dry bulb temperature, return air enthalpy, system total air flow, percent outside air, estimated average outside air reduction, and cooling efficiency. Savings are estimated based using a temperature BIN spreadsheet that calculates the difference in outside air enthalpy and return air enthalpy from the reduction in outside air.

Method for Calculating Demand Savings

Summer demand savings are calculated based on the top temperature BINs used in the spreadsheet.

Baseline Efficiencies from which savings are calculated

No ventilation control.

Operating Hours

Operating hours are site specific.

Incremental Cost

$750 to $1,500 per unit controlled.

Non-Electric Benefits - Annual Fossil Fuel Savings

The fossil fuel savings are custom-calculated for all projects. Savings are based on return air dry bulb temperature, return air enthalpy, system total air flow, percent outside air, estimated average outside air reduction, and boiler efficiency. Savings are estimated based using a temperature BIN spreadsheet that calculates the difference in outside air enthalpy and return air enthalpy from the reduction in outside air.

Revision Number

04

2.2.6 C&I LO COOLING - GAS-DRIVEN CHILLER

Description of Measure

This measure encourages the installation of efficient water-cooled and air-cooled gas fired engine driven water chilling packages (chillers). Chillers must use an environmentally friendly refrigerant in order to qualify for the program.

Method for Calculating Energy Savings

Energy savings are custom-calculated for each chiller installation based on the specific equipment, operational staging, operating profile, and load profile.

Equipment

Each chiller plant is characterized by its:
- Number of chillers,
- Sizes, in tons (the chillers may be of different sizes),
- Type, which may be:
  - Centrifugal,
    - R123 refrigerant,
    - R134a refrigerant
  - Water-cooled screw and scroll, or
  - Air-cooled
  - Gas Engine Driven
- Speed, constant or variable
- Auxiliary equipment
  - Chilled water pumps
  - Cooling tower pumps
  - Cooling tower fans
  - Other

Operational Staging

If more than one chiller is used, their operational relationship can be defined. When the load is high enough to permit two chillers to operate, they can be designated to operate together at the same loading, peak shaving, or, alternatively, either one can be operated at full output while the other follows the cooling load profile.

Operating Profile

The customer's cooling load profile, for each of 12 months, is characterized by:
- On-peak occupied hours the chiller is operated each week,
- Off-peak occupied hours the chiller is operated each week,
- On-peak un-occupied hours the chiller is operated each week,
- Off-peak un-occupied hours the chiller is operated each week.

Load Profile

The customer's load profile is estimated by determining the load at the peak outdoor conditions and the load at the minimum conditions. For systems with an air-side or water-side economizer, the minimum conditions are those just above the set point of the economizer. If the customer's load profile is not known, a default load profile will be developed; in this case it is also necessary to determine the value of any process loads.

Savings Calculation

With the above information, a calculation is made for each time period of the year based on the appropriate temperature bin data. The calculation is performed once for the chillers meeting the baseline efficiencies and again for the proposed chillers, and the difference determines the kWh and the kW savings for each period. These are summed to yield the total savings.

Method for Calculating Demand Savings

The demand savings calculation is described in the previous paragraph

Baseline Efficiencies from which savings are calculated

The baseline efficiencies are those required by the Ct Building Code for electric chillers. These efficiencies are shown in Table 2.2.1.A in the Appendix.

Compliance Efficiency from which incentives are calculated

The chiller rating at ARI conditions must meet a minimum efficiency to qualify for an incentive. Compliance efficiency is set to meet DPUC source BTU requirement.

Cooling System	**Comfort Cooling (IPLV*)**	**Process Cooling (IPLV*)**
Water-cooled		
< 150 tons	1.6 COP	2.0 COP
≥ 150 & < 300 Tons	1.7 COP	2.2 COP
≥ 300 Tons	2.0 COP	2.5 COP
Air -cooled		
Any Size	0.9 COP	1.2 COP
* This requirement may be modified based on the amount of heat recovery.		

Operating Hours

A single value for operating hours is not used. As described above, custom hourly calculations are made for each customer.

Incremental Cost

Incremental cost will be based on site-specific information.

Non-Electric Benefits - Annual Fossil Fuel Savings

The Non-electric fossil fuel benefit for this measure would be negative. The 'savings' would include any gas savings from the heat recovery minus the additional gas consumption from the engine. This would be estimated on a site specific basis.

Non-Electric Benefits - Annual O&M Cost Adjustments

Additional annual O&M costs would be added maintenance costs of the engine. These would be estimated on a site specific basis.

Revision Number

02

2.3.1 C&I LO MOTORS

Description of Measure

The measure is to upgrade a motor at the time of replacement or new construction.

Method for Calculating Energy Savings

Annual kWh savings = HP (0.746) (D) (1/EFFb -1/EFFi) (Hours)

HP = motor's rated nameplate horsepower
0.746 = conversion of HP to kW
EFFb = Baseline efficiency (see table below)
EFFi = Installed motor efficiency (see table below)
For HVAC applications,
D = Peak Factor from Table 1.1.1 (for HVAC applications)
Hours = Annual Hours of operation from Table 7.2.0

For non-HVAC applications,

Annual kWh savings = $$\sum_{1}^{N} HP_N (0.746)\left(\frac{1}{EFF_b} - \frac{1}{EFF_i}\right)(Hours_N)$$

N = the total number of defined combinations of load and Hours. (e.g., 1=10% of the hours at 100% load; 2=20% of the hours at 83% load, etc.)
HP_N = the HP required by the load at combination N
$Hours_N$ = the time, in hours, that is spent at combination N

Method for Calculating Demand Savings

kW savings = Hp (0.746 kW/hp) (D) (1/EFFb -1/EFFi)

Note – the peak factor is based on the motor being used in an HVAC application. The peak factor includes the effect of motor oversizing, which is unavoidable in most applications. Since motors come only in discrete sizes, a motor larger than what is needed is usually required.

For non-HVAC applications, the kW effect on peak must be determined by a custom analysis.

<u>Baseline Efficiencies from which savings are calculated</u>

Baseline motor Efficiencies (EPACT 1992)						
	Open Drip Proof			**Totally Enclosed Fan Cooled**		
HP	**1200 rpm**	**1800 rpm**	**3600 rpm**	**1200 rpm**	**1800 rpm**	**3600 rpm**
1	80.0	82.5	N/A	80.0	82.5	75.5
1.5	84.0	84.0	82.5	85.5	84.0	82.5
2	85.5	84.0	84.0	86.5	84.0	84.0
3	86.5	86.5	84.0	87.5	87.5	85.5
5	87.5	87.5	85.5	87.5	87.5	87.5
7.5	88.5	88.5	87.5	89.5	89.5	88.5
10	90.2	89.5	88.5	89.5	89.5	89.5
15	90.2	91.0	89.5	90.2	91.0	90.2
20	91.0	91.0	90.2	90.2	91.0	90.2
25	91.7	91.7	91.0	91.7	92.4	91.0
30	92.4	92.4	91.0	91.7	92.4	91.0
40	93.0	93.0	91.7	93.0	93.0	91.7
50	93.0	93.0	92.4	93.0	93.0	92.4
60	93.6	93.6	93.0	93.6	93.6	93.0
75	93.6	94.1	93.0	93.6	94.1	93.0
100	94.1	94.1	93.0	94.1	94.5	93.6
125	94.1	94.5	93.6	94.1	94.5	94.5
150	94.5	95.0	93.6	95.0	95.0	94.5
200	94.5	95.0	94.5	95.0	95.0	95.0

<u>Compliance Efficiency from which incentives are calculated</u>

Minimum Motor Compliance Efficiencies						
	Open Drip Proof			**Totally Enclosed Fan Cooled**		
HP	**1200 rpm**	**1800 rpm**	**3600 rpm**	**1200 rpm**	**1800 rpm**	**3600 rpm**
1	82.5	85.5	N/A	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	97.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4

Operating Hours

Default Facility Hours are taken from Table 2.0.0

Incremental Cost

Minimum Motor Incremental Costs						
	Open Drip Proof			**Totally Enclosed Fan Cooled**		
HP	**1200 rpm**	**1800 rpm**	**3600 rpm**	**1200 rpm**	**1800 rpm**	**3600 rpm**
1	$45	$45	$45	$50	$50	$50
1.5	$45	$45	$45	$50	$50	$50
2	$54	$54	$54	$60	$60	$60
3	$54	$54	$54	$60	$60	$60
5	$54	$54	$54	$60	$60	$60
7.5	$81	$81	$81	$90	$90	$90
10	$90	$90	$90	$100	$100	$100
15	$104	$104	$104	$115	$115	$115
20	$113	$113	$113	$125	$125	$125
25	$117	$117	$117	$130	$130	$130
30	$135	$135	$135	$150	$150	$150
40	$162	$162	$162	$180	$180	$180
50	$198	$198	$198	$220	$220	$220
60	$234	$234	$234	$260	$260	$260
75	$270	$270	$270	$300	$300	$300
100	$360	$360	$360	$400	$400	$400
125	$540	$540	$540	$600	$600	$600
150	$630	$630	$630	$700	$700	$700
200	$630	$630	$630	$700	$700	$700

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

05

2.4.1 C&I LO HVAC VFD

Description of Measure

Add variable frequency (VFD) control of a fan or pump system in a HVAC application. The fan (pump) speed will be controlled to maintain the desired system pressure. The application must have a load that varies and proper controls (Two-way valves, VAV boxes) must be installed.

Qualifying VFD applications are:

Heat rejection: Condenser fans, cooling tower fans	Less than 7.5 HP
VAV fans	Less than 10 HP
Pumps: Chilled water, hot water hydronic systems	Up to 50 HP

Method for Calculating Energy Savings

Annual kWh savings = (BHP /EFFi) (Hrs) (kWhSF)

Method for Calculating Demand Savings

Demand Savings = (BHP /EFFi)(kWSF)

BHP = System brake horsepower
EFFi = Installed motor efficiency
HRS = Annual Hours of operation
kWhSF = annual kWh savings factor based on typical load profile for application
kWSF = kW savings factor based on typical peak load from load of application
AF/BI = Air foil / backward incline
AF/BI IGV = AF/BI Inlet guide vanes
FC = Forward curved
FC IGV = FC Inlet guide vanes
CHWP = Chilled Water Pump
HWP = Hot Water Pump

HVAC Fan VFD Savings Factors			
Baseline	**kWhSF**	**Summer kWSF**	**Winter kWSF**
Constant Volume	0.53450577	0.34753664	0.65064177
AF/BI	0.35407485	0.26035565	0.40781240
AF/BI IGV	0.22666226	0.12954823	0.29144821
FC	0.17889831	0.13552275	0.18745625
FC IGV	0.09210027	0.02938371	0.13692166

HVAC Pump VFD Savings Factors			
System	**kWhSF**	**Summer kWSF**	**Winter kWSF**
CHWP	0.43277633	0.299056883	0.0
HWP	0.48198088	0.0	0.207967853

The above constants were derived using a temperature BIN spreadsheet and typical heating, cooling and fan load profiles.

Baseline Efficiencies from which savings are calculated

Based on the type of system. (See above table)

Operating Hours

Default Facility Hours are taken from Table 2.0.0

Incremental Cost

HVAC VFD incremental Costs		
HP	Fan	Pump
5	$920	$1,710
7.5	$1,310	$2,100
10		$2,150
15		$2,300
20		$2,730
25		$3,290
30		$3,670
40		$3,770
50		$4,580

Total Cost

Total cost to add VFD to existing system is approximately twice the incremental cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

09

2.5.1 C&I LO ICE-CUBE MAKERS

Description of Measure

This measure encourages the installation of efficient commercial ice-cube machines. It is based on the Consortium for Energy Efficiency's (CEE) guidelines, which is based, in turn, on FEMP guidelines.

Method for Calculating Energy Savings

For each ice-making machine proposed for this measure, the ice harvest rate, the energy consumption rate and the type of machine are needed.

$$S = \frac{E - A}{100} R \bullet 365$$

S = Savings, kWh per year
E = Baseline energy use rate, kWh per 100 lb of ice produced.
A = Actual energy use rate, kWh per 100 lb of ice produced.
100 = Conversion to kWh per lb.
R = Ice harvest rate, lb per day.
365 = Conversion to kWh per year.

Method for Calculating Demand Savings

$$kW = \frac{E - A}{100} \bullet \frac{R}{24}$$

kW = Demand savings, kw
E = Baseline energy use rate, kWh per 100 lb of ice produced.
A = Actual energy use rate, kWh per 100 lb of ice produced.
100 = Conversion to kWh per lb.
R = Ice harvest rate, lb per day.
24 = Conversion to kw.

Baseline Efficiencies from which savings are calculated

The baseline efficiency is taken from the CEE program. These values are derived from FEMP.

1/11/2005		Baseline Energy Rate , E, kwh/100lb		
Type	Type Description	Up To R, lb/day	E=	Otherwise, E=
SC-A	Self-Contained -Air-Cooled	125	26.4-0.11R	12.4
SC-W	Self-Contained - Water-Cooled	300	12.43-.0114R	9
IMH-A	Ice-Making Head - Air-Cooled	450	15.42 -0.0176 R	7.5
IMH-W	Ice-Making Head - Water-Cooled	470	12.04-0.0122R	6.3
RCU-A	Remote Condensing Unit -Air-Cooled	910	10.6-0.0039R	7

Compliance Efficiency from which incentives are calculated

The compliance efficiency is Tier 1 as defined by CEE.

Operating Hours

Operating hours are not used in the savings calculation.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

04

2.5.2 C&I LO SOLID-DOOR REF AND FREEZERS

Description of Measure

This measure encourages the installation of efficient commercial refrigerators and freezers with solid-doors. It is based on the Consortium for Energy Efficiency's (CEE) guidelines, which is based, in turn, on FEMP guidelines.

Method for Calculating Energy Savings

For each commercial refrigerator or freezer with solid-doors proposed for this measure, the internal volume, the energy consumption rate and the type of machine are needed.

S = E – A(365)

S = Savings, kWh per year
E = Baseline energy use rate, kWh per year.
A = Actual energy use rate, kWh per day.

The value of A is provided by CEE for each make, size, and type of equipment.

Method for Calculating Demand Savings

$$kW = \frac{S}{8760}$$

S = Savings, kWh per year
8760 = No. of hours per year

Baseline Efficiencies from which savings are calculated

The Baseline Energy Use Rate, kWh/yr, for Solid-Door refrigerators is:
E = Internal Volume times 45.624 + 1007

The Baseline Energy Use Rate, kWh/yr, for Solid-Door freezers is:
E = Internal Volume times 145.25 + 833

These equations are derived from CEE data, and will be updated as appropriate.

Compliance Efficiency from which incentives are calculated

The Tier 1 and 2 qualifying values are the same as proposed by CEE.

Commercial Solid Door Refrigerators and Freezers High Efficiency Specification

Equipment Type		Maximum energy use per day (kWh/day)
Refrigerator	Tier 1	.10V + 2.04
	Tier 2	.06V + 1.22
Freezer	Tier 1	.40V + 1.38
	Tier 2	.28V + 0.97

V = Interior Volume in cubic feet determined by ANSI/AHAM HRF1-1979
Test Method ANSI / ASHRAE 117 – 1992 @ 38^o F +/- 2^o F
2004 Consortium for Energy Efficiency, Inc.

Notes
1. Specifications were developed by Consortium for Energy Efficiency, Inc., 617-589-3949, http://www.cee1.org
2. Specifications were reproduced with permission from CEE
3. Specifications represent voluntary performance levels by Equipment Manufacturers
4. Products qualified using ASHRAE standard 117-2002 @ 38^{o}F+/- 2^{o}F
5. These compliance levels will be required as of 1-1-12 by EPAct 2005.

Operating Hours

This equipment is assumed to operate continuously.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Notes & References

Consortium for Energy Efficiency, Inc., 617-589-3949, http://www.cee1.org

Revision Number

05

2.5.3 C&I LO GLASS-DOOR REFRIGERATORS

Description of Measure

This measure encourages the installation of efficient commercial refrigerators with glass doors. It is based on the Consortium for Energy Efficiency's (CEE) guidelines, which is based, in turn, on FEMP guidelines.

Method for Calculating Energy Savings

For each refrigerator proposed for this measure, the annual energy savings is supplied directly by CEE based on the internal volume.

For Refrigerators meeting Tier 1 standards,
S = 19V+521

For Refrigerators meeting Tier 2 standards,
S = 50.6V+112.3

S = Savings, kWh per year
V = Internal volume, cu. ft.

Method for Calculating Demand Savings

$$kW = \frac{S}{8760}$$

S = Savings, kWh per year
8760 = No. of hours per year

Baseline Efficiencies from which savings are calculated

The baseline efficiency is assumed by CEE to be the least-efficient equipment on the market, and is included in the equation for energy savings.

Compliance Efficiency from which incentives are calculated

Commercial Glass Door, Reach-In High Efficiency Specification

	Maximum energy use per day (kWh/day)
Tier 1	.12V + 3.34
Tier 2	.086V + 2.39

V = Interior Volume in cubic feet determined by ANSI/AHAM HRF1-1979
Test Method ANSI / ASHRAE 117 – 1992 @ 38^{o} F +/- 2^{o} F
2004 CEE

6. Note: These compliance levels will be required as of 1-1-12 by EPAct 2005.

Operating Hours

This equipment is assumed to operate continuously.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Notes & References

Consortium for Energy Efficiency, Inc., 617-589-3949, http://www.cee1.org

Revision Number

06

2.5.4 C&I LO VENDING MACHINE OCCUPANCY CONTROLS

Description of Measure

Installation of vending machine occupancy sensors to limit energy consumption in periods of no usage.

Method for Calculating Energy Savings

Annual savings = 1,600 kWh per vending machine

Savings are based on a 2001 study done by the Nicholas Group, P.C.

Method for Calculating Demand Savings

Demand savings = 0

Baseline Efficiencies from which savings are calculated

Existing vending machine operating without the occupancy sensor control.

Incremental Cost

$75 per unit

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

05

2.7.1 C&I LO LEAN MANUFACTURING

Description of Measure

Incorporating PRIME (LEAN) in the manufacturing process allows a company to produce more in the same given time period. The savings are based on estimating the production increase with and without PRIME. Savings are based on two concepts: 1) Producing the more products in the same time period saves on the non- manufacturing consumption (mostly lighting). 2) Producing more products over the same time period reduces losses in the manufacturing equipment consumption (Less idle time, motors loaded more are more efficient.
Note: The PRIME process also reduces waste. Since this is very site dependent it typically is not considered in this calculation.

Method for Calculating Energy Savings

Annual Kwh savings = (EACWoP – EACWP)

Baseline:
EACWoP: Estimated annual consumption without PRIME at increased production levels

EACWoP = I kWh + H kWh + Q kWh
I kWh = 0.65 (PPA) (AkWh)
H kWh = 0.20 (PPA) (AkWh) (PAP/EP)
Q kWh = 0.15 (PPA) (AkWh) (PAP/EP)

EACWP = Estimated annual consumption with PRIME at increased production levels

EACWP = I kWh + H kWh + Q kWh
I kWh = 0.65 (PPA) (AkWh)
H kWh = 0.20 (PPA) (AkWh)
Q kWh = 0.15 (PPA) (AkWh) (PAP/EP)(1-SF)
SF = $0.1168 \times P^3 - 0.3402 \times P^2 + 0.4732 \times P + 0.0011$
P = (PAP-EP)/EP

PPA = Percentage of facility's total products affected By PRIME
AkWh = Existing annual kWh
PAP = number of products produced after PRIME
EP = existing number of products produced
I = energy use independent of production hours and production quantity
H = energy use dependent of production hours
Q = energy use dependent of production quantity
SF = Savings Factor

Method for Calculating Demand Savings

kW Savings = 0

Baseline Efficiencies from which savings are calculated

Baseline is calculated existing production methodology with increased production levels.

Operating Hours

Not used in calculation.

Incremental Cost

None

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Non-Electric Benefits - Annual O&M Cost Adjustments

The customer's cost savings from the increase in productivity and reduction in scrap would be quantified on a case by case basis.

Notes & References

Savings calculation is based on ERS (March 26, 2007) study. Measure life will be 5 years.

Revision Number

07

2.7.4 C&I LO CUSTOM

Description of Measure

This measure is used for C&I Lost Opportunity installations not covered by another specific measure.

Method for Calculating Energy Savings

Energy savings are calculated on a custom basis for each customer's specific situation. The savings are the difference in energy usage between the baseline and after conditions.

Method for Calculating Demand Savings

Measures may be lumped into two significantly different categories:
1.) Temperature-dependent (HVAC measures that vary with ambient temperature),
2.) Measures that are not temperature-dependent (process, lighting, time control).

Temperature-dependent methodologies:

The methodology used to determine the demand savings for temperature-dependent measures will depend on the type of analysis used to estimate the savings. Savings from temperature-dependent measures are typically determined by either full load hour analysis, bin temperature analysis, or a detailed computer simulation. The following will be the procedure used to estimate the demand savings for these measures:

When annual savings are calculated using a full load hour analysis, an appropriately derived (for measure and peak time period [On-Peak, Seasonal]) coincidence factor will be used for a measure that has a connected load that can be determined from rated or nameplate data. Demand savings will be the connected load kW savings times the appropriate coincidence factor.

When using a temperature bin analysis to calculate the energy savings, the demand (kW) savings are averaged over the appropriate temperature bins (On-Peak, Seasonal).

When a computer simulation is used to calculate savings, the demand savings will be averaged over the appropriated peak time period (On-Peak, Seasonal).

Non-Temperature-dependent measures:

Demand savings for measures that are not temperature-dependent will be determined by either the coincidence factors from Table 1.1.1 or the average estimated savings over the appropriate peak time periods (On-Peak, Seasonal). For example, for a process VFD measure, the savings will depend on cycling of the load. This cycling may occur many times during an hour. If the process is operating throughout the Seasonal summer period, the average demand savings will be:

(annual kWh savings)/(annual equivalent full load hours of operation).

If the process is operated only a portion of that time period the demand savings will be prorated based on that portion.

Baseline Efficiencies from which savings are calculated

Baseline efficiencies are based on code or common practice whichever is more efficient.

Compliance Efficiency from which incentives are calculated

There is no set compliance efficiency.

Operating Hours

The operating hours are determined on a case-by-case basis.

Incremental Cost

Incremental cost will be done on a case-by-case basis.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits are analyzed on a case-by-case basis.

Revision Number

02

2.8.1 C&I LO COOL ROOF

Description of Measure

The measure is to upgrade a roof's reflectance at the time of replacement or new construction.

Method for Calculating Energy Savings

A number of HVAC system configurations were simulated using a DOE-2 building simulation model. Results of these simulations were reviewed and (based on relative energy savings) were separated into two categories depending on the location of the cooling equipment's condenser. The savings results were based on roof square footage over electrically air conditioned space. Based on those results the following equations are used to estimate annual electric savings.

When air conditioning equipment is located on the roof (rooftop units, split systems, air cooled chillers)(does not include cooling towers)

Annual kWh savings = (ASF) (0.29872 kWh/SF)
ASF = Square footage of upgraded roof that is over electrically air conditioned spaces

When air conditioning equipment is not located on the roof (split systems, air cooled chillers, water cooled chillers)
Annual kWh savings = (ASF) (0.08145 kWh/SF)

Method for Calculating Demand Savings

When air conditioning equipment is located on the roof (rooftop units, split systems, air cooled chillers)(does not include cooling towers)

Summer Peak kW savings = (ASF) (0.00045 kW/SF)

When air conditioning equipment is not located on the roof (split systems, air cooled chillers, water cooled chillers)
Summer Peak kW savings = (ASF) (0.00019 kW/SF)

Baseline Efficiencies from which savings are calculated

Based on the Energy Cost Budget Method in ASHRAE 90.1-2001 that requires that roofs be modeled with a reflectance of 0.3.

Compliance Efficiency from which incentives are calculated

The new roof must provide a minimum reflectance of 0.70 and a minimum emittance of 0.75 as certified and labeled by the Cool Roof Rating Council (CRRC).

Operating Hours

N/A

Incremental Cost

$0.20 per square foot

Non-Electric Benefits - Annual Fossil Fuel Savings

Based on the DOE-2 model the average annual increase in fossil fuel usage was determined to be 0.0017 MBTU/SF.

Revision Number

05

C&I RETROFIT

3.1.1 C&I R STANDARD LIGHTING

Description of Measure

This measure provides an incentive to replace inefficient lighting with efficient lighting.

Method for Calculating Energy Savings

KWh savings, $S = S_R + S_c + S_o$

S_R, kWh = savings from retrofit of reduced-wattage lamps,
S_c, kWh = savings from reduced cooling
S_o, kWh = savings from use of occupancy sensors, if applicable

$S_R = (kW_B - kW_A)\ H$

S_R = Energy savings, kWh/year
kW_B = The total power usage of the lighting fixtures that are being replaced, kW.
kW_A = The total power usage of the new lighting fixtures that are being installed, kW.
H = The number of hours during which the lighting is used at the facility, hours/year.

S_c Calculation of lighting kWh savings due to the reduced cooling required to remove excess heat produced by the lighting fixtures. This is a simplified version of the method used in C&I Section 2.1.1

S_c = Additional savings due to the reduced cooling energy required to remove the energy from lighting, kWh per year.

$$S_C = \frac{(S_R) \bullet F}{COP}$$

F = Fraction of annual kWh energy savings that must be removed by the cooling system, as determined from the table below:

Building Area, A, Sq ft	F
< 2,000	0.48
2,000 – 20,000	$0.48 + \frac{0.195(A - 2,000)}{18,000}$
>20,000	0.675

COP = 2.4

The source of the equation for S_c and the derivation of the values for F and COP is from “Calculating Lighting and HVAC Interactions,” Ashrae Journal 11-93 as used by KCPL.

S_o Calculation of kWh savings due to occupancy sensors

S_o = Additional savings due to occupancy sensors

If the *Actual LPD* is less than or equal to the *Allowable LPD*, then S_o will be calculated as follows; otherwise, $S_o = 0$.

$$S_O = \frac{0.3H}{1000}\sum_{n=1}^{N} O_n W_n$$

H = Facility hours

N = Number of different fixture types with occupancy sensors

n = Fixture number

O_n = Quantity of fixtures of type n that have occupancy sensors

W_n = Input watts for fixture type n

Explanation of numerical constants:
- 0.3 is the generally accepted average energy reduction due to the use of occupancy sensors (see ref.)
- 1000 converts watts to kW

<u>Method for Calculating Demand Savings</u>

$$KW = \frac{1}{H}\left(C_L * S_R + C_o * \frac{S_o}{0.3}\right)\left(1 + \frac{G}{COP}\right)$$

CL is the lighting coincidence factor taken from Table 1.1.1 of Section 7.1.1.

C_o is the occupancy-sensor coincidence factor from Table 1.1.1 Section 7.1.1.

$S_0/0.3$ converts the occupancy sensor savings back to occupancy sensor connected load.

G = 0.73, and is the estimated lighting energy heat to space, based on modeling results.

H = the number of hours used in the energy savings calculation.

<u>Baseline Efficiencies from which savings are calculated</u>

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

<u>Compliance Efficiency from which incentives are calculated</u>

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Operating Hours

The operating hours are determined on a case-by-case basis, or the default facility hours are used from Table 2.0.0.

Total Cost

The cost to install the measure.

Non-Electric Benefits - Annual Fossil Fuel Savings

Space heating increase from reduced lighting load. Annual Fossil fuel Savings = -0.00079 MBTU's per annual kWh saved.
Based on August 22, 2003 Memorandum from Optimal energy, Inc..

Non-Electric Benefits - Annual O&M Cost Adjustments

O&M savings are due to the installation of new equipment. O&M Savings = $0.003667 per annual kWh saved.
Based on August 22, 2003 Memorandum from Optimal energy, Inc..

Revision Number

08

3.1.2 C&I R REFRIGERATOR LED

Description of Measure

This measure calculates the savings when older fluorescent lighting in commercial display refrigerators, coolers and freezers is replaced with LED systems intended for this application.

Method for Calculating Energy Savings

S = KW* H

S = Energy savings, kWh/year
KW = the total kW savings of the refrigeration package, as defined in the next section.
H = The number of hours during which the lighting is used at the facility, hours/year.

Method for Calculating Demand Savings

KW = (kW_B –kW_A)* Compressor factor

KW = the total kW savings of the refrigeration package, including the kW reduction due to the fixture replacement, and the reduced operation of the compressor due to not having to remove the excess lighting energy.
kW_B = The total power usage of the lighting fixtures that are being replaced, kW.
kW_A = The total power usage of the new lighting fixtures that are being installed, kW.
Compressor factor = 1.51 for coolers and 1.65 for freezers. The factors are based on effective refrigeration compressor EER values of 6.7 and 5.25 Btu/Wh, respectively.

Note: All of the kW savings associated with display refrigeration occur at the peak times because the lights are always on during the peak.

Baseline Efficiencies from which savings are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Compliance Efficiency from which incentives are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Operating Hours

The operating hours are determined on a case-by-case basis, or the default facility hours are used from Table 2.0.0.

Total Cost

The cost to install the measure.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

01

3.2.1 C&I R COOLING - ELECTRIC CHILLER

Description of Measure

This measure encourages the installation of efficient water-cooled and air-cooled water chilling packages (chillers) as replacements for less-efficient chillers. Chillers must use an environmentally friendly refrigerant in order to qualify for the program.

Method for Calculating Energy Savings

The energy consumption is custom-calculated for each chiller installation based on the specific equipment, operational staging, operating profile, and load profile.

These calculations are performed for both the old chiller plant and the new chiller plant. The difference in energy consumption between the two plants is the energy savings.

Equipment

Each chiller plant is characterized by its:

- Number of chillers,
- Sizes, in tons (the chillers may be of different sizes),
- Type, which may be:
  - Centrifugal,
    - R123 refrigerant,
    - R134a refrigerant
  - Water-cooled screw and scroll, or
  - Air-cooled
- Speed, constant or variable
- Auxiliary equipment
  - Chilled water pumps
  - Cooling tower pumps
  - Cooling tower fans
  - Other

Operational Staging

If more than one chiller is used, their operational relationship can be defined. When the load is high enough to permit two chillers to operate, they can be designated to operate together at the same loading, or, alternatively, either one can be operated at full output and the other can follow the cooling load profile.

Operating Profile

The customer's cooling load profile, for each of 12 months, is characterized by the:

- On-peak occupied hours the chiller is operated each week,
- Off-peak occupied hours the chiller is operated each week,
- On-peak un-occupied hours the chiller is operated each week,
- Off-peak un-occupied hours the chiller is operated each week.

Load Profile

The customer's load profile is estimated by determining the load at the peak outdoor conditions and the load at the minimum conditions. For systems with an air-side or water-side economizer, the minimum conditions are those just above the set point of the economizer. If the customer's load profile is not known, a default load profile will be developed; in this case it is also necessary to determine the value of any process loads.

Savings Calculation

With the above information, a calculation is made for each time period of the year based on the appropriate temperature bin data. The calculation is performed once for the old chillers and again for the proposed chillers, and the difference determines the kWh and the kW savings for each period. These are summed to yield the annual total savings for each year of the remaining life of the old chiller.

Method for Calculating Demand Savings

The demand savings calculation is described in the previous paragraph.

Baseline Efficiencies from which savings are calculated

Savings are calculated using the old chiller as the baseline.

Compliance Efficiency from which incentives are calculated

The proposed replacement chiller rating at ARI conditions must meet a minimum efficiency to qualify for an incentive. The minimum is set at an efficiency somewhat better than what Ashrae 90.1 requires. These minimum efficiency levels for the various sizes and types of chillers are shown in Table 2.2.1.A in the Appendix. The ARI conditions are shown in Table 2.2.1.B in the Appendix.

Operating Hours

A single value for operating hours is not used. As described above, custom hourly calculations are made for each customer.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

05

3.2.2 C&I R COOLING - HVAC

Description of Measure

This measure provides an incentive to replace inefficient cooling systems with systems that exceed the current efficiency standards.

Method for Calculating Energy Savings

$$S = \left(\frac{12}{[S/EER]_B} - \frac{12}{[S/EER]_P} \right) \bullet H \bullet T$$

S = Annual savings, kWh
S/EER_B = Efficiency of the equipment being replaced, expressed as SEER or EER
S/EER_P = Proposed efficiency expressed as SEER or EER. This value must be at least the value shown in Table 2.3.
H = Equivalent full load hours (EFLH) per year for the facility. The default hours are shown in Table 2.0.0.
T = Size, in tons
12 = Factor to convert from EER to kW/ton

Method for Calculating Demand Savings

$$KW = \left(\frac{12}{[S/EER]_B} - \frac{12}{[S/EER]_P} \right) \bullet T \bullet D$$

KW = Peak demand savings, kW
S/EER_B = Before efficiency expressed as SEER or EER
S/EER_P = Proposed efficiency expressed as SEER or EER
T = Size, in tons
12 = Factor to convert from EER to kW/ton
D = Peak Factor from Table 1.1.1

Baseline Efficiencies from which savings are calculated

There are no set baseline efficiencies. The energy savings are calculated as the difference between what is replaced and what is installed.

Compliance Efficiency from which incentives are calculated

The compliance efficiencies are shown in Table 2.3. The compliance efficiencies are the same as in the Cool Choice program for the size range covered by Cool Choice (up to 30 tons).

Operating Hours

The default value for equivalent full load hours (EFLH) per year for the facility is taken from Table 2.0.0.

Incremental Cost

The incremental cost is the difference in cost between the replacement unit and the cost of a unit that meets only the minimum required efficiency. Values for the minimum required efficiency are shown in the table in Sec 2.2.2.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

08

3.2.3 C&I R COOLING - GAS-DRIVEN CHILLER

Description of Measure

This measure encourages the installation of efficient water-cooled and air-cooled gas fired engine driven water chilling packages (chillers) as replacements for less-efficient chillers. Chillers must use an environmentally friendly refrigerant in order to qualify for the program.

Method for Calculating Energy Savings

The energy consumption is custom-calculated for each chiller installation based on the specific equipment, operational staging, operating profile, and load profile.

These calculations are performed for both the old chiller plant and the new chiller plant. The difference in energy consumption between the two plants is the energy savings.

Equipment

Each chiller plant is characterized by its:

- Number of chillers,
- Sizes, in tons (the chillers may be of different sizes),
- Type, which may be:
  - Centrifugal,
    - R123 refrigerant,
    - R134a refrigerant
  - Water-cooled screw and scroll, or
  - Air-cooled
  - Gas engine driven
- Speed, constant or variable
- Auxiliary equipment
  - Chilled water pumps
  - Cooling tower pumps
  - Cooling tower fans
  - Other

Operational Staging

If more than one chiller is used, their operational relationship can be defined. When the load is high enough to permit two chillers to operate, they can be designated to operate together at the same loading, peak shaving, or, alternatively, either one can be operated at full output and the other can follow the cooling load profile.

Operating Profile

The customer's cooling load profile, for each of 12 months, is characterized by the:

- On-peak occupied hours the chiller is operated each week,
- Off-peak occupied hours the chiller is operated each week,
- On-peak un-occupied hours the chiller is operated each week,
- Off-peak un-occupied hours the chiller is operated each week.

Load Profile

The customer's load profile is estimated by determining the load at the peak outdoor conditions and the load at the minimum conditions. For systems with an air-side or water-side economizer, the minimum conditions are those just above the set point of the economizer. If the customer's load profile is not known, a default load profile will be developed; in this case it is also necessary to determine the value of any process loads.

Savings Calculation

With the above information, a calculation is made for each time period of the year based on the appropriate temperature bin data. The calculation is performed once for the old chillers and again for the proposed chillers, and the difference determines the kWh and the kW savings for each period. These are summed to yield the annual total savings for each year of the remaining life of the old chiller.

For the period after the remaining life of the old chillers and before the end of life for the new chillers, the calculation is performed as described, except the efficiency that was used for the old chiller is replaced by the baseline efficiency.

Method for Calculating Demand Savings

The demand savings calculation is described in the previous paragraph

Baseline Efficiencies from which savings are calculated

The baseline efficiencies are a combination of existing chillers and those required by the Ct Building Code (for electric chillers). These efficiencies are shown in Table 2.2.1.A in the Appendix.

Compliance Efficiency from which incentives are calculated

The chiller rating at ARI conditions must meet a minimum efficiency to qualify for an incentive. Compliance efficiency is set to meet DPUC source BTU requirement.

Cooling System	**Comfort Cooling (IPLV*)**	**Process Cooling (IPLV*)**
Water-cooled		
< 150 tons	1.6 COP	2.0 COP
≥ 150 & < 300 Tons	1.7 COP	2.2 COP
≥ 300 Tons	2.0 COP	2.5 COP
Air -cooled		
Any Size	0.9 COP	1.2 COP
* This requirement may be modified based on the amount of heat recovery.		

Operating Hours

A single value for operating hours is not used. As described above, custom hourly calculations are made for each customer.

Total Cost

Total cost will be based on site specific information.

Non-Electric Benefits - Annual Fossil Fuel Savings

The Non-electric fossil fuel benefit for this measure would be negative. The ‘savings’ would include any gas savings from the heat recovery minus the additional gas consumption from the engine. This would be estimated on a site specific basis.

Non-Electric Benefits - Annual O&M Cost Adjustments

Additional annual O&M costs would be added maintenance costs of the engine. These would be estimated on a site specific basis.

Revision Number

01

3.3.1 C&I R CUSTOM MEASURE

Description of Measure

This measure is used for C&I Retrofit installations not covered by another specific measure.

Method for Calculating Energy Savings

Energy savings are calculated on a custom basis for each customer's specific situation. The savings are the difference in energy usage between the before and after conditions.

Method for Calculating Demand Savings

Measures may be lumped into two significantly different categories:
1.) Temperature-dependent (HVAC measures that vary with ambient temperature),
2.) Measures that are not temperature-dependent (process, lighting, time control).

Temperature-dependent methodologies:

The methodology used to determine the demand savings for temperature-dependent measures will depend on the type of analysis used to estimate the savings. Savings from temperature-dependent measures are typically determined by either full load hour analysis, bin temperature analysis, or a detailed computer simulation. The following will be the procedure used to estimate the demand savings for these measures:

When annual savings are calculated using a full load hour analysis, an appropriately derived (for measure and peak time period [On-Peak, Seasonal]) coincidence factor will be used for a measure that has a connected load that can be determined from rated or nameplate data. Demand savings will be the connected load kW savings times the appropriate coincidence factor.

When using a temperature bin analysis to calculate the energy savings, the demand (kW) savings are averaged over the appropriate temperature bins (On-Peak, Seasonal).

When a computer simulation is used to calculate savings, the demand savings will be averaged over the appropriated peak time period (On-Peak, Seasonal).

Non-Temperature-dependent measures:

Demand savings for measures that are not temperature-dependent will be determined by either the coincidence factors from Table 1.1.1 or the average estimated savings over the appropriate peak time periods (On-Peak, Seasonal). For example, for a process VFD measure, the savings will depend on cycling of the load. This cycling may occur many times during an hour. If the process is operating throughout the Seasonal summer period, the average demand savings will be:

(annual kWh savings)/(annual equivalent full load hours of operation).

If the process is operated only a portion of that time period the demand savings will be prorated based on that portion.

Baseline Efficiencies from which savings are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Compliance Efficiency from which incentives are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Operating Hours

The operating hours are determined on a case-by-case basis.

Total Cost

The cost to install the measure.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits are analyzed on a case-by-case basis.

Notes & References

" 2005 Coincidence Factor Study" 7-20-06 by RLW Analytics.

Revision Number

09

3.4.1 C&I R COOLER NIGHT COVERS

Description of Measure

Installation of retractable covers for open-type refrigerated display cases. The covers are deployed during the unoccupied times in order to reduce the energy loss.

Method for Calculating Energy Savings

S = W*H*F

S = Savings, kWh per year.
W = Width of the opening that the covers protect, ft.
H = Hours per year the covers are in use.
F = Savings factor based on the temperature of the case, kW/ft;

Low temperature (-35F to -5F)	F = 0.1 kW/ft
Medium temperature (0F to 30F)	F = 0.06 kW/ft
High temperature (35F to 55F)	F = 0.04 kW/ft

These savings values are based on a study by Southern California Edison.
Southern California Edison (SCE) conducted this test at its state-of-the-art Refrigeration Technology and Test Center (RTTC), located in Irwindale, CA. The RTTC's sophisticated instrumentation and data acquisition system provided detailed tracking of the refrigeration system's critical temperature and pressure points during the test period. These readings were then utilized to quantify various heat transfer and power related parameters within the refrigeration cycle. The results of SCE's test focused on three typical scenarios found mostly in supermarkets.

Method for Calculating Demand Savings

There are no demand savings for this measure because the covers will not be in use during the peak period.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Notes & References

"Effects Of The Low Emissivity Shields On Performance And Power Use Of A Refrigerated Display Case" *Southern California Edison Refrigeration Technology and Test Center Energy Efficiency Division* August 8, 1997.

Revision Number

00

3.4.2 C&I R EVAPORATOR FAN CONTROLS

Description of Measure

This measure is applicable to walk-in coolers and freezers that have evaporator fans that run constantly. The measure adds a control system to an existing facility. The control system shuts off the evaporator fans when the cooler's thermostat is not calling for cooling.

Method for Calculating Energy Savings

A custom calculation is performed for each facility.

S = N*P*H*factors

S = energy savings, kWh
N = Number of fans
P = Fan power, kW
H = Hours per year the fans are shut off
Factors = Other variables to take into account the motor efficiency, the number of phases, and the compressor efficiency

Method for Calculating Demand Savings

KW = C*P

KW = kW reduction from the summer peak
C is the diversity factor of 10%
P = Fan power, kW

Baseline Efficiencies from which savings are calculated

The baseline is 24-hour operation of the fans.

Operating Hours

Hours per year the fans are shut off.

Total Cost

This is based on standard prices for the equipment that is installed.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

00

3.4.3 C&I R EVAPORATOR FANS MOTOR REPLACEMENT

Description of Measure

This measure is for the replacement of the evaporator fan motors in the evaporator units of walk-in or reach-in coolers and freezers. The replacement fan motors are high-efficiency electrically commutated motors (ECM), which require only 60% of the power of normally-installed shaded-pole motors. The evaporator fans normally operate full time, 8760 hours per year.

Method for Calculating Energy Savings

A custom calculation is performed for each facility.

S = N*P*H*Factor

S = energy savings, kWh
N = Number of fans
P = Original fan power, kW
Fan power is determined from a measurement of amps and volts, if the HP is unknown.
H = 8760, the number of hours in a year
Factor = Other variables take into account the motor efficiency improvement and the compressor efficiency. For walk-in cooler applications, the compressor variable of 1.63 is based on a compressor efficiency of 2.25 kW/ton, and the savings from using EC motors is 40%. The overall factor is thus 0.65. Freezer and reach-in applications are not yet offered, and their factors will be determined at the time of the offering.

Method for Calculating Demand Savings

KW = 0.6*P

KW = kW reduction from the summer peak
P = Original fan power, kW
0.6 = the reduced power required by the EC motors and compressor.

Note – there is no coincidence factor needed in the formula, because the fans are always operating, and the peak is reduced by the full kW reduction.

Operating Hours

These fans operate continuously 8760 hours per year.

Total Cost

The total cost is based on standard prices for the equipment that is installed.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

02

SMALL BUSINESS

4.1.1 SMB STANDARD LIGHTING

Description of Measure

This measure provides an incentive to small businesses to replace inefficient lighting with efficient lighting.

Method for Calculating Energy Savings

KWh savings, $S = S_R + S_c + S_o$

S_R, kWh = savings from retrofit of reduced-wattage lamps,
S_c, kWh = savings from reduced cooling
S_o, kWh = savings from use of occupancy sensors, if applicable

$S_R = (kW_B - kW_A)\ H$

S_R = Energy savings, kWh/year
kW_B = The total power usage of the lighting fixtures that are being replaced, kW.
kW_A = The total power usage of the new lighting fixtures that are being installed, kW.
H = The number of hours during which the lighting is used at the facility, hours/year.

S_c Calculation of lighting kWh savings due to the reduced cooling required to remove excess heat produced by the lighting fixtures. This is a simplified version of the method used in C&I Section 2.1.1

S_c = Additional savings due to the reduced cooling energy required to remove the energy from lighting, kWh per year.

$$S_C = \frac{(S_R) \bullet F}{COP}$$

F = Fraction of annual kWh energy savings that must be removed by the cooling system, as determined from the table below:

Building Area, A, Sq ft	F
< 2,000	0.48
2,000 – 20,000	$0.48 + \frac{0.195(A - 2{,}000)}{18{,}000}$
>20,000	0.675

COP = 2.4

The source of the equation for S_c and the derivation of the values for F and COP is from "Calculating Lighting and HVAC Interactions," Ashrae Journal 11-93 as used by KCPL.

S_o Calculation of kWh savings due to occupancy sensors

S_o = Additional savings due to occupancy sensors

If the *Actual LPD* is less than or equal to the *Allowable LPD*, then S_o will be calculated as follows; otherwise, $S_o = 0$.

$$S_O = \frac{0.3H}{1000}\sum_{n=1}^{N} O_n W_n$$

H = Facility hours

N = Number of different fixture types with occupancy sensors

n = Fixture number

O_n = Quantity of fixtures of type n that have occupancy sensors

W_n = Input watts for fixture type n

Explanation of numerical constants:
- 0.3 is the generally accepted average energy reduction due to the use of occupancy sensors (see ref.)
- 1000 converts watts to kW

Method for Calculating Demand Savings

$$KW = \frac{1}{H}\left(C_L * S_R + C_o * \frac{S_o}{0.3}\right)(1 + \frac{G}{COP})$$

CL is the lighting coincidence factor taken from Table 1.1.1 of Section 7.1.1.

C_o is the occupancy-sensor coincidence factor from Table 1.1.1 Section 7.1.1.

$S_0/0.3$ converts the occupancy sensor savings back to occupancy sensor connected load.

G = 0.73, and is the estimated lighting energy heat to space, based on modeling results.

H = the number of hours used in the energy savings calculation.

Baseline Efficiencies from which savings are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Compliance Efficiency from which incentives are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Operating Hours

The operating hours are determined on a case-by-case basis, or the default facility hours from Table 2.0.0 are used.

Total Cost

The cost to install the measure.

Non-Electric Benefits - Annual Fossil Fuel Savings

Space heating increase from reduced lighting load. Annual Fossil fuel Savings = -0.00079 MBTU's per annual kWh saved.
Based on August 22, 2003 Memorandum from Optimal energy, Inc..

Non-Electric Benefits - Annual O&M Cost Adjustments

O&M savings are due to the installation of new equipment. O&M Savings = $0.003667 per annual kWh saved.
Based on August 22, 2003 Memorandum from Optimal energy, Inc..

Revision Number

08

4.1.2 SMB REFRIGERATOR LED

Description of Measure

This measure calculates the savings when older fluorescent lighting in commercial display refrigerators, coolers and freezers is replaced with LED systems intended for this application.

Method for Calculating Energy Savings

S = KW* H

S = Energy savings, kWh/year
KW = the total kW savings of the refrigeration package, as defined in the next section.
H = The number of hours during which the lighting is used at the facility, hours/year.

Method for Calculating Demand Savings

KW = (kW_B –kW_A)* Compressor factor

KW = the total kW savings of the refrigeration package, including the kW reduction due to the fixture replacement, and the reduced operation of the compressor due to not having to remove the excess lighting energy.
kW_B = The total power usage of the lighting fixtures that are being replaced, kW.
kW_A = The total power usage of the new lighting fixtures that are being installed, kW.
Compressor factor = 1.51 for coolers and 1.65 for freezers. The factors are based on effective refrigeration compressor EER values of 6.7 and 5.25 Btu/Wh, respectively.

Note: All of the kW savings associated with display refrigeration occur at the peak times because the lights are always on during the peak.

Baseline Efficiencies from which savings are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Operating Hours

The operating hours are determined on a case-by-case basis, or the default facility hours are used from Table 2.0.0.

Incremental Cost

The cost to install the measure.

<u>Non-Electric Benefits - Annual Fossil Fuel Savings</u>

Non-electric benefits have not been identified for this measure.

<u>Revision Number</u>

01

4.2.1 SMB CUSTOM

Description of Measure

This measure is used for Small Business installations not covered by another specific measure.

Method for Calculating Energy Savings

Energy savings are calculated on a custom basis for each customer's specific situation. The savings are the difference in energy usage between the before and after conditions.

Method for Calculating Demand Savings

Demand savings are calculated on a custom basis for each customer's specific situation.
The savings is the difference in power demand between the before and after conditions that would occur due to the installation of the measure at the time of the electric system peak.

Baseline Efficiencies from which savings are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Compliance Efficiency from which incentives are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Operating Hours

The operating hours are determined on a case-by-case basis.

Total Cost

The cost to install the measure.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

02

4.2.2 SMB AC TUNEUP

Description of Measure

This measure encourages users of Air Conditioning equipment to procure maintenance for their equipment from a service organization that uses a computer-based diagnostic tool. The computer-based diagnostic tool is the property of a third-party vendor, and analysis of the data is part of the service the vendor provides. Use of the computer diagnostics helps to ensure that the service is appropriate and complete.

Method for Calculating Energy Savings

The kW savings for each customer is multiplied by the that facility's specific EFLH value.

KWh = kW*EFLH

KWh = kWh energy savings per year
KW = kW savings
EFLH = Equivalent full-load hours of operation per year, based on facility type or customer-specific information.

Method for Calculating Demand Savings

The vendor provides, for each customer, the size of the equipment, the S/EER rating, and an Efficiency Index (EI) factor measured both before and after the tuneup activity. The EI is the ratio of the measured efficiency value to the rated efficiency value. The EI is used to calculated the before and after kW required by the equipment.

$$kW = \left(\frac{S}{1000SEER}\right)\left(\frac{1}{EI_B} - \frac{1}{EI_A}\right)D$$

KW = kW savings
S = Size of equipment, Btu/hr
SEER = Rating of equipment, Btu/Watt-hour
EI_B = EI before maintenance was performed
EI_A = EI after maintenance was performed
1000 = Conversion from Watts to kW

kW_p = kw *D

kW_p = kW peak demand savings

D = Peak factor from Table 1.1.1

Baseline Efficiencies from which savings are calculated

No baseline is used for the energy savings; the savings are specific to each customer.

Compliance Efficiency from which incentives are calculated

Incentives are not calculated based on the improvement of efficiency; they are based on a uniform payment for each piece of equipment that has been serviced.

Operating Hours

Each facility type is assigned a default value for EFLH, as shown in Table 2.0.0.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

07

4.3.1 SMB EVAPORATOR FAN CONTROLS

Description of Measure

This measure is applicable to walk-in coolers and freezers that have evaporator fans that run constantly. The measure adds a control system to an existing facility. The control system shuts off the evaporator fans when the cooler's thermostat is not calling for cooling.

Method for Calculating Energy Savings

A custom calculation is performed for each facility.

S = N*P*H*factors

S = energy savings, kwh
N = Number of fans
P = Fan power, kw
H = Hours per year the fans are shut off
Factors = Other variables to take into account the motor efficiency, the number of phases, and the compressor efficiency

Method for Calculating Demand Savings

KW = C*P

KW = kW reduction from the summer peak
C is the coincidence factor of 10%
P = Fan power, kW

Baseline Efficiencies from which savings are calculated

The baseline is 24-hour operation of the fans.

Operating Hours

Hours per year the fans are shut off.

Total Cost

This is based on standard prices for the equipment that is installed.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

03

4.3.2 SMB DOOR HEATERS

Description of Measure

This measure is applicable to walk-in coolers and freezers that have electric heaters on the doors whose purpose is to prevent condensation from forming. This measure adds a control system to an existing facility whose door heaters operate continuously. The control system shuts off the door heaters when the facility's humidity is too low to allow condensation to occur.

Method for Calculating Energy Savings

S = P*6500

S = energy savings, kwh
P = Door heater power, kw
6500 = Hours per year the heaters are shut off

Method for Calculating Demand Savings

KW = D*P

KW = kW reduction from the summer peak
D is the estimated diversity factor of 10%
P = Door heater power, kW

Baseline Efficiencies from which savings are calculated

The baseline is 24-hour operation of the heaters.

Operating Hours

Hours per year the heaters are shut off. These hours were determined from data collected each minute for one year for a number of applications.

Total Cost

The total cost is based on standard prices for the equipment that is installed.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

04

4.3.3 SMB VENDING MACHINE CENTRAL CONTROLS

Description of Measure

This measure is available for vending machines that are controlled by a central controller.

Method for Calculating Energy Savings

$S = kW(H_B - H_A)$

S = Energy savings, kwh/year
kW = The total power usage of the vending machines that are being controlled, kW.
H_B = The number of hours before being controlled during which the vending machines are turned on at the facility, hours/year. This value is usually 8760.
H_A = The number of hours after the controls are installed during which the vending machines are turned on at the facility, hours/year.

Method for Calculating Demand Savings

There are no demand savings for this measure.

Baseline Efficiencies from which savings are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Compliance Efficiency from which incentives are calculated

There are no set baseline and compliance efficiencies. The energy savings are calculated as the difference between what is observed before this measure is installed and what is observed after this measure is installed.

Operating Hours

The operating hours are determined on a case-by-case basis.

Total Cost

The cost to install the measure.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

02

4.3.4 SMB COOLER NIGHT COVERS

Description of Measure

Installation of retractable covers for open-type refrigerated display cases. The covers are deployed during the unoccupied times in order to reduce the energy loss.

Method for Calculating Energy Savings

S = W*H*F

S = Savings, kWh per year.
W = Width of the opening that the covers protect, ft.
H = Hours per year the covers are in use.
F = Savings factor based on the temperature of the case, kW/ft;

Low temperature (-35F to -5F)	F = 0.1 kW/ft
Medium temperature (0F to 30F)	F = 0.06 kW/ft
High temperature (35F to 55F)	F = 0.04 kW/ft

These savings values are based on a study by Southern California Edison.
Southern California Edison (SCE) conducted this test at its state-of-the-art Refrigeration Technology and Test Center (RTTC), located in Irwindale, CA. The RTTC's sophisticated instrumentation and data acquisition system provided detailed tracking of the refrigeration system's critical temperature and pressure points during the test period. These readings were then utilized to quantify various heat transfer and power related parameters within the refrigeration cycle. The results of SCE's test focused on three typical scenarios found mostly in supermarkets.

Method for Calculating Demand Savings

There are no demand savings for this measure because the covers will not be in use during the peak period.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Notes & References

"Effects Of The Low Emissivity Shields On Performance And Power Use Of A Refrigerated Display Case" *Southern California Edison Refrigeration Technology and Test Center Energy Efficiency Division* August 8, 1997.

Revision Number

00

4.3.5 SMB EVAPORATOR FANS MOTOR REPLACEMENT

Description of Measure

This measure is for the replacement of the evaporator fan motors in the evaporator units of walk-in or reach-in coolers and freezers. The replacement fan motors are high-efficiency electrically commutated motors (ECM), which require only 60% of the power of normally-installed shaded-pole motors. The evaporator fans normally operate full time, 8760 hours per year.

Method for Calculating Energy Savings

A custom calculation is performed for each facility.

S = N*P*H*Factor

S = energy savings, kWh
N = Number of fans
P = Original fan power, kW
Fan power is determined from a measurement of amps and volts, if the HP is unknown.
H = 8760, the number of hours in a year
Factor = Other variables take into account the motor efficiency improvement and the compressor efficiency. For walk-in cooler applications, the compressor variable of 1.63 is based on a compressor efficiency of 2.25 kW/ton, and the savings from using EC motors is 40%. The overall factor is thus 0.65. Freezer and reach-in applications are not yet offered, and their factors will be determined at the time of the offering.

Method for Calculating Demand Savings

KW = 0.6*P

KW = kW reduction from the summer peak
P = Original fan power, kW
0.6 = the reduced power required by the EC motors and compressor.

Note – there is no coincidence factor needed in the formula, because the fans are always operating, and the peak is reduced by the full kW reduction.

Operating Hours

These fans operate continuously 8760 hours per year.

Total Cost

The total cost is based on standard prices for the equipment that is installed.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

02

RESIDENTIAL

5.1.1 GENERAL SERVICE CFL LIGHT BULB (DIRECT INSTALL - NEW HOMES, HES & LOW INCOME)

Description of Measure

A direct installed screw-based general service CFL bulb.

General service CFL's are defined as standard base bulbs that are intended for general service applications as specified in the Energy Independence and Security Act of 2007. These bulbs will be gradually phased out of CEEF programs as the measure life declines annually.

Direct installed bulbs, as their name implies, are different than "retail bulbs" (see Measure 5.3.1) because their installation is performed or verified (in the situation that the builder installs the bulbs) by the home rater.

Method for Calculating Energy Savings

Annual Gross Energy Savings = Δ Watts x Hours x 365/1000

Where:
Δ Watts = 3.0 x CFL wattage. This represents an "incandescent to CFL" wattage ratio of 4.0 to 1 (Note 1)

Hours = See below (Used Living Room in example)
365 = days per year

For example, the annual savings for a 15 watt CFL:
Annual kWh = 3.0 x 15 watts x 2.97 hours/day x 365 days / 1000 = 48.8 kWh

Note that actual bulb wattage should be used to calculate energy savings – using a default average could lead to a large margin of error.

Annual Net Energy Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peaks (Note 2):

Summer Coincident Peak Gross Savings = CF_S x Δ Watts
Winter Coincident Seasonal Peak Gross Savings = CF_W x Δ Watts

Where :

CF = Average (Summer or Winter) Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

Baseline Efficiencies from which savings are calculated

Baseline is assumed to be an incandescent light source with a wattage which is 4.0 times higher than the wattage of the CFL bulb. For instance, it's assumed that a 60 Watt incandescent is "equivalent" to a 15 Watt CFL (15 x 4.0 = 60). For dimmable or three-way CFL bulbs, assume the highest wattage/setting when calculating the baseline equivalent.

Compliance Efficiency from which incentives are calculated

Energy Star CFL Bulb.

Operating Hours

Room Type	Average hours per day
Bedroom	1.08
Bathroom	0.65
Den/Office	2.97
Garage	1.32
Hallway	6.25
Kitchen	2.97
Living Room	2.97
Dinning Room	2.97
Exterior	2.89
Basement	1.29
Closet	1.24
Other	2.0

See notes 1 and 3

Incremental Cost

$6.25

Non-Electric Benefits - Annual O&M Cost Adjustments

$3.00 per bulb one time benefit. Estimate based on current cost of incandescent bulbs that would be used in place of one CFL.

Notes & References

Note 1. Residential Lighting Markdown Impact Evaluation, Nexus Market Research, January 20, 2009.

Note 2: Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007.

Note 3. Northeast Utilities SPECTRUM Lighting Catalog and Retail Lighting Programs Hours of Use Re-Analysis, December 20, 2001.

Revision Number

08

5.1.2 FLUORESCENT FXTURES (NEW HOMES & LOW INCOME)

Description of Measure

An Energy Star hardwired fluorescent fixture with pin based bulbs. Fixtures with screw-based (CFL) bulbs are treated as CFL bulbs for savings calculations (see 5.1.1).

Method for Calculating Energy Savings

Annual Gross Energy Savings = Δ Watts x Hours x 365/1000

Where:
Δ Watts = 2.7 x CFL wattage. This represents an incandescent to fluorescent wattage ratio of 3.7 to 1 (Note 1)

Hours = See below (Used Living Room in example)
365 = days per year

For example, the annual savings for a 25 watt fixture:
Annual kWh = 2.7 x 25 watts x 2.46 hours/day x 365 days / 1000 = 60.6 kWh

Annual Net Energy Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peaks (Note 2):

Summer Coincident Peak Gross Savings = CF_S x Δ Watts
Winter Coincident Seasonal Peak Gross Savings = CF_W x Δ Watts

Where :

CF = Average (Summer or Winter) Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

Baseline Efficiencies from which savings are calculated

Incandescent fixture with a wattage equal to 3.7 times the wattage of the efficient fluorescent fixture. For dimmable fixtures, assume the highest wattage/setting when calculating the baseline equivalent.

Compliance Efficiency from which incentives are calculated

Energy Star hard-wired fixture with equivalent lumen output.

Operating Hours

Room Type	Average hours per day
Bedroom	0.32
Bathroom	1.83
Den/Office	5.57
Hallway	1.72
Kitchen	5.37
Living Room	2.46
Dinning Room	0.99
Exterior	1.95
Other	1.98

Note 3:

Incremental Cost

$10

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Non-Electric Benefits - Annual O&M Cost Adjustments

$14.00 (one-time benefit per fixture). Estimate based on added cost of using incandescent bulbs over the life of the measure.

Notes & References

Note 1. *Northeast Utilities and United Illuminating Retail/Point of Purchase Lighting Program Impact Evaluation*, RLW Analytics, April 2003.

Note 2: Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007.

Note 3. Northeast Utilities SPECTRUM Lighting Catalog and Retail Lighting Programs Hours of Use Re-Analysis, December 20, 2001.

Revision Number

06

5.1.3 NON GENERAL SERVICE CFL LIGHT BULB (DIRECT INSTALL - NEW HOMES, HES & LOW INCOME)

Description of Measure

A direct installed screw-based non general service CFL bulb.

General service CFL's are defined as standard base bulbs that intended for general service applications as specified in the Energy Independence and Security Act of 2007. Non-general service CFLs include, but are not limited to reflector bulbs, 3-way bulbs, and candelabra based bulbs.

Direct installed bulbs, as their name implies, are different than “retail bulbs” (see Measure 5.3.1) because their installation is performed or verified (in the situation that the builder installs the bulbs) by the home rater.

Method for Calculating Energy Savings

Annual Gross Energy Savings = Δ Watts x Hours x 365/1000

Where:
Δ Watts = 3.0 x CFL wattage. This represents an “incandescent to CFL” wattage ratio of 4.0 to 1 (Note 1)

Hours = See below (Used Living Room in example)
365 = days per year

For example, the annual savings for a 15 watt CFL:
Annual kWh = 3.0 x 15 watts x 2.97 hours/day x 365 days / 1000 = 48.8 kWh

Note that actual bulb wattage should be used to calculate energy savings – using a default average could lead to a large margin of error.

Annual Net Energy Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peaks (Note 2):

Summer Coincident Peak Gross Savings = CF_S x Δ Watts
Winter Coincident Seasonal Peak Gross Savings = CF_W x Δ Watts

Where :

CF = Average (Summer or Winter) Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

Baseline Efficiencies from which savings are calculated

Baseline is assumed to be an incandescent light source with a wattage which is 4.0 times higher than the wattage of the CFL bulb. For instance, it's assumed that a 60 Watt incandescent is "equivalent" to a 15 Watt CFL (15 x 4.0 = 60). For dimmable or three-way CFL bulbs, assume the highest wattage/setting when calculating the baseline equivalent.

Compliance Efficiency from which incentives are calculated

Energy Star CFL Bulb.

Operating Hours

Room Type	Average hours per day
Bedroom	1.08
Bathroom	0.65
Den/Office	2.97
Garage	1.32
Hallway	6.25
Kitchen	2.97
Living Room	2.97
Dinning Room	2.97
Exterior	2.89
Basement	1.29
Closet	1.24
Other	2.0

See notes 1 and 3

Incremental Cost

$11.41

Non-Electric Benefits - Annual O&M Cost Adjustments

$4.00 per bulb one time benefit. Estimate based on current cost of incandescent bulbs that would be used in place of one CFL.

Notes & References

Note 1. Residential Lighting Markdown Impact Evaluation, Nexus Market Research, January 20, 2009.

Note 2: Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007.

Note 3. Northeast Utilities SPECTRUM Lighting Catalog and Retail Lighting Programs Hours of Use Re-Analysis, December 20, 2001.

Revision Number

00

5.2.1 ENERGY STAR CENTRAL AC

Description of Measure

Energy Star rated central AC system.

Method for Calculating Energy Savings

A. New Construction:

Annual Gross Energy Savings = 500 x size (1/13 – 1/SEER) / 1000

Where:

500 = Assumed annual full-run hours (Note 1).
Size = size of system in Btu
13 = baseline efficiency (SEER) for air cooled air conditioners and heat pumps (cooling mode) per ASHRAE Standard 90.1-2004 (Code).
SEER = rated SEER (efficiency) of new equipment

For example, for a 3 ton (36,000 Btu) 14 SEER system, the annual kWh savings would be = 500 x 36,000 x (1/13 – 1/14.5) / 1000 = 143.2 kWh.

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

See Notes 2 and 3.

B. Early Retirement:

If the contractor identifies an old central air unit still working and the customer agrees to replace it then a savings can be claimed for removing old unit and installing an Energy Star Unit.

For early retirement, the savings will be claimed in two parts. Five years of savings are claimed based on the old unit verses a code (SEER 13) unit (assumes old unit would have been installed for another 5 years) and 18 years of savings are claimed based on a code (SEER 13) unit verses the new unit (same as New Construction savings). For example, if a 3 ton SEER 8.0 unit was retired and replaced with a new SEER 15 unit, the lifetime savings would be 5x(865.38 kWh) + 18x(184.6 kWh)=7,650 kWh.

Annual Gross Energy Savings (5 Years) = 500 x size (1/Old SEER – 1/13) / 1000

Where:

500 = expected annual full-run hours (Note 1).
Size = size of system in Btu
Old SEER = Rated SEER (efficiency) of the old unit being replaced.
13 = baseline efficiency (SEER) for air cooled air conditioners and heat pumps (cooling mode) per ASHRAE Standard 90.1-2004.

The 18 years of code verses new savings shall be determined as shown in "New Construction" section above.

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

Note: Retirement savings may only be claimed if retirement is program induced.

Method for Calculating Demand Savings

New Construction:

Annual Gross kW = size (1/Baseline EER – 1/New EER) / 1000 x CF

Where:

Size = size of system in Btu/hr
Baseline EER = 11.1 for AC units and 10.9 for heat pumps. See Note 4.
New EER = Rated EER (Energy Efficiency Ratio) of new equipment.
EER Conversion Factor = 0.83 (Both AC units and heat pumps) X SEER if new EER unknown. See Note 5.
CF = Summer Seasonal Peak Coincidence Factor (Table 1.1.3)

Early Retirement:

For early retirement, 18 years of savings will be claimed as determined in "New Construction" section above. An additional 5 years of existing verses code savings will be claimed and calculated as follows:

Annual Gross kW = size (1/Baseline EER – 1/code unit EER) / 1000 x CF

Size = size of system in Btu/hr
Baseline EER = Existing Unit EER or Existing Unit SEER x EER Conversion factor when existing unit EER unknown.

Code unit EER = 11.1 for AC units and 10.9 for heat pumps.
See Note 4.
EER Conversion Factor = 0.83 (Both AC units and heat pumps) See Note 5.
CF = Summer Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Baseline Efficiencies from which savings are calculated

A 13 SEER (code minimum) system.

For early retirement 5 years of savings are claimed using the old unit efficiency as the baseline and 18 years of savings are claimed using the code minimum as the baseline.

Compliance Efficiency from which incentives are calculated

Energy Star or higher.

Operating Hours

500 hours per year.

Incremental Cost

$105 per SEER unit per ton above 13. For example, a 3 ton 15 SEER would have an assumed incremental cost of $630.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Notes & References

Note 1: 500 full load cooling hours is an estimate for Connecticut and is conservatively lower than 600 hours estimated by ARI.

Note 2: The energy savings methodology in the "New Construction" Section also applies to Ductless Mini Split Heat Pumps.

Note 3: For multi-speed units, a weighted average of the high speed and low speed efficiencies should be used. Assume 70% on low speed and 30% on high speed.

Note 4: Average EER for ARI rated SEER 13 AC units and heat pumps (Approx 2.8 tons).

Note 5: Average EER to SEER ratio for ARI rated AC units and heat pumps (Approx 2.7 tons).

Revision Number

07

5.2.2 HEAT PUMP

Description of Measure

A heat pump with a heating season performance factor (HSPF) of 8.5 or higher. Note only the heating savings is presented here; cooling savings from an efficient heat pump is the same as the cooling savings for an efficient air conditioner. Utilize methodology in measure 5.2.1 in this manual to determine cooling savings if unit is rated in SEER and 5.3.6 if unit is rated in EER.

Method for Calculating Energy Savings

A. New Construction:

Annual Gross Energy (heating) Savings = 1,500 x Size (1/7.7 – 1/HSPF) / 1000

Where:

1,500 = Assumed annual full-run hours (Note 1).
Size = size of system in Btu
7.7 = baseline efficiency (HSPF) for heat pumps
(heating mode) per ASHRAE Standard 90.1-2004 (Code)
HSPF = rated Heating Season Performance Factor of new equipment

If unit heating efficiency is a COP then multiply COP by 3.41 to get HSPF

For example, for a 3 ton (36,000 Btu) 9 HSPF system, the annual kWh savings would be = 1,500 x 36,000 x (1/7.7 – 1/9) / 1000 = 1,013 kWh.

The following chart can be used as a reference to look up the savings for various sizes and efficiencies (Notes 2 and 3):

Size	**8.5**	**9**	**9.5**
1 ton	220	338	443
2 ton	440	675	886
3 ton	660	1,013	1,329
4 ton	880	1,351	1,772
5 ton	1,100	1,688	2,215

Expected annual kWh heating savings for various sizes and efficiency of units

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

B. Early Retirement:

For early retirement, the savings will be claimed in two parts. Five years of savings are claimed based on the old unit verses a code (HSPF 7.7) unit (assumes old unit would have been installed for another 5 years) and 18 years of savings are claimed based on a code (HSPF 7.7) unit verses the new unit (same as New Construction savings). For example, if a 3 ton HSPF 6.0 unit was retired and replaced with a new HSPF 9.0 unit, the lifetime savings would be 5x(1986.9 kWh) + 18x(1013 kWh)=28,169 kWh.

Annual Gross Energy (heating) Savings (5 Years) = 1,500 x Size (1/Old HSPF – 1/7.7) / 1000

Where:

1,500 = Estimated annual full-run hours
Size = Size of system in Btu
Old HSPF = Heating Season Performance Factor of old existing equipment
7.7 = baseline efficiency (HSPF) for heat pumps
(heating mode) per ASHRAE Standard 90.1-2004 (Code)

If unit heating efficiency is a COP then multiply COP by 3.41 to get HSPF

The following table can be used as a reference to look up the old unit verses code savings:

Table: Annual energy savings (5 years) in kWh per ton

	Old Existing Equipment HSPF										
	5.0	**5.2**	**5.4**	**5.6**	**5.8**	**6.0**	**6.2**	**6.4**	**6.6**	**6.8**	**7.0**
HSPF 7.7 (Code)	1262.3	1123.9	995.7	876.6	765.8	662.3	565.6	474.8	389.6	309.4	233.8

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

C. Electric Resistance to Air Source Heat Pump Energy Savings:

Annual Gross Energy (heating) Savings = 1,500 x Size (1/3.41 – 1/HSPF) / 1000

Where:

1,500 = Assumed annual full-run hours (Note 1).
Size = size of system in Btu
3.41 = baseline efficiency (HSPF) for electric resistance heat
HSPF = rated Heating Season Performance Factor of efficient equipment

For example, for a 3 ton (36,000 Btu) 9 HSPF system, the annual kWh savings would be = 1,500 x 36,000 x (1/3.41 – 1/9) / 1000 = 9836 kWh.

Table: Annual energy savings in kWh per ton replacing Electric Resistance HP with a Heat Pump.

		Old Electric Resistance Unit COP=1 (HSPF=3.41)
New Heat Pump HSPF	**8.0**	3028.6
	8.2	3083.5
	8.4	3135.7
	8.6	3185.6
	8.8	3233.1
	9.0	3278.6

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

Demand savings are not claimed for this measure since backup resistance heat on the heat pump would most likely be used during winter seasonal peak periods.

Baseline Efficiencies from which savings are calculated

7.7 HSPF (code minimum) heat pump for new construction units.

For early retirement 5 years of savings are claimed using the old unit efficiency as the baseline and 18 years of savings are claimed using the code minimum as the baseline.

Compliance Efficiency from which incentives are calculated

8.5 or higher HSPF heat pump

Operating Hours

1500 hours per year

Incremental Cost

$420 per ton.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Notes & References

Note 1: 1500 full load heating hours is an estimate for Connecticut and is conservatively lower than the 2500 hours estimated by ARI.

Note 2: The above chart on energy savings also applies to Ductless Mini Splits Heat Pump equipments.

Note 3: For multi-speed units, a weighted average of the high speed and low speed efficiencies should be used. Assume 70% on low speed and 30% on high speed.

Revision Number

04

5.2.3 GEOTHERMAL HEAT PUMP

Description of Measure

Ground source heat pump (GSHP) systems. GSHP systems (or "geothermal"), supply heating, cooling, and in some cases water heating (desuperheater or full hot water capability). The savings from those three end-uses are presented separately.

Method for Calculating Energy Savings

The following table was developed from the results of "HVAC Systems in an Energy Star Home: Owning & Operating Costs (Update 2008)", CDH Energy Corp. The values in the table are given in units per ton of installed cooling capacity.

Heating Consumption			
Heating System	**Consumption**	**Engineering Units**	**Efficiencies**
Electric resistance	9,555	kWh/Ton	100%
Air Source Heat Pump	3,447	kWh/Ton	7.7 HSPF
Oil Furnace	315	Gallons/Ton	81% AFUE
	520	kWh/Ton	
Gas Furnace	423	Therms/Ton	78.4% AFUE
	321	kWh/Ton	
GSHP	1,569	kWh/Ton	3.9 COP
Note: Tonnage based on cooling capacity of Geothermal Unit			

Cooling Consumption and Summer Demand			
System	**Cooling (kWh/Ton)**	**Efficiency**	**Summer Demand (kW/Ton)**
Electric resistance	709	13 SEER	1.09
Air Source Heat Pump	515	13 SEER	1.11
Oil Furnace	710	13 SEER	1.09
Gas Furnace	710	13 SEER	1.09
GSHP	326	17.2 EER	0.71
Note: Tonnage based on cooling capacity			

Water Heating Consumption		
System	Consumption	Units
Electric resistance	4,305	kWh
Oil	154	Gallons
Gas	215	Therms

Annual kWh savings = annual kWh Heating savings + annual kWh Cooling savings +annual kWh water heating savings

The non-commissioning savings calculations below are shown for information only. Savings claimed by this measure will only be the commissioning savings calculated below. It is assumed that customers would have installed geothermal without program intervention.

1) Natural Gas Baseline.

a) Heating (kWh) Savings = INCCAP*(321 – (1,569)*(3.9 /INCOP))

b) Cooling (kWh) Savings = INCCAP*(709 – (326)*(17.2 /INEER))

c) Water Heating (kWh) Savings = 0 – (4,305/INWHCOP)

2) Oil Baseline:

a) Heating (kWh) Savings = INCCAP*(520 – (1,569)*(3.9 /INCOP))

b) Cooling (kWh) Savings = INCCAP*(709 – (326)*(17.2 /INEER))

c) Water Heating (kWh) Savings = 0 – (4,305/INWHCOP)

3) Electric Resistance Baseline:

a) Heating (kWh) Savings = INCCAP*(9,555 – (1,569)*(3.9 /INCOP))

b) Cooling (kWh) Savings = INCCAP*(709 – (326)*(17.2 /INEER))

c) Water Heating (kWh) Savings = 4,304 – (4,305/INWHCOP)

4) Air Source Heat Pump Baseline:

a) Heating (kWh) Savings = INCCAP*(4,753 – (1,569)*(3.9 /INCOP))

b) Cooling (kWh) Savings = INCCAP*(709 – (326)*(17.2 /INEER))

c) Water Heating (kWh) Savings = 4,304 – (4,305/INWHCOP)

INCCAP = installed nominal cooling capacity in tons

INCOP = GSHP's rated heating efficiency in COP. System must be tested to verify unit is operating at rated efficiency.

INEER = GSHP's rated Cooling efficiency in EER. System must be tested to verify unit is operating at rated efficiency.

INWHCOP = GSHP's rated water heating efficiency in COP
Use 1 for electric resistance, use 1.2 for desuperheater

The baseline is assumed to be GSHP. Therefore the only claimed savings from this measure would be from the commissioning requirement (and perhaps shell savings).

Commissioning energy savings are assumed to be 10% of the theoretical usage:

Gross Heating kWh savings = (157 kWh/ton)(ICCAP)(3.9)/(INCOP)

Gross Cooling kWh savings = (33 kWh/ton)(ICCAP)(17.2)/(INEER)

Annual Net Energy Savings = Gross Energy Savings x Energy Net Realization Rate

Method for Calculating Demand Savings

The retrofit and commissioning demand savings calculations below are shown for information only. The baseline for this measure is a new GSHP and therefore the retrofit savings below are not applicable at this time. There will be savings from commissioning of a new unit but it should not be claimed at this time. The analysis behind the savings currently does not meet the requirements for the Forward Capacity Market.

For retrofit Projects:

Summer Demand savings = Cooling (kW) savings = CF*INCCAP*(1.09 – 0.71*17.2/INEER)

Winter Demand savings = = CF*INCCAP*(5.5 – 3.4*17.2/INEER)

For Commissioning Savings:

Summer coincident peak demand gross savings = CF_S *INCCAP*0.071*17.2/INEER

Winter coincident peak demand gross savings = CF_w *INCCAP*0.34*17.2/INEER

Where :

CF = Summer or Winter Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

Baseline Efficiencies from which savings are calculated

It is assumed that the home would have a ground source heat pump without program intervention. However, it is assumed that the system would not be commissioned. Therefore, the baseline is an uncommissioned ground source heat pump, and savings is based on the commissioning (10%) savings (in addition to any shell savings through the Residential New Construction Program). Since commissioning savings vary greatly from project to project a value of 10% was chosen

System Replacement: The existing system will determine the heating and water heating baseline. Central air with a 13 SEER is the assuming cooling baseline.

Incremental Cost

Typically, incremental cost will range from $8,000 to $20,000 based on system size and system baseline. A rough estimate of incremental cost would be about $3,000 per ton. The $3,000 per ton estimate is based on the well costs. The well cost is a good estimate since it is the most significant part of the differential costs.

Non-Electric Benefits - Annual Fossil Fuel Savings

Fossil Fuel savings = fossil fuel heating savings + Fossil fuel water heating savings

Natural Gas Baseline:

Fossil fuel savings (therms) = INCCAP*423 + 215

Oil Baseline:
Fossil Fuel savings (gallons) = INCCAP*315 + 154

Revision Number

06

5.2.4 COMMISSIONING

Description of Measure

This measure applies to the verification of proper design and installation of central air conditioning and heat pump systems.
This savings estimate was developed by UI and CL&P in March, 2006 and is consistent with description of the savings made in Docket No. 05-07-14PH01 (EL-005) Filing made with Department on March 27, 2006.

Method for Calculating Energy Savings

Annual energy Savings (kWh) = (Efficiency savings) + (fan savings from reduction in ductwork static pressure)

A) Fan savings (kWh) = $\dfrac{(\text{CFM x BWCFM} - \text{FW}) \text{ x EFLH}}{1000 \text{ w/kW}}$

note: Fan savings will only be counted if measured air flow is >350 CFM/ton and Measured wattage is < 0.51 /CFM

CFM should be measured using True Flow™ air flow measuring device or other alternative method approved by program administrator. Fan wattage (BWCFM) should be a direct method or calculated based on the fan curve for the unit.

B) Efficiency Savings (kWh) = $\dfrac{\text{12 x Capacity x EFLH}}{\text{SEER}}$ x (1/EIb – 1/EIa)

CFM = System air flow in CFM
BWCFM = baseline watts per CFM (0.510 based on Proctor and Parker 2000)
FW = measured fan wattage
Capacity - Air conditioning units rated capacity in tons
12 - Conversion from tons to kBTU's
SEER - Seasonal energy efficiency ratio (nameplate)
EIb – Efficiency index before (95% based on the average tune-up reading)
EIa – Efficiency index after (output from tool)
EFLH – Equivalent Full Load Hours (assumed to be 500)

IMPORTANT – The following recommendations must be followed in order for efficiency savings to be valid.

1) Minimum outdoor temperature must be 55 Degrees F and 65 Degrees F for a TXV System. "Tents" should not be used to increase the ambient temperature around the condensing unit.
2) System must be running for 10 – 15 minutes prior to taking the first (initial) reading.
3) Compressor must be fully loaded (high speed for multi-speed units) and running at steady state efficiency.
4) A reasonable indoor load must be maintained throughout the test or the results. Therefore, return air must be at least 65 degrees F wet bulb and/or 80 degrees F dry bulb temperature.

Method for Calculating Demand Savings

Demand Savings (kW) = Efficiency savings (kW) + Fan Savings (kW)

A) Fan savings (kW) = $\dfrac{\text{(CFM x BWCFM – FW) x CF}}{\text{1000 w/kW}}$

note: Fan savings will only be counted if measured air flow is >350 CFM/ton and Measured wattage is < 0.51 /CFM

B) Efficiency Savings (kW) = $\dfrac{\text{12 x Capacity x CF}}{\text{SEER x 0.875}}$ x (1/EIb – 1/EIa)

CF – Coincidence factor
0.875 – Conversion from SEER to EER.

Baseline Efficiencies from which savings are calculated

The baseline efficiency is the nameplate SEER time the EIb (95%).

Compliance Efficiency from which incentives are calculated

An HVAC system that has documented performance testing using the Honeywell Service Assistant.

Operating Hours

500 hours for cooling.

Incremental Cost

The cost to the contractor for each tune-up is assumed to be $125, but costs may vary based on the contractor and geographic location. Also, $125 is assumed to be the minimum cost and is expected to only cover the diagnostic portion of the test in most situations. If significant problems are uncovered during the diagnostic portion of the test, the cost is expected to rise.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Notes & References

Note 1. *Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market*, RLW Analytics, Inc. December 2002.

Revision Number

04

5.2.5 AC SYS TUNE-UP

Description of Measure

This measure applies to diagnostic tune-up using the Service Assistant and is based on the measured changes in the efficiency index (EI) as measured with the Service Assistant Tool.

This savings estimate was developed by UI and CL&P in April, 2006.

Method for Calculating Energy Savings

$$\text{Annual Energy Savings (kWh)} = \frac{12 \times \text{Capacity} \times \text{EFLH}}{\text{SEER}} \times (1/\text{EIb} - 1/\text{EIa})$$

Capacity - Air conditioning units rated capacity in tons
12 - Conversion from tons to kBTU's
SEER - Seasonal energy efficiency ratio (nameplate)
EIb – Efficiency index before (output from tool)
EIa – Efficiency index after (output from tool)
EFLH – Equivalent Full Load Hours (assumed to be 500)

IMPORTANT – The following recommendations must be followed in order for savings from a tune-up to be valid.

1) On the occasion that only one reading is taken or EIa < EIb, the savings defaults to 0 and "deemed" savings is not claimed.
2) Minimum outdoor temperature must be 55 Degrees F and 65 Degrees F for a TXV System. "Tents" should not be used to increase the ambient temperature around the condensing unit.
3) System must be running for 10 – 15 minutes prior to taking the first (initial) reading.
4) Compressor must be fully loaded (high speed for multi-speed units) and running at steady state efficiency.
5) A reasonable indoor load must be maintained throughout the test or the results. Therefore, return air must be at least 65 degrees F wet bulb and/or 80 degrees F dry bulb temperature.
6) Units that have been tuned-up within measure life time period specified in Table 1.4 can not claim additional (double-counted) savings since the savings has already been.

Method for Calculating Demand Savings

$$\text{Demand Savings (kW)} = \frac{12 \times \text{Capacity} \times \text{DF}}{\text{SEER} \times 0.875} \times (1/\text{EIb} - 1/\text{EIa})$$

DF – diversity factor
0.875 – Conversion from SEER to EER.

Baseline Efficiencies from which savings are calculated

The baseline efficiency is the nameplate SEER multiplied by the EIb.

Compliance Efficiency from which incentives are calculated

An HVAC system that has documented performance testing using the Service Assistant.

Operating Hours

The full load operating hours for CT are assumed to be 500 hours / year.

Total Cost

The cost to the contractor for each tune-up is assumed to be $125, but costs may vary based on the contractor and geographic location. Also, $125 is assumed to be the minimum cost and is expected to only cover the diagnostic portion of the test in most situations. If significant problems are uncovered during the diagnostic portion of the test, the cost is expected to rise.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

07

5.2.6 ELECT COMM MOTOR

Description of Measure

ECM (electrically commutated motor) furnace fan motor

Method for Calculating Energy Savings

Energy Savings is estimated based on table below (note 4):

Estimated ECM electrical savings = 285 kWh per year

Note that SEER ratings for cooling systems take into account fan power, so the cooling savings for ECM fans may already be captured if savings is claimed based on the SEER of a central air cooling system.

Method for Calculating Demand Savings

Winter demand (kW) savings = (Peak Factor) heating kWh / heating FLH
= (0.5)(annual kWh savings)/(1,500) = 0.1 kW

Baseline Efficiencies from which savings are calculated

Permanent split capacitor (PSC) furnace fan motor.

Table 1: Specification for Gas Furnaces and Boilers (see Note 4)

Technology	**High-efficiency Measure Specification***	**Baseline**
Gas-fired furnaces	Tier 1: 90% Tier 2: 92% Tier 3: 94%	78%
Gas-fired boilers	85%	80%

* Annual Fuel Utilization Efficiency (AFUE) performance levels

Table 2: Air-handling (Electricity Use) performance level (see Note 4)

Technology	**Specification**
Gas-fired furnace with 90% AFUE	<= 2.0% The air handling unit's annual electricity use must be less than or equal to 2% of the total annual energy use

Operating Hours

1500 hours per year heating
500 hours per year cooling

Incremental Cost

$150 estimated.

Non-Electric Benefits - Annual Fossil Fuel Savings

Negative non-electric benefit due to increased fossil fuel heating usage (Note 1):
11.4 Therms gas
8.2 Gallons oil
12.5 Gallons propane

Notes & References

Note 1: Furnace with an ECM motor will burn slightly more fuel to compensate for lower heat generated by more efficient fan. Estimate by Joe Swift, Northeast Utilities, 2005 assuming average fossil fuel efficiency (AFUE) of 85%.

Note 2: The annual savings was taken from the 'Saving Energy with Efficient Residential Furnace Air Handlers: A Status Report and Program Recommendations', April 2003, Sachs, Smith.

Note 3: Gusdorf, J., Swinton and et al. "Saving electricity and reducing GHG emissions with ECM furnace motors: results from the CCHT and projections to various houses and locations", The Canadian Centre for Housing Technology, August 2004.

Note 4: Savings analysis by Joe Swift, Northeast Utilities and Consortium for Energy Efficiency (CEE) Residential Gas Heating Initiative, www.cee1.org

Revision Number

07

5.2.9 DUCT SEALING

Description of Measure

Ducts sealed to reduce outside infiltration. Duct improvements (sealing) should be verified with duct blaster test at 25 Pa using an approved test method. Alternative test methods (subtraction method, flow hood method, delta Q, etc) will generally yield inconsistent results and are not permitted.

Note that REM savings (5.4.1) includes duct sealing savings. Therefore, this measure does NOT apply to homes that are already claiming savings from REM/Rate. This is a stand-alone measure and is not intended to be applied to homes that fall into measure 5.4.1.

Method for Calculating Energy Savings

A) **New Construction:** The results below are engineering estimates of expected savings from verified duct sealing for new construction. This savings does NOT apply to Energy Star Homes. For those homes, savings should be calculated using the UDRH (see 5.4.1 REM Savings).

Duct Blaster Savings at 25 Pa	**Heating (MMBtu)**	Heating (Resistance)	Heating (Heat Pumps)	Heating (Geothermal)	kWh Fan Heating Savings	**kWh (Cooling)**
100 CFM Reduction	3.5	769.3	384.7	192.3	110.0	96.2

B) **Retrofit**

Savings for existing ducts that are sealed: Savings must be verified by measuring outside duct leakage at 25 Pascals using standard duct blaster testing procedures.

Duct Blaster Savings at 25 Pa	**Heating (MMBtu)**	Heating (Resistance)	Heating (Heat Pumps)	Heating (Geothermal)	kWh Fan Heating Savings	**kWh (Cooling)**
100 CFM Reduction	3.5	769.3	384.7	256.4	110.0	96.2

Method for Calculating Demand Savings

New Construction and Retrofit**

Estimated summer demand savings = 0.23 kW
Estimated winter demand savings = 2.2 kW (Electric resistance and Heat pumps)
Estimated winter demand savings = 0.73 kW (Geothermal - Retrofit)
Estimated winter demand savings = 0.55 kW (Geothermal – New Construction)

***per 100 CFM at 25 Pa duct leakage reduction*
Note: Demand savings are based on design load calculation in REM software hence no need to use coincidence factors.

Baseline Efficiencies from which savings are calculated

Ducts that have not been sealed

Compliance Efficiency from which incentives are calculated

Duct sealed to reduce outside leakage.

Incremental Cost

Actual cost or $100 per 1000 square feet

Non-Electric Benefits - Annual Fossil Fuel Savings

New Construction and Retrofit

Duct Blaster Savings at 25 Pa	**Heating (MBtu)**	Gallons Oil	Therms Gas	Gallons Propane
100 CFM Reduction	3.5	25.0	35.0	38.3

Estimated savings values include expected system efficiency

Notes & References

Note 1: REM/Rate™ home modeling, Vinay Ananthachar, Northeast Utilities, Aug 2008

Revision Number

12

5.2.12 HEAT PUMP - DUCTLESS

Description of Measure

Installation ductless heat pumps in existing homes with electric resistance heating. The heat pump will become the primary heat source and the electric resistance will become the secondary heat source.

Refer to measures 5.2.1 and 5.2.2 to determine savings for new construction and retrofit of air source heat pumps.

Method for Calculating Energy Savings

Savings for this measure are determined using either the table below adjusted for installed efficiencies or by performing a custom analysis (DOE-2, Billing analysis (PRISM), ..) for a specific project. The following table is based on the results from the 2009 KEMA pilot study (Note 1); the study provides savings per thousand BTU of heating and cooling capacities.

Table 1: Ductless Heat Pump Energy and Demand Savings Factors

Homes with all Electric Heat (Heating)				**All Homes (Cooling)**			
Hartford		Bridgeport		Hartford		Bridgeport	
kWh/MBTU	kW/MBTU	kWh/MBTU	kW/MBTU	kWh/MBTU	kW/MBTU	kWh/MBTU	kW/MBTU
130	0.019	140	0.032	3.1	0.0017	3.2	0.0014

Annual heating kWh savings = $$HCap \times \left(\frac{1}{3.413} - \frac{1}{HSPF_I} \right) \times \frac{1}{A} \times kWh_{SavingsH}$$

Annual cooling kWh savings = $$CCap \times \left(\frac{1}{10.1} - \frac{1}{SEER_I} \right) \times \frac{1}{B} \times kWh_{SavingsC}$$

H_{Cap} = Heating Capacity in MBTU
C_{Cap} = Cooling Capacity in MBTU
$HSPF_I$ = Installed Heating Seasonal Performance Factor
$SEER_I$ = Installed Seasonal Energy Efficiency Ratio
$KWh_{SavingsH}$ = Heating savings from Table 1 (kWh/MBTU)
$kWh_{SavingsC}$ = Cooling savings from Table 1 (kWh/MBTU)

A = 0.171; Efficiency conversion factor (for heating)
B = 0.037; Efficiency conversion factor (for cooling)
The above conversion factors are efficiency ratios to convert savings from heat pumps that was studied in the 2009 KEMA pilot (i.e. HSPF=8.2 for heating and SEER=16 for cooling) to the actual installed equipments.

The following methodology was used to calculate the above conversion factors:

$$A = \left(\frac{1}{HSPF_{Baseline}} - \frac{1}{HSPF_{Pilot\_Study}} \right)$$

Where,

$HSPF_{Baseline} = 3.413$
$HSPF_{Pilot\ Study} = 8.2$

Therefore,

$$A = \left(\frac{1}{3.413} - \frac{1}{8.2} \right) = 0.171$$

AND

$$B = \left(\frac{1}{SEER_{Baseline}} - \frac{1}{SEER_{Pilot\_Study}} \right)$$

Where,

$SEER_{Baseline} = 10.1$
$SEER_{Pilot\ Study} = 16.0$

$$B = \left(\frac{1}{10.1} - \frac{1}{16.0} \right) = 0.037$$

Graphical representation of the heat pump savings:

Figure 1

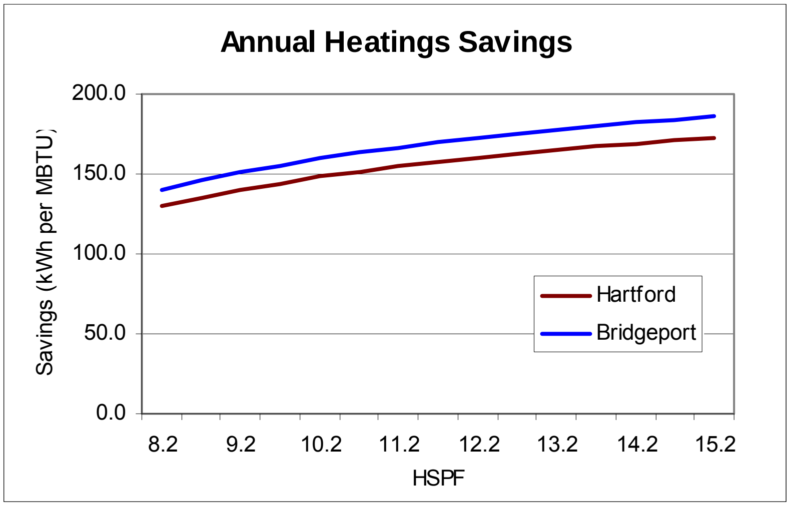


Figure 2

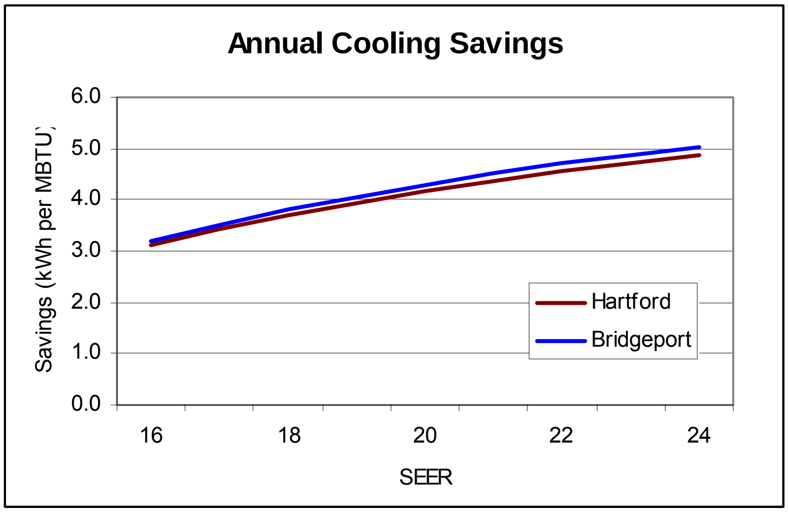


Figure 3

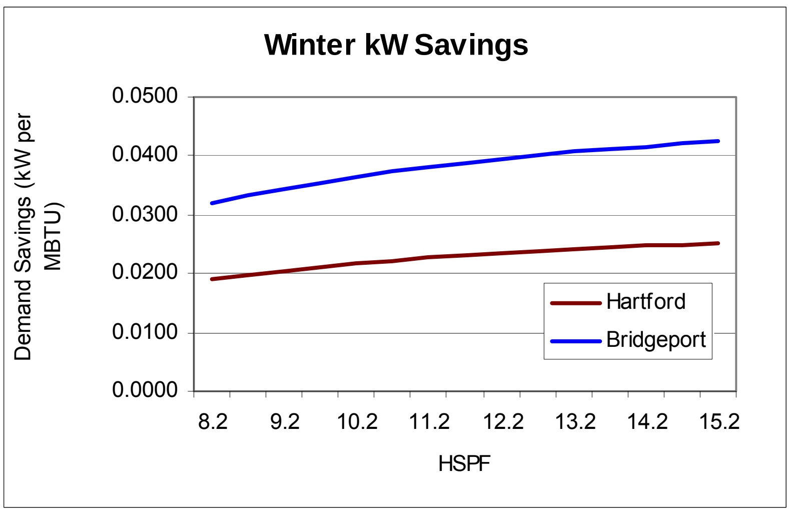
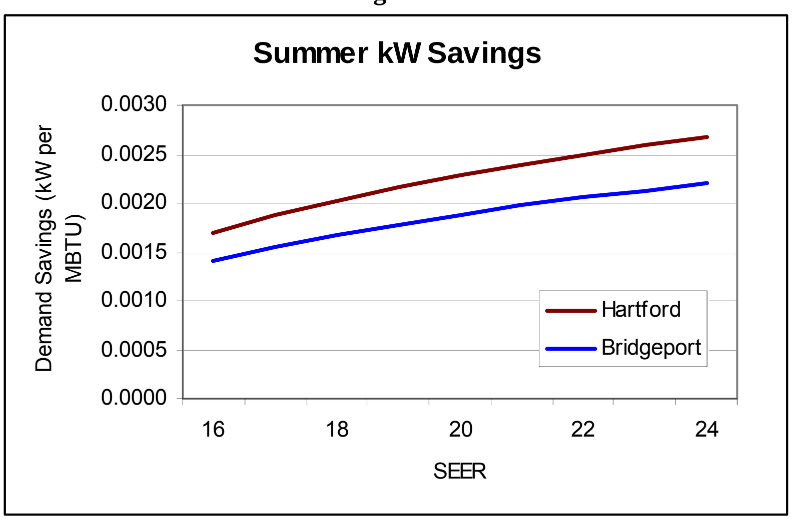


Figure 4



Method for Calculating Demand Savings

Summer and winter demand savings can be calculated using the table above adjusted by installed efficiencies and equations below or custom calculated for a specific project. Method (table or custom) should be consistent with the energy savings method.

Winter kW savings = $HCap * \left(\frac{1}{3.413} - \frac{1}{HSPF_I} \right) * \frac{1}{0.171} * kWSavings_H$

Summer kW savings = $CCap * \left(\frac{1}{10.1} - \frac{1}{SEER_I} \right) * \frac{1}{0.037} * kWSavings_C$

H_{Cap} = Heating Capacity in MBTU
C_{Cap} = Cooling Capacity in MBTU
$HSPF_I$ = Installed Heating Seasonal Performance Factor
$SEER_I$ = Installed Seasonal Energy Efficiency Ratio
$KW_{SavingsH}$ = Heating savings from Table 1 (kWh/MBTU)
$kW_{SavingsC}$ = Cooling savings from Table 1 (kWh/MBTU)

A = 0.171; Efficiency conversion factor (for heating)
B = 0.037; Efficiency conversion factor (for cooling)

Baseline Efficiencies from which savings are calculated

Estimated baseline efficiency for cooling is 10.1 SEER and electric resistance is the baseline for heating.

Compliance Efficiency from which incentives are calculated

HSPF ≥10

Operating Hours

Savings based on study (Reference 1)

Total Cost

As for any retrofit project, the installation costs vary considerably depending on the existing conditions and the size of the heat pump. A reasonable estimate would be $3,700 for the first ton plus $1,000 per ton for additional tonnage.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Notes & References

Reference:

1) Ductless Mini Pilot Study Final Report, KEMA, June, 2009

Revision Number

06

5.3.1 GENERAL SERVICE CFL BULBS (RETAIL PRODUCTS)

Description of Measure

A screw-based (integrated ballast) general service compact fluorescent light bulb. Typical CFL wattage is between 9 and 23 watts.

General service CFL's are defined as standard base bulbs that are intended for general service applications as specified in the Energy Independence and Security Act of 2007. These bulbs will be gradually phased out of CEEF programs as the measure life declines annually.

Method for Calculating Energy Savings

Gross Annual Energy Savings = Δ Watts x Hours x 365/1000

Where:

Δ Watts = 3.0 x CFL wattage based on a 4.0 wattage ratio (Note 1).
Hours = 2.8 Hours per day (Note 1).
365 = days per year

For example, the annual savings for a 15 watt CFL:
Annual kWh = 3.0 x 15 watts x 2.8 hours/day x 365 days / 1000 = 46.0 kWh

Annual Net Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Note that actual bulb wattage should be used to calculate energy savings.

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peak demand savings (Note 2):

Summer Coincident Peak Gross Savings = CF_S x Δ Watts
Winter Coincident Seasonal Peak Gross Savings = CF_W x Δ Watts

Where :

CF = Average (Summer or Winter) Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

Baseline Efficiencies from which savings are calculated

Baseline is assumed to be an incandescent light source with a wattage which is 4.0 times higher than the wattage of the CFL bulb. For instance, it's assumed that a 60 Watt incandescent is "equivalent" to a 15 Watt CFL (15 x 4.0 = 60). For dimmable or three-way CFL bulbs, assume the highest wattage/setting when calculating the baseline equivalent.

Compliance Efficiency from which incentives are calculated

Energy Star screw-based bulb with equivalent lumen output.

Operating Hours

2.8 Hours per day estimate (Note 1).

Incremental Cost

$2.25 based on NCP data.

Non-Electric Benefits - Annual O&M Cost Adjustments

$3.00 per bulb one time benefit. Estimate based on current cost of incandescent bulbs that would be used in place of one CFL.

Notes & References

Note 1. Residential Lighting Markdown Impact Evaluation, Nexus Market Research, January 20, 2009.

Note 2: Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007.

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07

5.3.2 PORTABLE LAMPS (RETAIL PRODUCTS & LOW INCOME)

Description of Measure

An Energy Star portable (plug type) light fixture with pin-based bulbs (i.e. table lamp, desk lamp, etc.). Note that torchieres are not included here; rather they are handled as a separate measure.

Method for Calculating Energy Savings

Annual Gross Energy Savings = Δ Watts x Hours x 365/1000

Where:
Δ Watts = 2.4 x CFL wattage. This represents an "incandescent to CFL" wattage ratio of 3.4 to 1 (Note 1)

Hours = 1.98 Hours per day (Note 3)
365 = days per year

For example, the annual savings for a 25 watt fixture:
Annual gross kWh = 2.4 x 25 watts x 1.98 hours/day x 365 days / 1000 = 43.4 kWh

Annual Net Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peaks (Note 2):

Summer Coincident Peak Gross Savings = CF_S x Δ Watts
Winter Coincident Seasonal Peak Gross Savings = CF_W x Δ Watts

Where :

CF = Average (Summer or Winter) Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

Baseline Efficiencies from which savings are calculated

Incandescent portable fixture with a wattage equal to 3.4 times the wattage of the efficient fluorescent fixture. For dimmable or three-way products, assume the highest wattage/setting when calculating the baseline equivalent.

Compliance Efficiency from which incentives are calculated

Energy Star lamp with equivalent lumen output.

Operating Hours

1.98 Hours per day (Note 3)

Incremental Cost

$10

Non-Electric Benefits - Annual O&M Cost Adjustments

$6.00 one-time benefit per fixture.

Notes & References

Note 1. : *Northeast Utilities and United Illuminating Retail/Point of Purchase Lighting Program Impact Evaluation*, RLW Analytics, April 2003.

Note 2: Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007.

Note 3. Northeast Utilities SPECTRUM Lighting Catalog and Retail Lighting Programs Hours of Use Re-Analysis, December 20, 2001.

Revision Number

06

5.3.3 TORCHIERE (RETAIL PRODUCTS & LOW INCOME)

Description of Measure

Energy Star torchiere (fixture).

Method for Calculating Energy Savings

Annual Gross Energy Savings = Δ Watts x Hours x 365/1000

Where:
Δ Watts = the lesser of 2.4 x fixture wattage (3.4 wattage conversion factor). (Note 1) **or** 190 – fixture Wattage (Note 4).

Hours = 1.98 Hours per day (Note 3)
365 = days per year

For example, the annual gross savings for a 55 watt torchiere fixture:

Δ Watts = the lesser of 2.4 x 55 = 132 OR 190 – 55 = 135.
Therefore, Δ Watts = 132 Watts (lesser of the two).

Annual Gross kWh = 132 Watts x 1.98 hours/day x 365 days / 1000 = 95.4 kWh

Annual Net Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peaks (Note 2):

Summer Coincident Peak Gross Savings = CF_S x Δ Watts
Winter Coincident Seasonal Peak Gross Savings = CF_W x Δ Watts

Where :

CF = Average (Summer or Winter) Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

Baseline Efficiencies from which savings are calculated

Incandescent or halogen torchiere with a wattage equal to 3.4 times the wattage of the efficient fluorescent fixture. For dimmable or three-way products, assume the highest wattage/setting when calculating the baseline equivalent.

Compliance Efficiency from which incentives are calculated

Energy Star torchiere with equivalent lumen output.

Operating Hours

1.98 Hours per day (Note 3)

Incremental Cost

$10

Non-Electric Benefits - Annual O&M Cost Adjustments

$5.00 (one-time benefit per fixture). Estimate based on increased cost of incandescent bulbs that would be used in the baseline case.

Notes & References

Note 1. : *Northeast Utilities and United Illuminating Retail/Point of Purchase Lighting Program Impact Evaluation*, RLW Analytics, April 2003.

Note 2: Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007.

Note 3. Northeast Utilities SPECTRUM Lighting Catalog and Retail Lighting Programs Hours of Use Re-Analysis, December 20, 2001.

Note 4. Public Act 04-85, An Act Concerning Energy Efficiency Standards, July 2004, limits torchiere wattage to 190 Watts. Therefore, the baseline is capped at 190 watts and the Δ Wattage is limited by this cap.

Revision Number

06

5.3.4 FIXTURE (HARD WIRED)

Description of Measure

An Energy Star hardwired fluorescent fixture with pin based bulbs. Note that fixtures with screw-based (CFL) bulbs are treated as CFL bulbs for savings calculations.

Method for Calculating Energy Savings

Annual Gross Energy Savings = Δ Watts x Hours x 365/1000

Where:

Δ Watts = 2.4 x fixture wattage (a 3.4 wattage conversion factor) (Note 1).
Hours = 1.98 Hours per day (Note 3)
365 = days per year

For example, the annual savings for a 25 watt fixture:

Annual gross kWh = 2.4 x 25 watts x 1.98 hours/day x 365 days / 1000 = 43.3 kWh

For fixtures with multiple bulbs, the wattage is the total wattage of all bulbs (not the wattage of one bulb).

Annual Net Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peaks (Note 2):

Summer Coincident Peak Gross Savings = CF_S x Δ Watts
Winter Coincident Seasonal Peak Gross Savings = CF_W x Δ Watts

Where :

CF = Average (Summer or Winter) Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

Baseline Efficiencies from which savings are calculated

Incandescent fixture with a wattage equal to 3.4 times the wattage of the efficient fluorescent fixture. For dimmable or three-way CFL bulbs, assume the highest wattage/setting when calculating the baseline equivalent.

Compliance Efficiency from which incentives are calculated

Energy Star hard-wired fixture with equivalent lumen output.

Operating Hours

1.98 Hours per day (Note 3)

Incremental Cost

$10

Non-Electric Benefits - Annual O&M Cost Adjustments

$14.00 (one-time benefit per fixture). Estimate based added cost of using incandescent bulbs over the life of the measure.

Notes & References

Note 1. : *Northeast Utilities and United Illuminating Retail/Point of Purchase Lighting Program Impact Evaluation*, RLW Analytics, April 2003.

Note 2: Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007.

Note 3. Northeast Utilities SPECTRUM Lighting Catalog and Retail Lighting Programs Hours of Use Re-Analysis, December 20, 2001.

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06

5.3.5 CEILING FAN & LIGHTS

Description of Measure

Energy Star ceiling fan/light combination.

Method for Calculating Energy Savings

Note that only the energy savings from the light is considered. Therefore, savings for this measure is based on the light wattage and is identical to the savings for a light fixture. Fan motor savings is negligible, and cooling savings has not been determined.

Annual Gross Energy Savings = Δ Watts x Hours x 365/1000

Where:

Δ Watts = 2.4 x fixture wattage (a 3.4 wattage conversion factor)(Note 1)
Hours = 1.98 Hours per day (Note 3)
365 = days per year

For example, the annual savings for a qualifying fan/light with a 25 watt light source:
Annual Gross kWh = 2.4 x 25 watts x 1.98 hours/day x 365 days / 1000 = 43.4 kWh

For fans with multiple bulbs, the wattage is the total wattage of all bulbs. For instance, if a ceiling fan has four 20 watt bulbs, the savings would be based on an 80 Watt light source.

Annual Net Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peaks (Note 2):

Summer Coincident Peak Gross Savings = CF_S x Δ Watts
Winter Coincident Seasonal Peak Gross Savings = CF_W x Δ Watts

Where :

CF = Average (Summer or Winter) Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

Baseline Efficiencies from which savings are calculated

Fan/light combination with an incandescent light source wattage equal to 3.4 times the light source wattage of the Energy Star fan/light combination.

Compliance Efficiency from which incentives are calculated

Energy Star fan/light combination with fluorescent light source.

Operating Hours

1.98 Hours per day (Note 3)

Incremental Cost

$10

Non-Electric Benefits - Annual O&M Cost Adjustments

$14.00 (one-time benefit per fixture). Estimate based added cost of using incandescent bulbs over the life of the measure.

Notes & References

Note 1. : *Northeast Utilities and United Illuminating Retail/Point of Purchase Lighting Program Impact Evaluation*, RLW Analytics, April 2003.

Note 2: Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007.

Note 3. Northeast Utilities SPECTRUM Lighting Catalog and Retail Lighting Programs Hours of Use Re-Analysis, December 20, 2001.

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06

5.3.6 ROOM WINDOW AIR CONDITIONER (RETAIL PRODUCTS)

Description of Measure

Room air conditioners meeting the minimum qualifying efficiencies established by the Consortium for Energy Efficiency (CEE) that are purchased from vendors participating in negotiated cooperative promotions.

Method for Calculating Energy Savings

The savings is the difference in consumption between the new CEE Tier unit and the base unit (Federal Standard).

Annual Gross kWh Savings = 272 hours * BTU/h Rating * (1/Fed Std EER - 1/Actual EER)/1000

Room AC Annual kWh Savings Based on 272 Hours of Operation			
EER Rating >	**9.7**	**11.2**	**11.6**
	Fed Std	CEE Tier 1	CEE Tier 2
Btu/h Rating			
5,000	0	18.8	23.0
6,000	0	22.5	27.6
EER Rating >	**9.8**	**11.3**	**11.8**
	Fed Std	CEE Tier 1	CEE Tier 2
Btu/h Rating			
8,000	0	29.5	37.6
10,000	0	36.8	47.0
11,000	0	40.5	51.7
12,000	0	44.2	56.5
13,000	0	47.9	61.2
EER Rating >	**9.7**	**11.2**	**11.6**
	Fed Std	CEE Tier 1	CEE Tier 2
Btu/h Rating			
14,000	0	52.6	64.3
15,000	0	56.3	68.9
16,000	0	60.1	73.5
17,000	0	63.8	78.1
18,000	0	67.6	82.7

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

Annual Gross kW Savings = BTU/h Rating * (1/Fed Std EER - 1/Actual EER)/1000 x Summer Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Baseline Efficiencies from which savings are calculated

The baseline efficiencies are the Federal Standards shown in the table above.

Compliance Efficiency from which incentives are calculated

The compliance efficiencies are the CEE Tier 1 Efficiencies shown in the table above.

Operating Hours

The full load hours was determined by Reference 1.

Incremental Cost

The incremental cost of a new CEE Tier 1 unit is assumed to be $53.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Non-Electric Benefits - Annual Water Savings

Non-electric benefits have not been identified for this measure.

Non-Electric Benefits - Annual O&M Cost Adjustments

Non-electric benefits have not been identified for this measure.

Notes & References

References:

1) Draft Coincidence Factor Study, Residential Room Air Conditioners, RLW, June 13, 2008.

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07

5.3.7 CLOTHES WASHER (RETAIL PRODUCTS, HES & LOW INCOME)

Description of Measure

Residential clothes washers meeting the Consortium for Energy Efficiency (CEE) Tier 3 efficiency standard or better for the Retail Products Program and Energy Star (July 2009) for the HES and Low Income Programs.

Method for Calculating Energy Savings

Gross Annual Savings (New Units)																			
		Water Heater and Dryer Fuel Type Known i.e. HES program											Water Heater and Dryer Fuel Type Unknown ie. Retail Sales						
													Estimated Water Heater & Dryer Fuel Mix						
Standard	MEF	Electric Water Heater & Dryer		Gas Water Heater & Dryer				Gas Water Heater & Electric Dryer		Oil Water Heater & Electric Dryer		Water	Electricity	Fossil WH	Fossil Dryer	Fossil Fuel Mix (Hot Water)			Fossil Fuel Mix (Dryer)
		Electric (kWh)	Gas (CCF)	Electric (kWh)	Dryer Gas (CCF)	WH Gas (CCF)	Total Gas (CCF)	Electric (kWh)	Gas (CCF)	Electric (kWh)	Oil (Gal)	(gallons)	kWh	Btu	Btu	30% Gas (CCF)	60% Oil (Gal)	10% Other (Btu)	100% Gas (CCF)
Federal Standard	1.26	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-
Energy Star (Jan 2007)	1.72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Star (July 2009)	1.8	30	-	-	0.77	0.44	1.2	22	0.4	22	0.4	580	17	41,545	22,250	0.12	0.18	4,154	0.22
CEE Tier 2	2.0	94	-	-	2.42	1.40	3.8	71	1.4	71	1.2	2,321	54	130,865	70,088	0.39	0.56	13,087	0.70
CEE Tier 3	2.2	147	-	-	3.77	2.18	5.9	110	2.2	110	1.8	4,061	84	203,946	109,229	0.61	0.87	20,395	1.09

Early Retirement Gross Annual Savings Typical Verses Energy Star (4 Years)												
		Water Heater and Dryer Fuel Type Known i.e. HES program										
Standard	MEF	Electric Water Heater & Dryer		Gas Water Heater & Dryer				Gas Water Heater & Electric Dryer		Oil Water Heater & Electric Dryer		Water
		Electric (kWh)	Gas (CCF)	Electric (kWh)	Dryer Gas (CCF)	WH Gas (CCF)	Total Gas (CCF)	Electric (kWh)	Gas (CCF)	Electric (kWh)	Oil (Gal)	(gallons)
Typical		-	-	-	-	-	-	-	-	-	-	-
Energy Star (Jan 2007)	1.72	554	-	-	1.7	25.1	26.9	130.3	20.2	130.3	20.9	5,598

How to use the above tables

For new units where the washer/dryer fuel type combinations are known then use the values in the "Water Heater and Dryer Fuel Type Known" portion of the table. For example; a new Tier 3 washer that will be used with an electric dryer in a home with electric hot water will save 147 kWh and 4,061 gallons of water. A new Tier 3 washer used with an electric dryer in a home with oil heated hot water will save 110 kWh and 1.8 gallons of oil .

For new units where the washer/dryer fuel type combinations are not known then use the values in the "Water Heater and Dryer Fuel Type Unknown" portion of the table. For example; the savings from the purchase of a new Tier 3 washer from a store will have savings of 84 kWh + 0.61 CCF (hot water) + 0.87 gallons of oil + 20,395 btu's (other hot water fuel) + 1.09 CCF (dryer). Savings are claimed for a mix of fuels since the fuel type combinations are not known.

For the HES and Low Income programs, additional savings will be claimed for the early retirement of the old unit. Four years of savings are claimed based on the old "Typical" unit verses the Jan. 2007 Energy Star standard (assumes old unit would have been installed for another 4 years) and 11 years of savings are claimed based on the Jan. 2007 Energy Star standard verses the new unit (Jul 2009 Energy Star). For example; a new Energy Star (July 09) washer that will replace an old "Typical" washer in a home with electric hot water and an electric dryer will save (4*554 kWh)+(11*30 kWh) or 2,546 over the life of the measure.

Note: Retirement savings may only be claimed if retirement is program induced.

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

No demand savings are claimed for this measure since there is insufficient peak coincident data.

Baseline Efficiencies from which savings are calculated

The baseline efficiency for new units is the efficiency of a washer meeting the Jan. 2007 Energy Star standard.

For early retirement, 4 years of savings are claimed using the old "typical" unit efficiency as the baseline (as determined by Reference 1).

Compliance Efficiency from which incentives are calculated

The compliance efficiency for Retail Products is CEE Tier 3. The compliance efficiency for HES and Low Income programs is Energy Star (July 2009).

Operating Hours

The number of wash cycles per year is used instead of the operating hours for the washing machine. The number of cycles per year is 392. See Note 1.

Incremental Cost

Clothes Washers	MEF	Incremental Cost ($)
Base Line	1.26	0
Energy Star	1.72	200
Tier 2	2.00	
Tier 3	2.20	473

Source:

1) Survey conducted by Applied Proactive Technologies (APT), Springfield, MA.
Updated to account for inflation.

2) Energy Star Savings Calculator.

Non-Electric Benefits - Annual Fossil Fuel Savings

Annual Fossil Fuel savings is shown in table above.

Non-Electric Benefits - Annual Water Savings

The annual water savings is shown in the table above.

Notes & References

References

2) Final Rule Technical Support Document (TSD): Energy Efficiency Standards for Consumer Products: Clothes Washers, December 2000.

Notes

1) The number of cycles per year comes from the Code of Federal Regulations 10 CFR Part 430

Revision Number

11

5.3.8 DISHWASHER (RETAIL PRODUCTS, HES & LOW INCOME)

Description of Measure

Dishwashers meeting the Consortium for Energy Efficiency (CEE) Tier 2 efficiency standard or better.

Method for Calculating Energy Savings

Gross Annual Savings (New Units)												
		Water Heater Fuel Type Known i.e. HES program						Water Heater Fuel Type Unknown ie. Retail Sales				
Standard	EF	Electric Water Heater	Gas Water Heater		Oil Water Heater		Water	Electricity	Fossil	Fossil Fuel Mix		
		Electric (kWh)	Electric (kWh)	Gas (CCF)	Electric (kWh)	Oil (Gal)	(gallons)	kWh	Btu	30% Gas (CCF)	60% Oil (Gal)	10% Other (Btu)
Energy Star	0.65	-	-	-	-	-	-	-	-	-	-	-
CEE Tier 2	0.68	15	-	0.67	-	0.75	108	3	53,913	0.16	0.36	5,391

Early Retirement Gross Annual Savings Typical Verses Energy Star (4 Years)												
		Water Heater Fuel Type Known i.e. HES program						Water Heater Fuel Type Unknown ie. Retail Sales				
Standard	EF	Electric Water Heater	Gas Water Heater		Oil Water Heater		Water	Electricity	Fossil	Fossil Fuel Mix		
		Electric (kWh)	Electric (kWh)	Gas (CCF)	Electric (kWh)	Oil (Gal)	(gallons)	kWh	Btu	30% Gas (CCF)	60% Oil (Gal)	10% Other (Btu)
Typical	0.51	-	-	-	-	-	-	-	-	-	-	-
Energy Star	0.65	95	-19	5.0	-19	5.6	645	3.4	402,841	1.21	2.69	40,284

<u>How to use the above tables</u>

For new units where the water heater fuel type is known use the values in the "Water Heater Fuel Type Known" portion of the table. For example; a new CEE Tier 2 dishwasher that will be used in a home with electric hot water will save 15 kWh and 108 gallons of water. A new CEE Tier 2 dishwasher used in a home with oil heated hot water will save 0.75 gallons of oil .

For new units where the water heater fuel type is not known use the values in the "Water Heater Fuel Type Unknown" portion of the table. For example; the savings from the purchase of a new CEE Tier 2 dishwasher from a store will have savings of 3 kWh + 0.16 CCF (gas) + 0.36 gallons of oil + 5,391 btu's (other hot water fuel). Savings are claimed for a mix of fuels since the water heater fuel type is not known.

For early retirement (HES or Low Income), four years of savings are claimed based on the old "Typical" unit verses the Energy Star standard (assumes old unit would have been installed for another 4 years) and 11 years of savings are claimed based on the Energy Star standard verses the new CEE Tier 2 unit.

Note: Retirement savings may only be claimed if retirement is program induced.

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

No demand savings are claimed for this measure since there is insufficient peak coincident data.

Baseline Efficiencies from which savings are calculated

The baseline consumption for the "Typical" (old) dishwasher is based on the AHAM shipment weighted average consumption for 1999.

The baseline efficiency for the new unit is that of a dishwasher which meets the Energy Star Standard (uses a minimum of 41% less electricity than a dishwasher meeting the Federal Standard).

Operating Hours

Operating hours do not apply since the Federal Standards are written in units of cycles/kWh.

Non-Electric Benefits - Annual Fossil Fuel Savings

Annual Fossil Fuel savings is shown in table above.

Non-Electric Benefits - Annual Water Savings

The annual water savings is shown in the table above.

Notes & References

References

1) AHAM Energy Efficiency and Consumption Trends

2) LBNL-40297, ENERGY DATA SOURCEBOOK FOR THE U.S. RESIDENTIAL SECTOR, September 1997.

3) Energy Star Website (www.energystar.gov) savings calculator.

Revision Number

05

5.3.9 REFRIGERATOR (RETAIL PRODUCTS)

Description of Measure

Refrigerators meeting the 2008 Energy Star Standard.

Method for Calculating Energy Savings

Refrigerators qualifying as Energy Star refrigerators must consume 20% less electricity than that required by current Federal Standards. These standards can be found in the Federal Register (10 CFR 430) for all types and configurations up to a total refrigerated volume of 39 cubic feet.

Determine Federal Standard Maximum Energy Use:

Federal Standard Energy Use kWh/yr	
Type	kWh
Manual Defrost Refrigerators	8.82*AV+248.4
Partial Automatic Defrost Refrigerators	8.82*AV+248.4
Top Mount Freezer without through-the-door ice	9.8*AV+276
Side Mount Freezer without through-the-door ice	4.91*AV+507.5
Bottom Mount Freezer without through-the-door ice	4.6*AV+459
Top Mount Freezer with through-the-door ice	10.2*AV+356
Side Mount Freezer with through-the-door ice	10.1*AV+406

Where AV = Adjusted Volume
Adjusted Volume = Fresh Volume + 1.63*Freezer Volume

Determine Energy Savings:

Determine Federal Standard Energy use using formulas above.

Energy Star 2004 Energy Use = 0.85*Federal Standard Energy Use

Energy Star 2008 Energy Use = 0.80*Federal Standard Energy Use

Gross annual energy savings = Energy Star 2004 Energy Use- Energy Star 2008 Energy Use

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

The availability of CEE tier 2 and 3 products in the market is limited and therefore they are not currently specified as the minimum compliance. Savings from those products, when available, can be determined as follows:

CEE Tier 2 Energy Use = 0.75*Federal Standard Energy Use

CEE Tier 3 Energy Use = 0.70*Federal Standard Energy Use

Gross annual energy savings = Energy Star 2004 Energy Use- CEE Tier 2 or 3 Energy Use

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.1368 Watts/kWh

PF_W = 0.0979 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

Baseline Efficiencies from which savings are calculated

The baseline efficiency is that of a refrigerator which meets the 2004 Energy Star Standard.

Compliance Efficiency from which incentives are calculated

The compliance efficiency is that of a refrigerator which meets the Energy Star 2008 standard (CEE Tier 1) and uses a minimum of 20% less electricity than a refrigerator meeting the Federal Standard.

Operating Hours

Operating hours are included in the Federal Standards and are not separated from the Federal Standard calculations.

Incremental Cost

The incremental cost of a refrigerator meeting Energy Star standards is estimated to be $79.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Revision Number

05

5.3.10 ROOM AC RETIREMENT (TURN-IN & LOW INCOME)

Description of Measure

This measure applies to old room air conditioners which are in working condition, but are turned in or replaced (Low Income) and sent to a de-manufacturing facility where they are properly disassembled, with all materials recycled where possible.

Method for Calculating Energy Savings

Turn-In Program

Savings for this program will be claimed in two parts. Four years of savings are claimed based on the old unit verses the Federal Standard (assumes old unit would have been installed for another 4 years) and 12 years of savings are claimed based on the Federal Standard verses the new CEE Tier 1 unit (same as New Unit savings in 5.3.6).

The size (Btu/Hr) and efficiency rating of the old air conditioner for the turn-in program is based on Reference 1 which studied the 2004 and 2005 RAC retirement programs. The 2008 program rules were different from the previous program years and it is assumed that future years will be operated similar to 2008. The assumptions used for determining the gross savings in Reference 1 remain valid. The net realization rates however, are assumed to be 100% since future programs will requires that a new Consortium for Energy Efficiency (CEE) Tier 1 or better air conditioner be purchased to receive an incentive.

Low Income

Early retirement savings for the Low Income program will also be claimed in two parts. Four years of savings are claimed based on the old unit verses the Federal standard (assumes old unit would have been installed for another 4 years) and 12 years of savings are claimed based on the Federal Standard verses the Energy Star standard.

The size (Btu/Hr) and efficiency rating of the old (“Typical”) air conditioner for the Low Income replacement program is based on 1999 AHAM shipment weighted averages.

Gross Energy Savings

If actual size and efficiency of the old and new units is known then they should be used in the formulas below. The default values below may be used if actual size and efficiency of the old and new units are not known.

Turn-in Program

For the turned-in unit verses the Federal standard savings (4 years):

Full Load Hours x Size x (1/EER old – 1/EER Federal Standard) / 1000 = 51 kWh

For the Federal standard verses the new CEE Tier 1 unit savings (12 years):

Full Load Hours x Size x (1/EER Federal Standard – 1/EER new) / 1000 = 26.3 kWh

Where:

Full Load Hours = 272 (based on Ref 2)
Size = 7,000 btu/hr (based on Ref 1)
EER old = 7.7 (based on Ref 1)
EER new = 11.2 (CEE Tier 1 rating for 7,000 btu unit)
EER Federal Standard = 9.7 (units <8,000 btuh)

Net Energy Savings

Gross Energy Savings x Net Realization Rate (Table 1.3C)

Low Income

For the old unit verses the Federal standard savings (4 years):

Full Load Hours x Size x (1/EER old – 1/EER Federal Standard) / 1000 = 21.4 kWh

For the Federal standard verses the new Energy Star unit savings (12 years):

Full Load Hours x Size x (1/EER Federal Standard – 1/EER new) / 1000 = 24.7 kWh

Where:

Full Load Hours = 272 (based on Ref 2)
Size = 9,596 btu/hr (based on AHAM 1999 average size)
EER old = 9.07 (based on AHAM 1999 average efficiency)
EER new = 10.8 (Energy Star for units 8,000 to 13,999 btuh)
EER Federal Standard = 9.8 (units 8,000 to 13,999 btuh)

Net Energy Savings

Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

If actual size and efficiency of the old and new units is known then they should be used in the formulas below. The default values below may be used if actual size and efficiency of the old and new units are not known.

Gross kW savings

Turn-in Program

For the turned-in unit verses the Federal standard savings (4 years):

Size x (1/EER old – 1/EER Federal Standard) / 1000 x CF

= 0.06 kW

For the Federal standard verses the new CEE Tier 1 unit savings (12 years):

Size x (1/EER Federal Standard – 1/EER new) / 1000 x CF

= 0.03 kW

Low Income

For the old unit verses the Federal standard savings (4 years):

Size x (1/EER old – 1/EER Federal Standard) / 1000 x CF

= 0.02 kW

For the Federal standard verses the new Energy Star unit savings (12 years):

Size x (1/EER Federal Standard – 1/EER Energy Star) / 1000 x CF

= 0.03 kW

Where:

CF = Summer Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Baseline Efficiencies from which savings are calculated

Old verses Federal Standard

The baseline EER for the "Typical" (old) AC in the low income program is based on AHAM shipment weighted average (9.07) for 1999.

The baseline for the turn-in program is the average EER of units retired per Reference 1 (7.7).

New Unit

The baseline efficiency for the new unit is that of an AC which meets the Federal Standard.

Compliance Efficiency from which incentives are calculated

CEE Tier 1 for the Turn-In program

Energy Star for the Low Income Program.

Operating Hours

The full load operating hours for CT is assumed to be 272 hours per year based on Reference 2.

Total Cost

The cost is approximately $85 per unit which includes the customer incentive and de-manufacturing fees.

Notes & References

References:

1) Impact, Process, and Market study of CT Appliance retirement Program, Nexus Market Research, Inc., December 2005, Table 2.13, page 25

2) Draft Coincidence Factor Study, Residential Room Air Conditioners, RLW, June 13, 2008.

Revision Number

04

5.3.11 REFRIGERATOR RETIREMENT (HES & LOW INCOME)

Description of Measure

This measure is for the replacement of older refrigerators in the HES and Low Income programs. HES Participants are offered an incentive to replace their older refrigerator with a new energy star refrigerator. Low income participants receive the appliance at no cost.

Method for Calculating Energy Savings

For the HES program early retirement savings will be claimed in two parts. Five years of savings are claimed based on the old "Typical" unit verses the Energy Star 2004 standard (assumes old unit would have been installed for another 5 years) and 13 years of savings are claimed based on the 2004 Energy Star standard verses the new 2008 Energy Star unit (same as New Unit savings in 5.3.9).

For the Low Income program early retirement savings are determined the same as HES except that ten years of savings are claimed based on the old "Typical" unit verses the 2004 Energy Star standard (assumes old unit would have been installed for another 10 years) and 13 years of savings are claimed based on the Energy Star standard verses the new 2008 Energy Star unit (same as New Unit savings in 5.3.9).

Gross Energy Savings

If actual size and kWh consumption of the old and new units is known then they should be used and the energy star 2004 baseline should be calculated as shown in 5.3.9. The default values below may be used if actual size and kWh consumption of the old and new units are not known.

HES

For the "Typical" unit verses the Energy Star standard savings (5 years):

Assume that savings is based on an average adjusted volume of 20.64 ft^3 (based on AHAM shipment weighted average for 1999).

690 kWh (Based on AHAM) – 533 kWh (Consumption for 21.87 ft^3 Adjusted Volume
Side by Side Energy Star 2004 Refrigerator)

= 157 kWh

For the Energy Star 2004 standard verses the new Energy Star 2008 unit savings (13 years):

533 kWh (Energy Star 2004) -502 kWh (Energy Star 2008) = 31 kWh

Note: Federal Standard and Energy Star consumption are calculated as shown in measure 5.3.9.

Low Income

For the "Typical" unit verses the Energy Star standard savings (10 Years):

Assume that savings is based on an average adjusted volume of 20.64 ft^3 (based on AHAM shipment weighted average for 1999).

690 kWh (Based on AHAM) – 408 kWh (Consumption for 20.78 ft^3 Adjusted Volume Energy Star 2004 Refrigerator)

= 282 kWh

For the Energy Star 2004 standard verses the new Energy Star 2008 unit savings (13 years):

408 kWh (Energy Star 2004) -384 kWh (Energy Star 2008) = 24 kWh

Note: Federal Standard and Energy Star consumption are calculated as shown in measure 5.3.9.

Net Energy Savings

Gross Energy Savings x Net Realization Rate (Table 1.3C)

The availability of CEE tier 2 and 3 products in the market is limited and therefore they are not currently specified as the minimum compliance. The Energy Star 2004 standard verses the new Tier 2 or 3, when available, can be determined as shown in 5.3.9 for new refrigerators.

Method for Calculating Demand Savings

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.1368 Watts/kWh

PF_W = 0.0979 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

Baseline Efficiencies from which savings are calculated

The baseline consumption for the “Typical” (old) refrigerator is based on the AHAM shipment weighted average consumption for 1999.

The baseline efficiency for the new unit is that of a refrigerator which meets the 2004 Energy Star Standard.

Compliance Efficiency from which incentives are calculated

The compliance efficiency is that of a refrigerator which meets the 2008 Energy Star standard (CEE Tier 1) and uses a minimum of 20% less electricity than a refrigerator meeting the Federal Standard.

Operating Hours

Operating hours are included in the annual energy consumption estimated for the refrigerators and are not broken out of the annual estimates of kWh.

Incremental Cost

The incremental cost of a refrigerator meeting Energy Star standards compared to a refrigerator meeting the federal standard is estimated to be $79.

Notes & References

References:

1) AHAM Energy Efficiency and Consumption Trends.

Revision Number

06

5.3.12 FREEZER (HES & LOW INCOME)

Description of Measure

This measure is for the replacement of older freezers in the HES and Low Income programs. HES Participants are offered an incentive to replace their older freezer with a new Energy Star freezer that consumes 10% less electricity than that required by current Federal Standards. Low income participants receive the appliance at no cost.

Method for Calculating Energy Savings

For the HES program early retirement savings will be claimed in two parts. Four years of savings are claimed based on the old "Typical" unit verses the Federal standard (assumes old unit would have been installed for another 4 years) and 11 years of savings are claimed based on the Federal standard verses the new Energy Star unit.

For the Low Income program early retirement savings are determined the same as HES except that eight years of savings are claimed based on the old "Typical" unit verses the Federal Standard (assumes old unit would have been installed for another 8 years) and 11 years of savings are claimed based on the Federal standard verses the new Energy Star unit.

Gross Energy Savings

The default values below may be used if actual size and kWh consumption of the old and new units are not known. If actual size and kWh consumption of the old and new units are known then they should be used and the energy star baseline should be calculated as follows:

Federal Standard Energy Use kWh/yr	
Type	kWh
Upright Freezers with manual defrost	7.55*AV+258.3
Chest freezers and all other freezers except compacts	9.88*AV+143.7

Where AV = Adjusted Volume
Adjusted Volume = Total Refrigerated Volume * 1.73

Energy Star Energy Use = 0.90*Federal Standard Energy Use

HES

For the "Typical" unit verses the Federal standard savings (4 years):

Assume that savings is based on an average adjusted volume of 21.01 ft^3 (based on AHAM shipment weighted average for 1999).

472 kWh (Based on AHAM) – 400 kWh (Weighted average consumption for 21.56 ft^3 Adjusted Volume Federal Standard chest and upright freezers)

= 72 kWh

For the federal standard verses the new Energy Star unit savings (11 years):

400 kWh (Federal Standard) -360 kWh (Weighted average consumption for 21.56 ft^3 Adjusted Volume energy Star chest and upright freezers)

= 40 kWh

Low Income

For the “Typical” unit verses the Federal standard savings (8 Years):

Assume that savings is based on an average adjusted volume of 21.01 ft^3 (based on AHAM shipment weighted average for 1999).

472 kWh (Based on AHAM) – 357 kWh (Consumption for 21.56 ft^3 Adjusted Volume Federal Standard chest freezer)

= 115 kWh

For the federal standard verses the new Energy Star unit savings (11 years):

357 kWh (fed) -321 kWh = 36 kWh

Net Energy Savings

Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.1368 Watts/kWh

PF_W = 0.0979 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

Baseline Efficiencies from which savings are calculated

The baseline consumption for the “Typical” (old) freezer is based on the AHAM shipment weighted average consumption for 1999.

The baseline efficiency for the new unit is that of a freezer which meets the federal Standard

Compliance Efficiency from which incentives are calculated

The compliance efficiency is that of a freezer which meets the energy star standard.

Operating Hours

Operating hours are included in the annual energy consumption estimated for the freezers and are not broken out of the annual estimates of kWh.

Incremental Cost

The incremental cost of a freezer meeting Energy Star standards compared to a freezer meeting the federal standard is estimated to be $33.

Notes & References

References:

1) AHAM Energy Efficiency and Consumption Trends.

2) AHAM Estimated 2007 Distributor Sales for Connecticut.

Revision Number

05

5.3.13 DEHUMIDIFIER RETIREMENT (HES & LOW INCOME)

Description of Measure

This measure is for the replacement of older dehumidifiers in the HES and Low Income program. Participants in HES are offered an incentive to replace their older dehumidifier with a new Energy Star dehumidifier. Low income participants receive the appliance at no cost.

Method for Calculating Energy Savings

Early retirement savings will be claimed in two parts. Four years of savings are claimed based on the old "Typical" unit verses the Federal standard (assumes old unit would have been installed for another 4 years) and 12 years of savings are claimed based on the Federal Standard verses the new Energy Star unit.

Gross Energy Savings

The default values below may be used if actual size and energy factor of the old and new units are not known. If actual size and energy factor of the old and new units are known then they should be used and the Federal Standard baseline should be calculated using the energy factors as shown below.

For the "Typical" unit verses the Federal Standard savings (4 years):

Annual Energy Consumption (kWh) = (Liters/day x 67.5 days/year)/Energy Factor

Where Liters/day = Pints/day * 0.473

Typical Consumption for a Dehumidifier Currently in Service kWh/Yr					
Capacity (pints/day)	Size Used (pints/day)	Days/Year	Liters/day	Energy Factor	kWh
45-54	50	67.5	23.50	1.28	1239
Average Energy Use for Federal Standard (kWh/yr)					
Capacity (pints/day)	Size Used (pints/day)	Days/Year	Liters/day	Energy Factor	kWh
1-25	22.4	67.5	10.60	1.00	715
25-35	30	67.5	14.19	1.20	802
35-45	40	67.5	18.92	1.30	982
45-54	49.5	67.5	23.41	1.30	1216
54-75	64.5	67.5	30.51	1.50	1373
75-185	92.8	67.5	43.89	2.25	1317

Gross Annual Energy Savings = Typical consumption – Federal Standard Consumption

Estimated Energy Savings	
Typical verses Federal Standard (4 Years)	
Capacity (pints/day)	kWh
1-25	524
25-35	438
35-45	257
45-54	24
54-75	-134
75-185	-77

For the Federal standard verses the new Energy Star unit savings (12 years):

Average Energy Use for Federal Standard (kWh/yr)					
Capacity (pints/day)	Size Used (pints/day)	Days/Year	Liters/day	Energy Factor	kWh
1-25	22.4	67.5	10.60	1.00	715
25-35	30	67.5	14.19	1.20	802
35-45	40	67.5	18.92	1.30	982
45-54	49.5	67.5	23.41	1.30	1216
54-75	64.5	67.5	30.51	1.50	1373
75-185	92.8	67.5	43.89	2.25	1317
Energy Star Consumption kWh/yr					
Capacity (pints/day)	Size Used (pints/day)	Days/Year	Liters/day	Energy Factor	kWh
1-25	22.4	67.5	10.60	1.20	596
25-35	30	67.5	14.19	1.40	684
35-45	40	67.5	18.92	1.50	851
45-54	49.5	67.5	23.41	1.60	988
54-75	64.5	67.5	30.51	1.80	1144
75-185	92.8	67.5	43.89	2.50	1185

Gross Annual Energy Savings = Federal Standard consumption – Energy Star Consumption

Federal Standard verses Energy Star (12 Years)	
Capacity (pints/day)	kWh
1-25	119
25-35	117
35-45	131
45-54	228
54-75	229
75-185	132

Net Energy Savings

Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

Due to insufficient peak coincident data, the average kW savings shall be claimed for the summer seasonal peak demand savings. The average kW savings is conservatively lower than what the summer seasonal peak will be and is calculated by dividing the kWh saved by the hours of use (1,620).

No winter seasonal peak kW savings shall be claimed.

Baseline Efficiencies from which savings are calculated

The baseline efficiency for the "Typical" (old) dehumidifier is 1.28 L/kWh.

The baseline efficiency for the new unit is that of a dehumidifier which meets the Federal Standard.

Compliance Efficiency from which incentives are calculated

The compliance efficiency is Energy Star efficiency.

Operating Hours

Energy Star estimates dehumidifiers operate 67.5 days per year or a total of 1620 hours per year.

Revision Number

07

5.3.14 DEHUMIDIFIER (RETAIL PRODUCTS)

Description of Measure

Purchase of a new dehumidifier that consumes at least 10% less electricity than the Energy Star standard.

Method for Calculating Energy Savings

Annual Energy Consumption (kWh) = (Liters/day x 67.5 days/year)/Energy Factor

Energy Star Consumption kWh/yr						
Capacity (pints/day)	Size Used (pints/day)	Days/Year	Liters/day	Energy Factor	% Better Than Fed	kWh
1-25	22.4	67.5	10.60	1.20	20%	596
25-35	30	67.5	14.19	1.40	17%	684
35-45	40	67.5	18.92	1.50	15%	851
45-54	49.5	67.5	23.41	1.60	23%	988
54-75	64.5	67.5	30.51	1.80	20%	1144
75-185	92.8	67.5	43.89	2.50	11%	1185
10% Better than Energy Star Consumption kWh/yr						
Capacity (pints/day)	Size Used (pints/day)	Days/Year	Liters/day	Energy Factor	% Better Than Energy Star	kWh
1-25	22.4	67.5	10.60	1.32	10%	542
25-35	30	67.5	14.19	1.54	10%	622
35-45	40	67.5	18.92	1.65	10%	774
45-54	49.5	67.5	23.41	1.76	10%	898
54-75	64.5	67.5	30.51	1.98	10%	1040
75-185	92.8	67.5	43.89	2.75	10%	1077

Gross Annual Energy Savings = Energy Star consumption – 10 % better than Energy Star Consumption

Annual Energy Savings (10% Better Than Energy Star)			
Capacity (pints/day)	Energy Factor	kWh	kW
1-25	1.32	54	0.033
25-35	1.54	62	0.038
35-45	1.65	77	0.048
45-54	1.76	90	0.055
54-75	1.98	104	0.064
75-185	2.75	108	0.067

Annual Net Energy Savings = Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

Due to insufficient peak coincident data, the average kW savings shall be claimed for the summer seasonal peak demand savings. The average kW savings is conservatively lower than what the summer seasonal peak will be and is calculated by dividing the kWh saved by the hours of use (1,620).

No winter seasonal peak kW savings shall be claimed.

Baseline Efficiencies from which savings are calculated

The baseline is the Energy Star Standard.

Compliance Efficiency from which incentives are calculated

The compliance efficiency is 10 % better than Energy Star efficiency.

Operating Hours

Energy Star estimates dehumidifiers operate 67.5 days per year or a total of 1620 hours per year.

Notes & References

Baseline energy factors and hours of operation are from the energy star website.

Revision Number

06

5.3.15 NON GENERAL SERVICE CFL BULBS (RETAIL PRODUCTS)

Description of Measure

A screw-based (integrated ballast) non general service compact fluorescent light bulb. Typical CFL wattage is between 9 and 23 watts.

General service CFL's are defined as standard base bulbs that intended for general service applications as specified in the Energy Independence and Security Act of 2007. Non-general service CFLs include, but are not limited to reflector bulbs, 3-way bulbs, and candelabra based bulbs.

Method for Calculating Energy Savings

Gross Annual Energy Savings = Δ Watts x Hours x 365/1000

Where:

Δ Watts = 3.0 x CFL wattage based on a 4.0 wattage ratio (Note 1).
Hours = 2.8 Hours per day (Note 1).
365 = days per year

For example, the annual savings for a 15 watt CFL:
Annual kWh = 3.0 x 15 watts x 2.8 hours/day x 365 days / 1000 = 46.0 kWh

Annual Net Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Note that actual bulb wattage should be used to calculate energy savings.

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peak demand savings (Note 2):

Summer Coincident Peak Gross Savings = CF_S x Δ Watts
Winter Coincident Seasonal Peak Gross Savings = CF_W x Δ Watts

Where :

CF = Average (Summer or Winter) Seasonal Peak Coincidence Factor (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

Baseline Efficiencies from which savings are calculated

Baseline is assumed to be an incandescent light source with a wattage which is 4.0 times higher than the wattage of the CFL bulb. For instance, it's assumed that a 60 Watt incandescent is "equivalent" to a 15 Watt CFL (15 x 4.0 = 60). For dimmable or three-way CFL bulbs, assume the highest wattage/setting when calculating the baseline equivalent.

Compliance Efficiency from which incentives are calculated

Energy Star screw-based bulb with equivalent lumen output.

Operating Hours

2.8 Hours per day estimate (Note 1).

Incremental Cost

$5.00 based on NCP data.

Non-Electric Benefits - Annual O&M Cost Adjustments

$4.00 per bulb one time benefit. Estimate based on current cost of incandescent bulbs that would be used in place of one CFL.

Notes & References

Note 1. Residential Lighting Markdown Impact Evaluation, Nexus Market Research, January 20, 2009.

Note 2: Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007.

Revision Number

07

5.4.1 REM SAVINGS

Description of Measure

Energy Star Home which is certified through a HERS (Home Energy Rating System) rating. Energy Star Homes are limited to single family homes or multi-family homes that are three stories or less. Hi-rise units do not qualify for Energy Star certification and the savings methodology below does not apply to those units.

Method for Calculating Energy Savings

The traditional method of qualifying Energy Star Homes is through a HERS rating. The rating involves inputting the key energy features into a computer program (geometry, orientation, thermal performance, mechanical systems, etc.) that will generate a HERS score and other useful information regarding the energy usage of the home. REM/Rate® (REM) is the software that is used in Connecticut (and in most jurisdictions) to generate HERS ratings.

A feature of REM is that it enables the user to define a base home ("user defined reference home", or UDRH) and calculate the savings of an actual home relative to the UDRH. The UDRH is the same size as the "as-built" and utilizes the same type of mechanical systems and fuels. However, the thermal and mechanical efficiencies of the UDRH are set to baseline levels. The baseline levels are established from the most recent studies available and program administrator field experience.

The UDRH report generates heating, cooling and water heating consumption for the "as-built" home and the defined "base" home. The difference between those values is the savings. This savings is referred to "REM" savings.

The following table is an example of what a typical UDRH report looks like.

	UDRH Consumption	**As-Built Consumption**	**Savings**
Heating	40.5	34.8	5.7
Cooling	4.5	2.3	2.2
Water Heating	20.6	17.5	3.1

Note that the numbers above represent MBtu's. Based on the corresponding fuel for these end-uses, the above numbers can be converted to their respective units of measure (i.e. gallons of oil, Therms of gas, kWh of electricity, etc).

The REM savings above includes the effect of installing a programmable thermostat, so additional savings should not be claimed if one (or more) is programmable thermostat is installed. Also, REM has the ability to incorporate lights and appliances into an "expanded" rating. Connecticut does NOT use the expanded rating. Therefore, the REM savings does not include savings for lights and appliances. These savings (if any) are calculated separately.

Since REM savings is based on a whole building approach (i.e. it includes the effects of upgraded insulation, tighter ducts, increased efficiencies, etc), this savings methodology takes precedence over "code-plus" measures. Savings for homes that have a REM analysis done should be calculated using the UDRH Report; and no additional savings should be claimed based on code-plus measures.

Baseline Efficiencies from which savings are calculated

An "average" home built in Connecticut as determined by a baseline evaluation. Note that the baseline is NOT a home built to minimum code standards. While many homes fail to meet some aspects of the energy code, their performance overall exceeds minimum code performance substantially and therefore, the baseline exceeds minimum code performance as well.

Compliance Efficiency from which incentives are calculated

Energy Star

Incremental Cost

Incremental cost is assumed to be $1.00 per square foot heated living space.

Non-Electric Benefits - Annual Fossil Fuel Savings

There is fossil fuel savings for homes that utilize fossil fuel for heating and/or water heating. Most homes in the program utilize fossil fuel for heating and water heating, so the UDRH MBtu savings numbers will be converted to the appropriate fossil fuel unit.

Notes & References

Note 1. *Baseline Evaluation for the Energy Star Home New Construction Program*, January 2002. Prepared for Northeast Utilities and United Illuminating.

Revision Number

06

5.4.4 INFILTRATION REDUCTION TESTING (BLOWER DOOR TEST) FOR NEW HOMES, HES & LOW INCOME

Description of Measure

Energy savings due to reductions in infiltration that are not already captured through alternative measures (5.4.1, 5.4.5 & 5.4.6) which capture the effects of reduced infiltration. The savings calculations below do not account for duct leakage reduction. Therefore, this measure can be paired with the duct sealing measure (5.2.9) without fear of double-counting.

Method for Calculating Energy Savings

Table 1 – Savings for new homes per 1000 Sq ft

Infiltration Measurement (CFM per Sq ft)	Electric Resistance savings (kWh)	Geothermal Savings (kWh)	Air Source Heat Pumps (kWh)	Air Handling savings	Cooling Savings
1.00	0.0	0.0	0.0	0	0
0.96	109.9	27.5	55.0	2.5	2.2
0.92	219.8	55.0	109.9	5.0	4.5
0.88	329.7	82.4	164.9	7.5	6.7
0.83	439.6	109.9	219.8	10.0	9.0
0.79	549.5	137.4	274.8	12.5	11.2
0.75	659.4	164.9	329.7	15.0	13.5
0.71	769.3	192.3	384.7	17.5	15.7
0.67	879.2	219.8	439.6	20.0	17.9
0.63	989.2	247.3	494.6	22.5	20.2
0.58	1099.1	274.8	549.5	25.0	22.4
0.54	1209.0	302.2	604.5	27.5	24.7
0.50	1318.9	329.7	659.4	30.0	26.9
0.46	1428.8	357.2	714.4	32.5	29.2
0.42	1538.7	384.7	769.3	35.0	31.4
0.38	1648.6	412.1	824.3	37.5	33.7
0.33	1758.5	439.6	879.2	40.0	35.9
0.29	1868.4	467.1	934.2	42.5	38.1

Blower Door Savings for New Homes (based on a baseline of 1 CFM at 50Pa per square foot conditioned floor area).

Table 2 – Retrofit Savings

Savings per 100 CFM (at 50 Pa) reduction		
Measure	**Savings**	**Units**
Electric Resistance Heat	263.8	kWh
Heat Pump Heating	131.9	kWh
Geothermal Heating	87.9	kWh
Air Handler (fan) Heating	6.0	kWh
Fossil Fuel Heating	1.2	MMBtu
Cooling	5.4	kWh

Method for Calculating Demand Savings

New Construction and Retrofit**
Estimated summer demand savings = 0.009 kW
Estimated winter demand savings = 0.117 kW (Electric Resistance and HP)
= 0.039 kW (Geothermal - Retrofit)
Estimated winter demand savings = 0.03 kW (Geothermal – New Construction)

***per 100 CFM at 50 Pa reduction*
Note: Demand savings are based on design load calculation in REM software hence no need to use coincidence factors.

Compliance Efficiency from which incentives are calculated

Infiltration of less than 1 CFM per square foot conditioned leakage verified with blower door testing.

Incremental Cost

25 cents per square foot of conditioned space (estimated)

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating.

Infiltration Measurement (CFM per Sq ft)	MMBtu	Gallons Oil	Therms Gas	Gallons Propane
1.00	0	0.0	0.0	0.0
0.96	0.50	3.6	5.0	5.5
0.92	1.00	7.1	10.0	10.9
0.88	1.50	10.7	15.0	16.4
0.83	2.00	14.3	20.0	21.9
0.79	2.50	17.9	25.0	27.3
0.75	3.00	21.4	30.0	32.8
0.71	3.50	25.0	35.0	38.3
0.67	4.00	28.6	40.0	43.7
0.63	4.50	32.1	45.0	49.2
0.58	5.00	35.7	50.0	54.6
0.54	5.50	39.3	55.0	60.1
0.50	6.00	42.9	60.0	65.6
0.46	6.50	46.4	65.0	71.0
0.42	7.00	50.0	70.0	76.5
0.38	7.50	53.6	75.0	82.0
0.33	8.00	57.1	80.0	87.4
0.29	8.50	60.7	85.0	92.9

Estimated savings values include expected system efficiency

Notes & References

Note 1: REM/Rate™ analysis done by Vinay Ananthachar, Northeast Utilities, August 2008.

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09

5.4.5 HIGH PERFORMANCE WALL INSULATION (NEW HOMES)

Description of Measure

High performance insulation: In order to be considered as high performance, the above-grade wall R-value must be better R-21 or that the whole wall U-value (not including effects of thermal mass) must be better that 0.06 and Grade I installation standards as defined by RESNET. Also, meets ENERGY STAR thermal bypass requirements.

Note that thermal mass does NOT equate to R-value. Solid wood walls (log cabins) are NOT considered high performance walls and do NOT qualify (they do not meet the R-value or infiltration requirement).

Since the savings calculation includes the effects of decreased infiltration, homes that qualify for this measure do NOT qualify for any incentive for blower door reduction, nor should savings for both measures be counted. Also, if a home is HERS rated, the UDRH savings takes precedent over the savings presented here.

Method for Calculating Energy Savings

REM/Rate™ Home Energy Analysis software was used to calculate savings (Note 1).

Energy Savings = Home with High Performance Wall Insulation – Typical Home

Annual Energy Saving in MMBtu

	w/o infiltration	w/ infiltration	
Annual Heating savings	258,856	531,335	Btu per 100 sq ft
	0.26	0.53	MMBtu per 100 sq ft

Annual Savings (per 100 Sq ft)

	w/o Infiltration	w/ Infiltration	
Electric resistance savings	56.9	116.8	kWh
Heat pump savings	28.4	58.4	kWh
Fan savings (furnace or AH)	1.4	2.7	kWh

Cooling Savings = estimated at 2.1 kWh per 100 square feet of wall

Method for Calculating Demand Savings

The estimated summer demand savings = 0.0049 kW
The estimated winter demand savings = 0.053 kW (Electric Resistance and HP)

Note: Demand savings are per 100 Sq ft
Note: Demand savings are based on design load calculation in REM software hence no need to use coincidence factors.

Incremental Cost

50 cents per square foot

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating.

Non-Electric Savings,

	Energy Savings		Units
	w/o Infiltration	w/ Infiltration	
Annual gas savings	2.6	5.3	Therms
Annual oil savings	1.8	3.8	Gallons
Annual Propane savings	2.8	5.8	Gallons

Notes & References

Note 1: REM/Rate™ Analysis performed by Vinay Ananthachar, Northeast Utilities, Aug 2008.

Revision Number

07

5.4.6 HIGH PERFORMANCE CEILING INSULATION (NEW HOMES)

Description of Measure

High performance insulation: In order to be considered as high performance, the ceiling insulation R-value must be better R-35 or that the whole component U-value (not including effects of thermal mass) must be better that 0.042 and Grade I installation standards as defined by RESNET. Also, have proven ability to substantially retard infiltration relative to standard fiberglass insulation

Since the savings calculation includes the effects of decreased infiltration, homes that qualify for this measure do NOT qualify for any incentive for blower door reduction, nor should savings for both measures be counted (either the infiltration as determined below or the blower door test may be used, but not both). Also, if a home is HERS rated, the UDRH savings takes precedent over the savings presented here; and if a home meets ENERGY STAR standards via the EPA approved Building Option Packages (BOP), then savings from this measure should not be counted.

Method for Calculating Energy Savings

New Construction (for new homes, uses fiberglass code-minimum as baseline)

REM/Rate™ Home Energy Analysis software was used to calculate savings (Note 1).

Energy Savings =	**Home with High Performance**	**–**	**Typical Home**
Ceiling Insulation			

Annual Energy Savings (MMBtu)

	w/o Infiltration	w/ Infiltration	
Annual Heating savings	300,000	591,667	Btu per 100 sq ft
	0.30	0.59	MMBtu per 100 sq ft

Annual Energy Savings per 100 Sq ft

	w/o Infiltration	w/ Infiltration	Units
Electric resistance savings	65.9	130.1	kWh
Heat pump savings	33.0	65.0	kWh
Fan savings (furance or AH)	1.2	2.6	kWh

Cooling Savings = estimated at 3.2 kWh per 100 square feet of wall

Method for Calculating Demand Savings

The estimated summer demand savings = 0.008 kW
The estimated winter demand savings = 0.051 kW (Electric Resistance and HP)

Note: Demand savings are per 100 sq ft
Note: Demand savings are based on design load calculation in REM software hence no need for using coincidence factor.

Incremental Cost

25 cents per square foot

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating

Therefore,

	Energy Savings	Units	
	w/o Infiltration	w/ Infiltration	
Annual gas savings	3.0	5.9	Therms
Annual oil savings	2.1	4.2	Gallons
Annual Propane savings	3.3	6.5	Gallons

Notes & References

Note1: Note 1: REM/Rate™ Analysis performed by Vinay Ananthachar, Northeast Utilities, Aug 2008

Revision Number

07

5.5.1 WATER HEATER THERMOSTAT SETTING (HES & LOW INCOME)

Description of Measure

This measure is for lowering of the hot water temperature in an electric domestic hot water heater.

Method for Calculating Energy Savings

Please see the table below: Savings will occur only when the lower temperature of the hot water does not require the use of more hot water. Savings will not occur in an application such as a shower or faucet where the user demands a certain water temperature and will increase the hot water flow to make up for the lower temperature. Additionally, this measure will increase a dishwasher's electricity consumption due to the lower hot water supply temperature.

Lower Electric Water Heater Temp from 140 to 125F

Gross Annual Energy Savings	
Hot Water Consumption - Cotheswasher	
Number of cycles per year	392.0
Water use per cycle[2]	26.16
Percent Hot Water[1]	29%
Annual clotheswasher hot water consumption (Gal)	2,974.2
Hot Water Consumption - Dishwasher	
Number of cycles per year	215.0
Water use per cycle[2]	4.36
Percent Hot Water[1]	100%
Annual dishwasher hot water consumption (Gal)	937.4
Energy Savings = Delta Temp x 8.3 X water savings / 10^6	
Temp of water into house (Deg F)	55
Temp of hot water from tank (Deg F)	140
Temp of hot water from tank after Reset (Deg F)	125
Delta Temp (Deg F)	15
Pounds per gallon	8.3
Btu savings per gallon	124.5
Mbtu savings per year (clotheswasher)	0.37
Mbtu savings per year (dishwasher)	-0.12
Total Mbtu saved per year	0.25
Savings for Homes With Electric Hot Water Heaters	
Water Heater Electricity Savings = Mbtu savings x 293 / water heater EF	
kWh/Mbtu	293
Elect saved per year from clothes washing (kWh)	108
Electric Water Heater Energy Factor[3]	0.90
Total electricity saved per year at water heater (kWh)	120.55
Electricity Savings Due to Dishwasher Preheater (kWh)	-34.2
Total electricity saved per year (kWh)	86.36
Savings for Homes With Gas Hot Water Heaters	

Natural gas savings = savings in Mbtu / water heater EF	
Gas saved per year at the water heater (MBtu)	0.37
Gas Water Heater Energy Factor[3]	0.575
Total gas saved per year at water heater (Mbtu)	0.64
Electricity Savings Due to Dishwasher Preheater (kWh)	-34.2
Savings for Homes With Oil Hot Water Heaters	
Number 2 oil saved = savings in btu / water heater EF / 140,000	
No 2 oil btu per gallon	140,000
Oil saved at the water heater (Gal)	2.64
Oil Fired Water Heater Energy Factor[3]	0.495
Total oil saved per year at water heater (Gal)	5.34
Electricity Savings Due to Dishwasher Preheater (kWh)	-34.2

Net Energy Savings

Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

No demand savings are claimed for this measure since there is insufficient peak coincident data.

Baseline Efficiencies from which savings are calculated

The base line efficiency is considered to be the 140F water heater outlet temperature.

Compliance Efficiency from which incentives are calculated

The compliance efficiency is considered to be the 125F water heater outlet temperature.

Operating Hours

The operating hours are included in the water consumption values in the table.

Total Cost

This measure is commonly done by a contractor and has a total cost of approximately $5.25.

Non-Electric Benefits - Annual Fossil Fuel Savings

See Method for Calculating Energy Savings.

Non-Electric Benefits - Annual Water Savings

See Method for Calculating Energy Savings.

Notes & References

References:

[1]Table 2, LBNL-35475, "The effect of Efficiency Standards on Water Usage and Water Heating Energy Use in the U.S.: A Detalied End-use Treatment", May 1994

[2]Weighted average of Energy star and conventional water consumption from 2008 E-Star calculator

[3]Based on 2004 fed standard (10CFR 430) for a 50 gallon tank

Revision Number

07

5.5.2 WATER HEATER WRAP (HES & LOW INCOME)

Description of Measure

Electric Hot water heaters with fiberglass insulation are wrapped with an insulating blanket to reduce standby heat loss through the skin. This measure is not necessary for newer units which are insulated with foam.

Method for Calculating Energy Savings

The reference used to determine the increase in water heater energy factor (EF) due to this measure is "Meeting the Challenge: The Prospect of Achieving 30 percent Energy Savings Through the Weatherization Assistance Program" by the Oak Ridge National Laboratory - May 2002.

The home studied in the Northeast had a gas fired water heater, and was not applicable, since only electric water heaters are wrapped in this program. The southern home in the study did have an electric water heater. The difference in the actual heating and storage of hot water may be a little different in the South versus the Northeast, but the southern home can still be used as a good approximation.

The temperature of the water entering the heater may be warmer in the South versus the Northeast, especially in the Winter, but this would not affect standby losses which the wrapping seeks to reduce. The other difference is that the heat loss from the tank to the environment may be greater in the Northeast than the South because of the more mild Southern winters and the warmer southern summers. However, the Southern house can be used as a good conservative approximation to a house in the Northeast.

The Oak Ridge study predicted that wrapping a 40 gallon water heater would result in an increase in the energy factor form 0.86 to 0.88. The tables below provide the savings estimate for the increase in energy factor.

Household Hot Water Use From Table 4 in LBNL-35475											
Home Vintage	Appliance Vintage	Fixtures and fittings vintage	Sink filling	Faucet flow	Bath filling	Showers	Clothes washer	Dishwasher	Toilets	Yard/other	Total
gals/day	gals/day	gals/day	gals/day	gals/day	gals/day	gals/day	gals/day	gals/day	gals/day	gals/day	gals/day
Pre 1994	All	All	7.9	4.6	9.5	26.0	8.2	3.4	0.0	0.0	59.6
Post 1993	All	All	6.7	3.4	9.5	26.0	9.8	5.8	0.0	0.0	61.2
Average			7.3	4.0	9.5	26.0	9.0	4.6	0.0	0.0	60.4

Annual Gross Energy Consumption - Savings						
EF	Water inlet Temp	Water Outlet Temp	Pounds of hot water	Total Hot Water BTU's	Total Energy Input (Btu's)	Total Energy Input (kWh)
0.86	58	135	183,996	14,167,686	16,474,053	4,828
0.88	58	135	183,996	14,167,686	16,099,643	4,719
Savings (kWh)						110

Net Energy Savings

Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

No demand savings are claimed for this measure since there is insufficient peak coincident data.

Baseline Efficiencies from which savings are calculated

The base line efficiency used is that of a foam-insulated electric water heater with an energy factor of 0.86.

Compliance Efficiency from which incentives are calculated

The tank must have fiberglass insulation.

Operating Hours

Operating hours are included in the water usage estimates.

Total Cost

The estimated cost is $25.00 for material and labor.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Notes & References

References:

1) The reference used for this measure is "Meeting the Challenge: The Prospect of Achieving 30 percent Energy Savings Through the Weatherization Assistance Program" by the Oak Ridge National Laboratory - May 2002.

2) LBNL-35475, "The effect of Efficiency Standards on Water Usage and Water Heating Energy Use in the U.S.: A Detalied End-use Treatment", May 1994

Revision Number

05

5.5.3 LOW FLOW SHOWERHEAD (HES & LOW INCOME)

Description of Measure

This measure is for the installation of 2.2 GPM low flow showerheads.

Method for Calculating Energy Savings

The gross savings are estimated as shown in the table below.

Annual Gross Savings					
Water Savings = (Actual gpm- replacement gpm) x usage per HH x 365 / number of showers					
As found actual shower flow (GPM)	3.0	3.5	4.0	4.5	5.0
Replacement showerhead flow (GPM)	2.2	2.2	2.2	2.2	2.2
Showers per household[3]	2	2	2	2	2
Usage per household (min/day)[1]	13	13	13	13	13
Annual water savings per showerhead (Gal)	1,898	3,084	4,271	5,457	6,643
Energy Savings = Delta Temp x 8.3 X water savings / 10^6					
Temp of water into house (Deg F)	55	55	55	55	55
Temp of water from shower (Deg F)	105	105	105	105	105
Delta Temp (Deg F)	50	50	50	50	50
Pounds per gallon	8.3	8.3	8.3	8.3	8.3
Btu required per gallon	415	415	415	415	415
Mbtu saved per year	0.79	1.28	1.77	2.26	2.76
Electricity Savings = savings at shower in Mbtu x 293 / water heater energy factor					
kWh/Mbtu	293	293	293	293	293
Elect saved per year at the showerhead (kWh)	231	375	519	664	808
Electric Water Heater Energy Factor[2]	0.90	0.90	0.90	0.90	0.90
Total elect saved per year at water heater (kWh)	256	417	577	737	898
Natural gas savings = savings at shower in Mbtu / water heater energy factor					
Gas saved per year at the showerhead (MBtu)	0.79	1.28	1.77	2.26	2.76
Gas Water Heater Energy Factor[2]	0.575	0.575	0.575	0.575	0.575
Total gas saved per year at water heater (Mbtu)	1.37	2.23	3.08	3.94	4.79
Number 2 oil saved = savings at shower in btu / water heater energy factor / 140,000					
No 2 oil btu per gallon	140,000	140,000	140,000	140,000	140,000
Oil saved at the showerhead (Gal)	5.63	9.14	12.66	16.18	19.69
Oil Fired Water Heater Energy Factor[2]	0.495	0.495	0.495	0.495	0.495
Total oil saved per year at water heater (Gal)	11.4	18.5	25.6	32.7	39.8

[1]Table 3, LBNL-35475, "The effect of Efficiency Standards on Water Usage and Water Heating Energy Use in the U.S.: A Detalied End-use Treatment", May 1994

[2]Based on 2004 fed standard (10CFR 430) for a 50 gallon tank

[3]Estimate

Net Energy Savings

Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

No demand savings are claimed for this measure since there is insufficient peak coincident data.

Baseline Efficiencies from which savings are calculated

The baseline efficiency is the as found shower head flow rate.

Compliance Efficiency from which incentives are calculated

The compliance efficiency is 2.2gpm

Operating Hours

The operating hours can be calculated from the use time in the table above.

Total Cost

The total cost for material and labor is approximately $8.10 for the Earth Massage and $14.70 for the handheld.

Non-Electric Benefits - Annual Fossil Fuel Savings

The equivalent fossil fuel savings for this measure is shown above in MBtu of gas and gallons of No. 2 oil.

Non-Electric Benefits - Annual Water Savings

The annual water savings is shown in the table above in gallons/year.

Notes & References

References:

1) LBNL-35475, "The effect of Efficiency Standards on Water Usage and Water Heating Energy Use in the U.S.: A Detalied End-use Treatment", May 1994

Revision Number

08

5.5.4 FAUCET AERATOR (HES & LOW INCOME)

Description of Measure

Replacement of federal standard 2.2 gpm faucet aerators with best available aerators.

Method for Calculating Energy Savings

The gross savings are estimated as shown in the table below.

Gross Annual Savings	
Water Savings = (2.2 - 1.5 gpm) x usage per HH x 365 / number of faucets	
Best available efficient aerator (GPM)	1.5
Federal Standard Faucet flow (GPM)	2.2
Faucets per household[3]	3
Usage per household (min/day)[1]	3.0
Annual water savings per faucet (Gal)	255.5
Energy Savings = Delta Temp x 8.3 X water savings / 10^6	
Temp of water into house (Deg F)	55
Temp of water from faucet (Deg F)	80
Delta Temp (Deg F)	25
Pounds per gallon	8.3
Btu required per gallon	207.5
Mbtu saved per year	0.05
Electricity Savings = Mbtu savings at faucet x 293 / water heater EF	
kWh/Mbtu	293
Elect saved per year at the faucet (kWh)	16
Electric Water Heater Energy Factor[2]	0.90
Total elect saved per year at water heater (kWh)	17.26
Natural gas savings = savings at faucet in Mbtu / water heater EF	
Gas saved per year at the faucet (MBtu)	0.05
Gas Water Heater Energy Factor[2]	0.575
Total gas saved per year at water heater (Mbtu)	0.09
Number 2 oil saved = savings at faucet in btu / water heater EF / 140,000	
No 2 oil btu per gallon	140,000
Oil saved at the faucet (Gal)	0.38
Oil Fired Water Heater Energy Factor[2]	0.495
Total oil saved per year at water heater (Gal)	0.77

[1]Per Table 3 in LBNL-35475, "The effect of Efficiency Standards on Water Usage and Water Heating Energy Use in the U.S.: A Detalied End-use Treatment, May 1994, All faucets with dishwasher

[2]Based on 2004 fed standard (10CFR 430) for a 50 gallon tank

[3]Estimate

Net Energy Savings

Gross Energy Savings x Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

No demand savings are claimed for this measure since there is insufficient peak coincident data.

Baseline Efficiencies from which savings are calculated

The baseline efficiency is the flow rate of an aerator meeting the federal standard of 2.2 gpm.

Compliance Efficiency from which incentives are calculated

The compliance efficiency is 1.5 gpm.

Operating Hours

The operating hours can be calculated from the use time in the table above.

Total Cost

The total installed cost is $4.40 for the dual thread aerator and $6.40 for the flip (shut-off type) aerator.

Non-Electric Benefits - Annual Fossil Fuel Savings

The annual expected non-electric benefits are shown in shown in " Method for Calculating Energy Savings."

Non-Electric Benefits - Annual Water Savings

The annual expected water savings is shown in shown in " Method for Calculating Energy Savings."

Notes & References

References:

1) LBNL-35475, "The effect of Efficiency Standards on Water Usage and Water Heating Energy Use in the U.S.: A Detalied End-use Treatment", May 1994

Revision Number

06

5.5.5 INSTALL CEILING INSULATION (HES & LOW INCOME)

Description of Measure

Installation of ceiling insulation in a residential living unit. The type of insulation installed is assumed to be either loose fill or batt-type insulation. Insulation must be installed between conditioned area and ambient (attic or outside) space. Insulation that is installed between two living spaces (i.e. between floors on a two family unit) does not qualify.

Method for Calculating Energy Savings

A parallel flow analysis was conducted (Note 1) and the following charts were generated. The R-value refers to the rated R-value of the insulation. The effective ceiling R-value and heat transfer was calculated to generate these charts. Note that the savings is based on 100 square feet of ceiling area.

Pre-Existing Insulation R-value	Total Post-Installed Insulation R-Value (including pre-existing)						
	19	**21**	**27**	**30**	**33**	**39**	**45**
0	1,319	1,333	1,362	1,372	1,380	1,392	1,401
3	402	417	445	455	463	475	484
6	203	217	246	255	263	276	285
9	115	130	158	168	176	188	197
12	66	81	109	119	127	139	148
15	35	49	78	88	96	108	117
19		14	43	53	61	73	82
21			29	38	46	59	68
27				10	18	30	39

Annual kWh Savings for Electric Resistance Heat (per 100 sq. ft.)

Pre-Existing Insulation R-value	Total Post-Installed Insulation R-Value (including pre-existing)						
	19	**21**	**27**	**30**	**33**	**39**	**45**
0	660	667	681	686	690	696	701
3	201	208	223	228	231	238	242
6	101	108	123	128	132	138	142
9	58	65	79	84	88	94	99
12	33	40	55	59	63	70	74
15	17	25	39	44	48	54	58
19		7.09	21	26	30	36	41
21			14	19	23	29	34
27				5	9	15	19

Annual kWh Savings for Electric Heat Pump (per 100 sq. ft.)

For example, suppose a house with electric resistance heat currently has 2 inches (assumed R-6) insulation in the attic. Insulation is installed to bring the total Insulation R-value up to R-30. The savings would be

calculated by locating the R-6 on the left-hand column (pre-existing condition) and following across the row to R-30 (Total Post-installed Insulation R-value). For electric heat, the savings would be 255 kWh per 100 square feet of ceiling area.
In cases where the exact R-value (either pre or post) falls between the values on these tables, linear extrapolation can be used to approximate the savings.

Cooling savings is not defined for this measure.

Method for Calculating Demand Savings

There are no summer or winter demand savings claimed for this measure.

Total Cost

Actual cost or $1 per square foot as a default.

Non-Electric Benefits - Annual Fossil Fuel Savings

The following charts can be used to calculate fossil fuel savings for ceiling insulation. These charts are similar in nature to the charts above.

Pre-Existing Insulation R-value	Total Post-Installed Insulation R-Value (including pre-existing)						
	19	**21**	**27**	**30**	**33**	**39**	**45**
0	42.9	43.3	44.3	44.6	44.9	45.3	45.5
3	13.1	13.5	14.5	14.8	15.0	15.4	15.7
6	6.6	7.1	8.0	8.3	8.6	9.0	9.2
9	3.7	4.2	5.1	5.5	5.7	6.1	6.4
12	2.2	2.6	3.5	3.9	4.1	4.5	4.8
15	1.1	1.6	2.5	2.8	3.1	3.5	3.8
19		0.5	1.4	1.7	2.0	2.4	2.7
21			0.9	1.2	1.5	1.9	2.2
27				0.3	0.6	1.0	1.3

Annual Gallons of Oil Saved (per 100 sq. ft.)

Pre-Existing Insulation R-value	Total Post-Installed Insulation R-Value (including pre-existing)						
	19	**21**	**27**	**30**	**33**	**39**	**45**
0	60.0	60.7	62.0	62.4	62.8	63.4	63.8
3	18.3	19.0	20.3	20.7	21.1	21.6	22.0
6	9.2	9.9	11.2	11.6	12.0	12.5	12.9
9	5.2	5.9	7.2	7.6	8.0	8.6	9.0
12	3.0	3.7	5.0	5.4	5.8	6.3	6.7
15	1.6	2.2	3.5	4.0	4.3	4.9	5.3
19		0.6	1.9	2.4	2.8	3.3	3.7
21			1.3	1.7	2.1	2.7	3.1
27				0.4	0.8	1.4	1.8

Annual Therms of Gas Saved (per 100 sq. ft.)

Pre-Existing Insulation R-value	Total Post-Installed Insulation R-Value (including pre-existing)						
	19	**21**	**27**	**30**	**33**	**39**	**45**
0	65.6	66.3	67.7	68.2	68.6	69.2	69.7
3	20.0	20.7	22.1	22.6	23.0	23.6	24.1
6	10.1	10.8	12.2	12.7	13.1	13.7	14.2
9	5.7	6.4	7.9	8.4	8.8	9.4	9.8
12	3.3	4.0	5.4	5.9	6.3	6.9	7.4
15	1.7	2.4	3.9	4.4	4.8	5.4	5.8
19		0.7	2.1	2.6	3.0	3.6	4.1
21			1.4	1.9	2.3	2.9	3.4
27				0.5	0.9	1.5	1.9

Annual Gallons of Propane Saved (per 100 sq. ft.)

<u>Notes & References</u>

Note 1. Parallel flow method per 2005 ASHRAE Fundamentals.

<u>Revision Number</u>

05

5.5.6 INSTALL WALL INSULATION (HES & LOW INCOME)

Description of Measure

Insulation installed (either bat or blown-in) in a wall. Assuming that there is no insulation installed previously.

Method for Calculating Energy Savings

Parallel flow method was used to calculate savings (Note 1) based on a typical 2 x 4 wall.
Savings is based on 100 square feet of wall area (net of window and doors).

Savings = ($1/R_{existing} - 1/R_{New}$) x Degree Days x 24 x Adjustment x Area

where: $R_{existing}$ is the effective R-value of the existing wall assumed to be 3
R_{New} is the upgraded effective R-value of the wall, assumed to be 11 (R-13 insulation installed).
Degree days = 5,885 assumed state average
Adjustment = 0.64 ASHRAE adjustment factor (note 2)
Area = 100 square feet .

Annual Btu conductive saving = 2,191,360

Therefore, Annual Savings (for homes with electric heat):
Electric resistance savings = 642 kWh
Heat Pump savings = 321 kWh

Method for Calculating Demand Savings

There are no summer or winter demand savings claimed for this measure.

Total Cost

Actual cost or $0.75 per square foot as default.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating.

Annual fossil fuel savings = Btu savings / system efficiency

where: Btu savings = 2,191,360
75% is the assumed system efficiency including distribution loss.

Therefore,
annual gas savings = 29.2 Therms/year (for gas heated homes)
annual oil savings = 20.9 Gallons/year (for oil heated homes)
annual propane = 31.9 Gallons/year (for propane heated homes)

Notes & References

Note 1. Joe Swift, Northeast Utilities, 2002. Reviewed and updated in April, 2005.

Note 2. ASHRAE degree-day correction. 1989 ASHRAE Handbook Fundamentals 28.2, Fig 1

Revision Number

05

5.5.7 GAS FIRED WATER HEATER

Description of Measure

This measure applies to new high efficiency indirect water heater or on demand natural gas fired tankless water heater.

Method for Calculating Energy Savings

Qualifying high efficiency indirect water heaters must be attached to a natural gas ENERGY STAR® rated boiler.

Qualifying high efficiency on demand natural gas fired tankless water heater must have an Energy Factor (EF) of 0.82 or greater with electric ignition.

Energy Savings:
Average Energy savings = 60.8 CCFs per unit

Baseline Efficiencies from which savings are calculated

Baseline efficiency = 60%

Notes & References

Note 1: ENERGY STAR, www.energystar.gov, Aug 2008
Note 2: Consortium for Energy Efficiency (CEE), www.cee1.org, Sep 2008

Revision Number

02

LOW INCOME

6.1.6 SECURITY

Description of Measure

Energy Efficient outdoor security lighting. The difference between “security lighting” and “outdoor lighting” is that security lighting is controlled to operate throughout the night. Motion controlled lighting or lighting which only operates sporadically is not covered by this definition. Note that when necessary, a lighting measure can be treated as a custom measure.

Method for Calculating Energy Savings

Annual Energy Savings = Δ Watts x Hours x 365/1000

Where:

Δ Watts = 2.5 x fixture wattage (3.5 equivalent wattage conversion factor). See Note 1.
Hours = 12 hours per day (Note 2)
365 = days per year

For example, the annual savings for a 13 watt security fixture:
Annual kWh = 2.5 x 13 watts x 12 hours/day x 365 days / 1000 = 142 kWh

Security Light (overnight use) Light Savings		
Fixture Wattage	**Wattage Equivalent**	**Annual kWh Savings**
9.0	31.5	99
13.0	45.5	142
17.0	59.5	186
20.0	70.0	219
23.0	80.5	252
27.0	94.5	296
30.0	105.0	329
39.0	136.5	427

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peak demand savings:

Summer Coincident Peak Gross Savings = CF_S x Δ Watts
Winter Coincident Seasonal Peak Gross Savings = CF_W x Δ Watts

Where :

CF = Average (Summer or Winter) Seasonal Peak Coincidence Factor.

CFs = 0%
CFw= 26% (Table 1.1.3)

Annual Net kW Savings = Gross kW Savings x Net Realization Rate (Table 1.3C)

Note that summer or winter demand net realization rate should be used as applicable.

The winter coincidence factor is conservatively low since data specific to this application does not exist.

Baseline Efficiencies from which savings are calculated

Incandescent fixture with a wattage equal to 3.5 times the wattage of the efficient fluorescent fixture and identical usage patterns.

Compliance Efficiency from which incentives are calculated

Energy Star hard-wired fixture with equivalent lumen output and usage pattern.

Operating Hours

12 hours per day (overnight).

Incremental Cost

$10.

Non-Electric Benefits - Annual O&M Cost Adjustments

$14.00 (one-time benefit per fixture). Estimate based on cost of incandescent bulbs that would be used.

Notes & References

Note 1. Northeast Utilities estimate, Joe Swift, April 2005.

Note 2. Hours of use is an estimate based on various recent evaluation work including: *CFL Metering Study*, (California), KEMA Inc. 2005.

Revision Number

04

6.1.7 LIGHTING CUSTOM

Description of Measure

A custom project is defined as a project for which accurate savings can not be determined through the existing defined measures. In order for a lighting project to be considered as a “custom lighting” measure, there must be very strong and documented evidence that the current savings algorithms are clearly not appropriate to use. Keep in mind that our current savings assumptions are based on average values derived from a wide range of sample points. Therefore, a lighting measure should not be considered custom simply because the expected savings does not e*xactly* match the defined savings. The fact is that most lighting projects if evaluated on an individual basis would not match the calculated savings exactly, but when looked at collectively, the savings results should be reasonably accurate. Instead, a lighting project should be custom if it clearly exhibits outlier type behavior which would clearly make the existing savings algorithms inappropriate to use and that the existing savings assumptions would produce an error of unacceptable magnitude. Obviously, this involves some level of judgment, and some consideration should be placed on the size of the project and the expected magnitude of the change in savings before a project is defined as custom.

For instance, a large lighting project involves replacing hallway lights in a large multi-unit complex that are on 24 hours per day. Our current assumption for indoor lighting is 3.2 hours per day, but it is known that the sample that this number was based on only included main living areas and did not include common areas. Therefore, it would be appropriate to calculate the savings based on the known (actual) parameters. On the other hand, a single light bulb installed in an outdoor fixture which is kept on overnight by use of a timer would not be considered a custom lighting project even though it’s daily hours of use greatly exceed the “average value” that we use in our planning assumptions because presumably this type of usage (bulbs used in outdoor fixtures) would already be reflected in the average values that we use to calculate savings.

For custom lighting measures, the energy and demand savings should be documented by a third party and reviewed by a staff person.

Method for Calculating Energy Savings

Annual Energy Savings = Δ Watts x Hours x 365/1000

> Δ Watts = the difference between the baseline wattage and final wattage.
> Hours = daily hours of use
>
> Both of these variables (and any other factors used to determine energy savings) should be documented.

Method for Calculating Demand Savings

The following formulas are used to calculate the Seasonal Peaks (Note 1):

Summer Coincident Peak Savings = 0.088 x Δ Watts
Winter Coincident Seasonal Peak Savings = 0.264 x Δ Watts

Baseline Efficiencies from which savings are calculated

The previous (to program intervention) light source.

Compliance Efficiency from which incentives are calculated

The installed (as a result of the program) light source.

Operating Hours

Measured on site.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-electric benefits have not been identified for this measure.

Notes & References

Note 1: Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007.

Revision Number

03

6.2.1 DUCT INSULATION

Description of Measure

Insulation installed on heating ducts in unconditioned space (either attic or unconditioned basement).

Method for Calculating Energy Savings

Engineering estimates (Note 1) were made based on expected operating conditions of residential mechanical systems in this climate. There are four different scenarios modeled: (1) supply duct located in unconditioned basement, (2) return ducts located in unconditioned basement, (3) supply ducts located in the (unheated) attic and, (4) return ducts located in the (unheated) attic. Heating and cooling (for homes with central cooling) savings are presented here:

Annual Energy Savings

	Heating (MBtu)	kWh (Cooling)
Supply Basement	23.4	106
Return Basement	0.4	51
Supply Attic	29.6	482
Return Attic	8.0	264
Average Savings (all)	**15.3**	**225.6**

Expected Annual savings per 100 square feet of duct that is insulated. Note that the cooling savings is only for homes with central air that use the same duct system.

Method for Calculating Demand Savings

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000
Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:
PF_S = 1.70 Watts/kWh (Cooling)
PF_W = 0.553 Watts/kWh (Elect Heating)
Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Baseline Efficiencies from which savings are calculated

Ducts without insulation.

Compliance Efficiency from which incentives are calculated

Ducts insulated to R-6 or better. Duct insulation should not be compressed so that it achieves its rated R-value.

Total Cost

Actual cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

The heating savings (above) can be converted to appropriate fossil fuel units of measure:

Annual Energy Savings

	Heating (MBtu)	Gallons Oil	Therms Gas	Gallons Propane
Supply Basement	23.4	166.8	233.6	255.3
Return Basement	0.4	2.5	3.6	3.9
Supply Attic	29.6	211.7	296.4	324.0
Return Attic	8.0	57.1	79.9	87.3
Average Savings (all)	**15.3**	**109.6**	**153.4**	**167.6**

Expected Annual savings per 100 square feet of duct that is insulated. Estimated savings values are take into account average expected system efficiency of 75%.

Notes & References

Note 1: Analysis by Joe Swift, Northeast Utilities, 2005.
Calculation updated using 3EPlus software, 2009.

Revision Number

05

6.2.3 PIPE INSULATION

Description of Measure

Pipe insulation installed on hot water pipes in unconditioned basements.

Method for Calculating Energy Savings

Savings for hot water pipes (from an electric resistance source), annual savings is estimated at based on pipe size in table below. The savings values are for 10 linear of hot pipe in unconditioned space.

Pipe Insulation Annual Electrical Savings	
Pipe Diameter (inches)	Savings (kWh)
0.50	55
0.75	72
1.00	90
1.25	107
1.50	122

Method for Calculating Demand Savings

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.0944 Watts/kWh

PF_W = 0.1389 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

Actual cost OR $10 ($1 per foot) assumed installed cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

There is fossil fuel savings for hot pipes with a fossil fuel source. Savings values by diameter for 10 linear feet of insulation are presented in the following table:

Pipe Insulation Annual Fossil Fuel Savings			
Pipe Diameter (inches)	Oil (Gallons)	Gas (therms)	Propane (Gallons)
0.50	1.7	1.2	1.3
0.75	2.2	1.6	1.7
1.00	2.7	2.0	2.2
1.25	3.3	2.3	2.6
1.50	3.7	2.7	3.0

Annual savings per 10 linear feet of hot pipe.

Notes & References

Savings calculation by Joe Swift, Northeast Utilities, 2003 and updated in 2005.

Revision Number

06

6.2.6 HVAC SYSTEM CUSTOM

Description of Measure

Replacement of an old inefficient HVAC system (or component) such as a fossil-fuel furnace, boiler, heat pump or air conditioner (window, sleeve or central).

Method for Calculating Energy Savings

This is a custom measure, therefore savings is estimated based on actual before and after conditions. Savings estimates should be documented and reviewed by program staff. Default savings values presented in other measures within this document may also be used when applicable. Since this is an early retirement measure, savings is a step function based on the savings from the removal of the old equipment plus the savings from installing an efficient piece of new equipment.

Method for Calculating Demand Savings

Demand savings shall be determined on a case basis. Method for determining demand savings shall be consistent with other measures within this document when applicable.

Baseline Efficiencies from which savings are calculated

Existing mechanical system or component which meets the following criteria:

1) The existing equipment is being used as the primary source of heating and/or cooling.

2) The existing equipment is in good operating condition and can be expected to be in use in the same location for at least 5 more years if not for program intervention. The inverse of this holds true also: the existing equipment is being replaced because of program intervention and would not have been replaced at this time without intervention or influence from the program.

3) The new unit is sufficiently more efficient to insure that the savings will justify the cost, that the benefit-cost test will be greater than 1, and the measure passes any other applicable benefit/cost screening.

Compliance Efficiency from which incentives are calculated

Newly installed system meeting Energy Star or other appropriate high performance efficiency standard.

Operating Hours

Assumed to be 500 per year for cooling and 1500 per year for heating. See notes 1 and 2 below.

Total Cost

Actual Cost (preferable) or -

- $3,000 as a default for heating systems or central air/heat pump systems
  Note that since this is an early retirement measure, adjustments are made to the cost within the program screening model to account for the deferral of future replacements.

Non-Electric Benefits - Annual Fossil Fuel Savings

Default savings estimates for fossil fuel are presented below.

Fossil fuel savings for Boiler:

Input (existing size) Assumed to be 100,000Btu/h									
		Savings (MBtu) for furnaces or boilers with tankless coils							
	New	**80%**	**82%**	**84%**	**86%**	**88%**	**90%**	**92%**	**92%**
Existing	**50%**	52.7	54.8	56.8	58.8	60.6	62.4	64.1	64.1
	55%	39.9	42.0	44.1	46.0	47.9	49.6	51.3	51.3
	60%	29.3	31.4	33.4	35.4	37.2	39.0	40.7	40.7
	65%	20.3	22.4	24.4	26.4	28.2	30.0	31.7	31.7
	70%	12.5	14.7	16.7	18.7	20.5	22.3	24.0	24.0

Notes & References

Note 1: 500 full load cooling hours is an estimate for Connecticut and is conservatively lower than 600 hours estimated by ARI.

Note 2: 1500 full load heating hours is an estimate for Connecticut and is conservatively lower than the 2500 hours estimated by ARI.

Revision Number

04

6.4.1 ELECTRICAL OUTLET GASKETS

Description of Measure

Outlet gasket placed on exterior wall OR wall that communicates directly with unconditioned space. Savings from this measure shall only be claimed if a blower door test is not feasible.

Method for Calculating Energy Savings

Annual gross energy savings per outlet cover (for homes with electric heat):

Electric resistance savings = 14 kWh (note 1)
Heat Pump savings = 7 kWh

Annual Net Energy Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

The above default values should be used only if Blower Door (refer to section 5.4.4) testing is not possible or practical. Savings estimates based on actual measured infiltration reduction (through blower door testing) are more precise.

Method for Calculating Demand Savings

Demand savings for electrically heated homes

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.00 Watts/kWh

PF_W = 0.553 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

Actual cost OR $2.50 assumed installed cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating. The savings for other types of fuel can be calculated from the electric savings value.

Annual fossil fuel savings = $$\frac{14\,{}^{kWh}\!/_{yr} \times 3413\,{}^{Btu}\!/_{kWh}}{75\%} = 63{,}709\,Btu/yr$$

Where, 3413 converts from kWh to Btu
75% is the assumed system efficiency including distribution loss.

Therefore,

Savings (per gasket) = 0.064 MBtu
Annual gas savings = 0.64 Therms/year (for gas heated homes)
Annual oil savings = 0.46 Gallons/year (for oil heated homes)
Annual propane = 0.71 Gallons/year (for propane heated homes)

Notes & References

Note 1: Savings calculated by Joe Swift, Northeast Utilities, 2005.

Revision Number

07

6.4.2 DOOR SWEEP

Description of Measure

Door sweep installed on exterior door. Savings from this measure shall only be claimed if a blower door test is not feasible.

Method for Calculating Energy Savings

Annual gross energy savings (for homes with electric heat):

Electric resistance savings = 132 kWh (note 1)
Heat Pump savings = 66 kWh

Annual Net Energy Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

Demand savings for electrically heated homes

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.00 Watts/kWh

PF_W = 0.553 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

Actual cost or $15 assumed installed cost.

<u>Non-Electric Benefits - Annual Fossil Fuel Savings</u>

Non-Electric savings would occur for homes that have a non-electric source of heating.

Annual fossil fuel savings = $\dfrac{132 \, {}^{kWh}\!/\!_{yr} \times 3413 \, {}^{Btu}\!/\!_{kWh}}{75\%} = 600{,}688 \, Btu/yr$

Where, 3413 converts from kWh to Btu
75% is the assumed system efficiency including distribution loss.

Therefore,
Savings (per door sweep) = 0.60 MBtu
Annual gas savings = 6.0 Therms/year (for gas heated homes)
Annual oil savings = 4.3 Gallons/year (for oil heated homes)
Annual propane = 6.6 Gallons/year (for propane heated homes)

<u>Notes & References</u>

Note 1: Savings estimate from NU Low Income Tracking system (2005). Reviewed by Joe Swift, Northeast Utilities and deemed appropriate.

<u>Revision Number</u>

06

6.4.3 DOOR KIT

Description of Measure

Installation of a door kit to reduce infiltration. Savings from this measure shall only be claimed if a blower door test is not feasible.

Method for Calculating Energy Savings

Savings assumed to be the same as the savings for a door sweep (Measure 6.4.2).

Annual gross energy savings (for homes with electric heat):

Electric resistance savings = 132 kWh
Heat Pump savings = 66 kWh

Annual Net Energy Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

Demand savings for electrically heated homes

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.00 Watts/kWh

PF_W = 0.553 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

Actual cost OR $20 assumed installed cost.

<u>Non-Electric Benefits - Annual Fossil Fuel Savings</u>

Non-Electric savings would occur for homes that have a non-electric source of heating.

Annual fossil fuel savings = $$\frac{132\,{}^{kWh}\!/_{yr} \times 3413\,{}^{Btu}\!/_{kWh}}{75\%} = 600{,}688\,Btu/yr$$

Where, 3413 converts from kWh to Btu
75% is the assumed system efficiency including distribution loss.

Therefore,
Savings (per door sweep) = 0.60 MBtu (75% heating efficiency assumed)
Annual gas savings = 6.0 Therms/year (for gas heated homes)
Annual oil savings = 4.3 Gallons/year (for oil heated homes)
Annual propane = 6.6 Gallons/year (for propane heated homes)

<u>Revision Number</u>

05

6.4.5 CAULKING & SEALING

Description of Measure

Caulking or sealing of linear cracks in building shell for the purpose of reducing infiltration. Caulking or sealing for the purpose of controlling moisture does not qualify unless there is documented evidence that infiltration is being reduced. Examples of this measure would include caulking under the baseboard on exterior walls, or the use of caulk to air-seal recessed lights. Sealing a roof or installing flashing on the exterior of a building would not qualify since the purpose of this measure would be to control moisture and it would have very little effect on infiltration. To reduce the chance of gaming, savings (infiltration reductions) achieved through this measure should be verified through the use of a blower door with the blower door results taking precedence of the savings values presented here.

Method for Calculating Energy Savings

Engineering estimate was used to calculate expected amount of savings based on 10 linear feet of sealing (Note 1).

Annual Savings (for homes with electric heat):

Electric resistance savings = 74 kWh per 10 linear feet
Heat Pump savings = 37 kWh per 10 linear feet.

Method for Calculating Demand Savings

Demand savings for electrically heated homes
Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.00 Watts/kWh

PF_W = 0.553 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

$50 per person-hour plus materials or actual cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating.

> Savings (per 10 linear feet of caulk) = 0.34 MBtu (75% heating efficiency assumed)
> Annual gas savings = 3.4 Therms/year (for gas heated homes)
> Annual oil savings = 2.4 Gallons/year (for oil heated homes)
> Annual propane = 3.8 Gallons/year (for propane heated homes)

Notes & References

Note 1. Estimate by Joe Swift, Northeast Utilities, 2005.

Revision Number

05

6.4.6 POLYETHYLENE TAPE

Description of Measure

Polyethylene taping of linear cracks in building shell for the purpose of reducing infiltration. Tape must only be applied to areas that areas where drafts are noticeable in order to qualify for savings. Similar to caulking, the savings for this measure should be verified with a blower door (see blower door savings 6.4.14) with the blower door savings taking over-riding the savings values presented here.

Method for Calculating Energy Savings

Engineering estimate was used to calculate expected amount of savings based on 10 linear feet of sealing (Note 1).

Annual Savings (for homes with electric heat):

Electric resistance savings = 74 kWh per 10 linear feet
Heat Pump savings = 37 kWh kWh per 10 linear feet.

The above default values should be used only if Blower Door (refer to section 5.4.4) testing is not possible or practical. Savings estimates based on actual measured infiltration reduction (through blower door testing) are more precise.

Method for Calculating Demand Savings

Demand savings for electrically heated homes
Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.00 Watts/kWh

PF_W = 0.553 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

$50 per person-hour plus materials or actual cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating.

Savings (per 10 linear feet of caulk) = 0.34 MBtu (75% heating efficiency assumed)
Annual gas savings = 3.4 Therms/year (for gas heated homes)
Annual oil savings = 2.4 Gallons/year (for oil heated homes)
Annual propane = 3.8 Gallons/year (for propane heated homes)

Notes & References

Note 1. Joe Swift, Northeast Utilities, 2005.

Revision Number

06

6.4.7 WEATHERSTRIP WINDOW

Description of Measure

Weatherstrip installed on a window. Savings from this measure shall only be claimed if a blower door test is not feasible.

Method for Calculating Energy Savings

Annual gross energy savings (for homes with electric heat):

Electric resistance savings = 70 kWh (note 1)
Heat Pump savings = 35

Annual Net Energy Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

Demand savings for electrically heated homes
Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.00 Watts/kWh

PF_W = 0.553 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

Actual cost or $7.15 assumed installed cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating. The savings for other types of fuel can be calculated from the electric savings value.

Annual fossil fuel savings = 70 kWh/year x 3413 Btu/kwh / 75% = 318,547 Btu/year

where: 3413 converts from kWh to Btu
75% is the assumed system efficiency including distribution loss.

Therefore,
annual gas savings = 3.2 Therms/year (for gas heated homes)
annual oil savings = 2.3 Gallons/year (for oil heated homes)
annual propane = 3.5 Gallons/year (for propane heated homes)

Notes & References

Note 1: Savings estimate from NU Low Income Tracking system (2005). Reviewed by Joe Swift, Northeast Utilities and deemed appropriate.

Revision Number

07

6.4.8 WEATHERSTRIP DOOR

Description of Measure

Weatherstrip installed on exterior door. Savings from this measure shall only be claimed if a blower door test is not feasible.

Method for Calculating Energy Savings

Annual gross energy savings (for homes with electric heat):

Electric resistance savings = 120 kWh (note 1)
Heat Pump savings = 60 kWh

Annual Net Energy Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

The above default values should be used only if Blower Door (refer to section 5.4.4) testing is not possible or practical. Savings estimates based on actual measured infiltration reduction (through blower door testing) are more precise.

Method for Calculating Demand Savings

Demand savings for electrically heated homes

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.00 Watts/kWh

PF_W = 0.553 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

Actual cost or $25 assumed installed cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating. The savings for other types of fuel can be calculated from the electric savings value.

Annual fossil fuel savings = 120 kWh/year x 3413 Btu/kwh / 75% = 546,080 Btu/year

where: 3413 converts from kWh to Btu
75% is the assumed system efficiency including distribution loss.

Therefore,
annual gas savings = 5.5 Therms/year (for gas heated homes)
annual oil savings = 3.9 Gallons/year (for oil heated homes)
annual propane = 6.1 Gallons/year (for propane heated homes)

Notes & References

Note 1: Savings estimate from NU Low Income Tracking system (2005). Reviewed by Joe Swift, Northeast Utilities and deemed appropriate.

Revision Number

05

6.4.9 INSULATE ATTIC HATCH

Description of Measure

Insulation and weather stripping applied to an attic hatch (approximately 6 square feet assumed).

Method for Calculating Energy Savings

Btu Annual Savings = (Conductive savings) + (Infiltration savings)

1) **Conductive Savings** = $(1/R_{existing} - 1/R_{New})$ x Degree Days x 24 x Adjustment x Area

where: $R_{existing}$ is the R-value of the current hatch, assumed to be 1.0
R_{New} is the upgraded (with pane) R-value, assumed to be 20
Degree days = 6200 assumed state average
Adjustment = 0.64 ASHRAE adjustment factor (note 1)
Area = size of attic hatch in square feet, assumed to be 6.

Annual Btu conductive saving = 542,882 Btu

2) **Infiltration Savings** = 600,000 Btu estimated based on geometry of opening (Note 2).

Total Btu savings 1,143,000 *(rounded)*

Therefore, Annual Savings (for homes with electric heat):
Electric resistance savings = 335 kWh
Heat Pump savings = 167 kWh

Method for Calculating Demand Savings

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.00 Watts/kWh

PF_W = 0.553 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

Actual cost or $40 assumed installed cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating.

Annual fossil fuel savings = MMBtu savings / system efficiency

Where, MMBtu savings = 1.143
75% is the assumed system efficiency including distribution loss.

Therefore,

Annual gas savings = 11.4 Therms/year (for gas heated homes)
Annual oil savings = 8.2 Gallons/year (for oil heated homes)
Annual propane = 12.7 Gallons/year (for propane heated homes)

Notes & References

Note 1: ASHRAE degree-day correction. 1989 ASHRAE Handbook Fundamentals 28.2, Fig 1
Note 2: Estimate by Joe Swift, Northeast Utilities, 2005.

Revision Number

05

6.4.10 REPAIR WINDOW

Description of Measure

General repair of a window which is expected to produce energy savings (i.e. fix broken pane, caulk, etc.) Savings from this measure shall only be claimed if a blower door test is not feasible.

Method for Calculating Energy Savings

The savings for this measure will vary greatly depending on the condition of the window and type of repair. Therefore, defining an average savings is difficult. Consideration should be given to making this a custom measure (depending on the scope and size of the project). With that said, for the purpose of coming up with a default savings, it is assumed that an average window repair will increase the efficiency to the same magnitude as weather-stripping an average window. Therefore, savings is equal to the savings for weather stripping a window (measure 6.4.7).

Annual Gross Energy Savings

Annual Gross Energy Savings (for homes with electric heat):

Electric resistance savings = 70 kWh (note 1)
Heat Pump savings = 35 kWh (assumed COP of 2.0).

Annual Net Energy Savings = Gross Energy Savings x Energy Net Realization Rate (Table 1.3C)

Method for Calculating Demand Savings

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.00 Watts/kWh

PF_W = 0.553 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

Actual cost or $20 assumed installed cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

Non-Electric savings would occur for homes that have a non-electric source of heating. The savings for other types of fuel can be calculated from the electric savings value.

Annual fossil fuel savings = $$\frac{70\, {}^{kWh}\!/_{yr} \times 3413\, {}^{Btu}\!/_{kWh}}{75\%} = 318{,}547\ Btu/yr$$

Where, 3413 converts from kWh to Btu
75% is the assumed system efficiency including distribution loss.

Therefore,
Annual gas savings = 3.2 Therms/year (for gas heated homes)
Annual oil savings = 2.3 Gallons/year (for oil heated homes)
Annual propane = 3.5 Gallons/year (for propane heated homes)

Revision Number

05

6.4.11 WINDOW UPGRADE

Description of Measure

Installing a storm panel (storm window) on an existing single pane window. Average size assumed to be 12 square feet.

Method for Calculating Energy Savings

Btu Savings = ($U_{existing}$ – U_{New}) x Degree Days x 24 x Adjustment x Area

Where,
$U_{existing}$ is the U-value of the current window, assumed to be 0.89 (Note 1)
U_{New} is the upgraded (with pane) U-value, assumed to be 0.48 (Note 1)
Heating Degree days = 5885 (Note 2)
Adjustment = 0.64 ASHRAE adjustment factor (note 3)
Area = size of window in square feet, assumed to be 12.

Annual Btu saving from above = 444,737 Btu = 0.445 MMBtu

Electric resistance heat, savings = Btu/3413
= 130 kWh

Heat pump savings = Electric resistance heat savings/2 (Assume COP of 2)
= 65 kWh

Method for Calculating Demand Savings

Summer Seasonal Peak kW = (Annual Net Energy Savings x PF_S)/1000

Winter Seasonal Peak kW = (Annual Net Energy Savings x PF_W)/1000

Where:

PF_S = 0.00 Watts/kWh

PF_W = 0.553 Watts/kWh

Note: The Peak Factors (PF) are based on CL&P load research data.

United Illuminating currently does not claim demand savings from this measure.

Total Cost

Actual cost or $50 assumed installed cost.

<u>Non-Electric Benefits - Annual Fossil Fuel Savings</u>

Non-Electric savings would occur for homes that have a non-electric source of heating.

Annual fossil fuel savings = MMBtu savings / system efficiency

Where, MMBtu savings = 0.445
75% is the assumed system efficiency including distribution loss.

Therefore,
Annual savings = 0.59 MMBtu
Annual gas savings = 5.9 Therms/year (for gas heated homes)
Annual oil savings = 4.2 Gallons/year (for oil heated homes)
Annual propane = 6.5 Gallons/year (for propane heated homes)

<u>Notes & References</u>

Note 1. 2005 ASHRAE Handbook Fundamentals Chapter 31. Assume Existing is 1/8" single glazing, wood/vinyl. Assume retrofit is double glazing, ½" air space, wood/vinyl.

Note 2, National Climatic Data Center 30 year average for CT.

Note 3. ASHRAE degree-day correction. 1989 ASHRAE Handbook Fundamentals 28.2, Fig 1

<u>Revision Number</u>

05

6.4.15 WEATHERIZATION (CUSTOM MEASURE)

Description of Measure

A custom project is defined as a project for which accurate savings can not be determined through the existing defined measures. In order for a lighting project to be considered as “custom”, it includes measures that are NOT defined in this manual, or there must be very strong and documented evidence that the current savings algorithms in this manual are clearly not appropriate to use.

For instance, foam insulation may be used to insulate and seal the attic of a house and the ducts within that space. In this case, the foam is performing many functions (insulating and sealing both attic and ducts) and the savings from this project would not be equal to the sum of its parts. One acceptable option would be to model this home using a home energy software and calculate the savings based on the foam “package”.

Method for Calculating Energy Savings

The energy savings for custom projects is determined and documented on a case-by-case basis using commonly accepted engineering estimating techniques, approved energy simulation software, or through actual metering.

Method for Calculating Demand Savings

The summer and winter demand savings for custom projects is determined and documented on a case-by-case basis using commonly accepted engineering estimating techniques, approved energy simulation software, or through actual metering.

Total Cost

Actual Cost.

Non-Electric Benefits - Annual Fossil Fuel Savings

Since the majority of homes are heated with fossil fuel, fossil fuel heating savings will be a likely result of most weatherization measures.

Revision Number

04

APPENDIX

7.1.1 TABLE 1.1 PEAK FACTORS

Table 1.1.1 C&I Seasonal Peak Coincidence Factors

Default Commercial and Industrial Seasonal Peak Coincidence Factors
(at meter without line losses)

Use this Table to determine demand (kW) savings during summer and winter seasonal peak hours.

$$CF\_summer = \frac{kWh\_saved\_during\_the\_seasonal\_peak\_hours\_(90\%\_of\_the\_50/50\_peak\_forecast)\_June\_Aug}{(number\_of\_hours)*connected\_load(nameplate\_kW)}$$

$$CF\_winter = \frac{kWh\_saved\_during\_the\_seasonal\_peak\_hours\_(90\%\_of\_the\_50/50\_peak\_forecast)\_Dec\_Jan}{(number\_of\_hours)*connected\_load(nameplate\_kW)}$$

	HVAC							**Refrigeration**
	Unitary AC (Not chillers)	Variable Frequency Drives			Heating	Efficient Motors		SBEA
		Pumps	Fans	All		Cooling	Heating	
		Avg of cooling and other	Avg of Air Handler Unit and Cooling tower					
Summer	0.82	0.55	0.28	0.44		0.73		0.1
			AHU only					
Winter		0.43	0.44	0.36	*	0.60	0.8	0.1

* Specific to each measure

Lighting Summer Seasonal Peak Hours (90% of 50/50 Peak Forecast) Without Occupancy Sensors	
Sector Type	**Coincidence Factor**
Grocery	0.90
Manufacturing	0.67
Medical (Hospital)	0.74
Office	0.70
Other	0.48
Restaurant	0.78
Retail	0.80
University/College	0.65
Warehouse	0.73
School	0.60
Total Equal Weight by Sector	0.70

Lighting Winter Seasonal Peak Hours (90% of 50/50 Peak Forecast) **Without Occupancy Sensors**	
Sector Type	**Coincidence Factor**
Grocery	0.77
Manufacturing	0.43
Medical (Hospital)	0.62
Office	0.54
Other	0.43
Restaurant	0.64
Retail	0.65
University/College	0.53
Warehouse	0.54
School	0.38
Total Equal Weight by Sector	0.55

Lighting Summer Seasonal Peak Hours (90% of 50/50 Peak) **With Occupancy Sensors**	
Sector Type	**Coincidence Factor**
Manufacturing	0.20
Medical	0.24
Office	0.27
Other	0.02
University/College	0.28
Warehouse	0.25
School	0.21
Total Equal Weight by Sector	0.15

Lighting Winter Seasonal Peak Hours (90% of 50/50 Peak) **With Occupancy Sensors**	
Sector Type	**Coincidence Factor**
Manufacturing	0.17
Medical	0.22
Office	0.30
Other	0.07
University/College	0.23
Warehouse	0.18
School	0.16
Total Equal Weight by Sector	0.13

Table 1.1.2 (Deleted)

Table 1.1.3 Residential Seasonal Peak Coincidence Factors (at meter without line losses)

Use these tables to determine demand (kW) savings during summer and winter seasonal peak hours.

Residential Seasonal Peak Coincidence Factors

End Use >>>	Cooling	Heating	Refrig'n	Water Heating
Summer	Central = 0.75		0.3	0.1
	Window = 0.303			
Winter	0	0.5	0.21	0.15

Lighting Summer Seasonal Peak Hours (90% of 50/50 Peak Forecast)	
Sector Type	**Coincidence Factor**
June	0.08
July	0.09
August	0.10
Average Summer	0.09

Lighting Winter Seasonal Peak Hours (90% of 50/50 Peak Forecast)	
Sector Type	**Coincidence Factor**
December	0.25
January	0.28
Average Winter	0.26

Calculating Peak Day savings for gas measures

Natural gas peak day usage is driven by the heating load; thus peak day savings is the savings associated with conservation measures that takes place during the coldest continuous 24 hour period of the year.

The methodology for peak day savings estimating for natural gas efficiency measures is summarized below:

1) **Residential space heating efficiency upgrades**: Since energy savings correlate directly to outside air temperatures, the demand savings for residential space heating measures is estimated based on as a percentage (0.977%) of annual savings The 0.977% factor is based on Bradley Airport peak degree day average (58.5) of the last thirty years divided by the average heating degree days (5,990) for the last thirty years. (note 1)

Peak Day savings (residential heating) = 0.00977 x annual heating savings

2) **Residential gas water heating:** The peak day savings are estimated by estimating the percent of hot water consumption during the peak day. This is done by multiplying the annual savings associate with a hot water measure by 0.310%. This factor is based on water heating load constant over the year and the difference in service water temperature throughout the year. Based on the DOE-2 typical meteorological year (TMY) for Hartford the January (coldest month) service water

temperature is 40 degrees and average is 54 degrees. Assumed hot water set point is 130 degrees. Therefore,

$$\text{Peak Factor} = \frac{(1\ \text{day}) \times (130\ \text{degrees} - 44\ \text{degrees})}{(365\ \text{Days}) \times (130\ \text{degrees} - 54\ \text{degrees})} = 0.00310$$

Peak Day savings (residential water) = 0.00310 x annual water heating savings

3) **Measures with savings daily constant saving:** An example would be a process heating measure. For these measures the peak day savings will be estimated by dividing the annual savings by 365 days per year.

   Peak Day Savings = annual savings / 365 days per year

4) **Custom measures:** Measures that are not weather dependent, nor have consistent savings from day to day or are analyzed with a more detailed analysis tool such as the hourly DOE-2 program will be analyzed on a case by case basis. For example a complex boiler replacement or controls measure might be modeled using DOE-2. In this case hourly building simulation can calculate the savings for the peak day based on (TMY) data used in the program. These measures are typically analyzed by a third party consultant and reviewed for reasonableness.

References:

2005 Coincident Factor Study for UI & CL&P by RLW, January 2007

Coincidence Factor Study Residential and Commercial Industrial Lighting Measures by RLW, Spring 2007

7.1.2 TABLE 1.2 LOAD SHAPES

Table 1.2: Load Shapes by end use and sector.

Load Shape	Winter Peak Energy %	Winter Off-Peak Energy %	Summer Peak Energy %	Summer Off-Peak Energy %
End Use	**Residential**			
Cooling	5.0%	5.0%	65.0%	25.0%
Heating	55.0%	30.0%	5.0%	10.0%
Lighting	30.0%	40.0%	10.0%	20.0%
Refrigeration	30.0%	30.0%	20.0%	20.0%
Water Heating	30.0%	30.0%	20.0%	20.0%
	Commercial & Industrial			
Cooling	3.0%	2.0%	80.0%	15.0%
Heating	60.0%	35.0%	5.0%	0.0%
Lighting	50.0%	10.0%	30.0%	10.0%
Refrigeration	30.0%	30.0%	20.0%	20.0%
Other	50.0%	10.0%	30.0%	10.0%
Motors	50.0%	10.0%	30.0%	10.0%
Process	50.0%	10.0%	30.0%	10.0%

Winter is defined as October – May
Summer is defined as June – September
Peak is defined as 6:00 AM – 11:00 PM weekdays (no holidays)
Off-peak is defined 11:00 PM to 6:00 AM, plus all weekend and holiday hours.

7.1.3 TABLE 1.3 REALIZATION RATES

Table 1.3A: C & I Realization Rates – CL&P

Commercial and Industrial Realization Rates used in CL&P Programs

	Gross Realization %					Net Realization %		
End-use	**kWh**	**Winter Seasonal Peak kW**	**Summer Seasonal Peak kW**	**Free-ridership %**	**Spillover %**	**kWh**	**Winter Seasonal Peak kW**	**Summer Seasonal Peak kW**
Energy Conscious Blueprint								
Cooling	97.8 %	97.8 %	97.8 %	16.6 %	0.2 %	**81.8 %**	**81.8 %**	**81.8 %**
Heating	117.7 %	117.7 %	117.7 %	8.3 %	4.1 %	**112.8 %**	**112.8 %**	**112.8 %**
Lighting	112.3 %	112.3 %	112.3 %	24.4 %	1.4 %	**86.5 %**	**86.5 %**	**86.5 %**
Motors	83.9 %	83.9 %	83.9 %	42.1 %	0.7 %	**49.2 %**	**49.2 %**	**49.2 %**
Other	83.9 %	83.9 %	83.9 %	55.2 %	7.1 %	**43.5 %**	**43.5 %**	**43.5 %**
Process	100.9 %	100.9 %	100.9 %	15.3 %	4.4 %	**89.9 %**	**89.9 %**	**89.9 %**
Refrigeration	68.1 %	68.1 %	68.1 %	7.3 %	54.9 %	**100.5 %**	**100.5 %**	**100.5 %**
Energy Opportunities								
Cooling	88.4 %	88.4 %	88.4 %	2.5 %	0.3 %	**86.5 %**	**86.5 %**	**86.5 %**
Heating	88.4 %	88.4 %	88.4 %	8.7 %	0.0 %	**80.7 %**	**80.7 %**	**80.7 %**
Lighting	97.4 %	97.4 %	97.4 %	6.0 %	4.1 %	**95.5 %**	**95.5 %**	**95.5 %**
Motors	75.8 %	75.8 %	75.8 %	24.9 %	0.0 %	**56.9 %**	**56.9 %**	**56.9 %**
Other	75.8 %	75.8 %	75.8 %	34.3 %	1.0 %	**50.6 %**	**50.6 %**	**50.6 %**
Process	101.5 %	101.5 %	101.5 %	21.0 %	5.3 %	**85.6 %**	**85.6 %**	**85.6 %**
Refrigeration	75.8 %	75.8 %	75.8 %	41.1 %	2.4 %	**46.5 %**	**46.5 %**	**46.5 %**
Demand R	61.0 %	43.0 %	43.0 %	0.0 %	0.0 %	**61.0 %**	**43.0 %**	**43.0 %**
Small Business Energy Advantage								
Cooling	100.0 %	100.0 %	100.0 %	0.8 %	0.0 %	**99.2 %**	**99.2 %**	**99.2 %**
Heating	100.0 %	100.0 %	100.0 %	0.8 %	0.0 %	**99.2 %**	**99.2 %**	**99.2 %**
Lighting	97.8 %	75.5 %	81.0 %	1.6 %	0.1 %	**96.3 %**	**74.4 %**	**79.8 %**
Other	100.0 %	100.0 %	100.0 %	0.8 %	0.0 %	**99.2 %**	**99.2 %**	**99.2 %**
Comp. Air	14.9%	95.3%	95.3%	0.8 %	0.0 %	**14.8 %**	**94.5 %**	**94.5 %**
Refrigeration	106.9 %	20.9 %	17.2 %	0.8 %	0.0 %	**106.0 %**	**20.7 %**	**17.1 %**
O&M								
PRIME	100.0 %	100.0 %	100.0 %	0.0 %	0.0 %	**100.0 %**	**100.0 %**	**100.0 %**
Cooling	88.2 %	88.2 %	88.2 %	12.1 %	0.0 %	**77.5 %**	**77.5 %**	**77.5 %**
Heating	100.0 %	100.0 %	100.0 %	0.0 %	0.0 %	**100.0 %**	**100.0 %**	**100.0 %**
Other	100.0 %	100.0 %	100.0 %	0.0 %	0.0 %	**100.0 %**	**100.0 %**	**100.0 %**
Process	81.8 %	81.8 %	81.8 %	3.1 %	0.0 %	**79.3 %**	**79.3 %**	**79.3 %**
Retro-com	100.0 %	100.0 %	100.0 %	0.0 %	0.0 %	**100.0 %**	**100.0 %**	**100.0 %**
Load Management								
Load Response	100.0 %	100.0 %	100.0 %	0.0 %	0.0 %	**100.0 %**	**100.0 %**	**100.0 %**

References:

Northeast Utilities Impact Evaluation of the Demand Reduction Program,
-RLW Analytics, Inc., Final Report January 2006

Northeast Utilities Custom Services Impact Evaluation 2004 Measure Installations
-RLW Analytics, Inc., Final Report March 2006

Northeast Utilities New Construction Impact Evaluation 2000 Measure Installations
-RLW Analytics, Inc., Final Report December 2002

Northeast Utilities 1999 Express Services Program Impact Evaluation
-PA Consulting Group, Final Report June 2001

Northeast Utilities 1999 O & M Services Program Impact and Process Evaluation
-RLW Analytics, Inc., Final Report October 2001

CL&P 2007 C&I Programs Free-ridership and Spillover,
-PA Consulting Group, October 28, 2008

Connecticut Small Business Energy Advantage Year 2007 Impact Evaluation,
-The Cadmus Group, 4th Draft, July 27, 2009

* Gross realization rates for ECC Other, O&M Other and O&M Heating were reduced to 100.0%

Table 1.3B: C & I Realization Rates - UI

Commercial and Industrial Realization Rates used in UI Programs

	Gross Realization %					**Net Realization %**		
End-use	**kWh**	**Winter Seasonal Peak kW**	**Summer Seasonal Peak kW**	**Free-ridership %**	**Spillover %**	**kWh**	**Winter Seasonal Peak kW**	**Summer Seasonal Peak kW**
Energy Conscious Blueprint								
Lighting	112.3 %	112.3%	112.3%	36.8%	0.7%	**71.8%**	**71.8%**	**71.8%**
Motors	83.9%	83.9%	83.9%	41.0%	0.0%	**49.5%**	**49.5%**	**49.5%**
Cooling Unitary	97.8%	97.8%	97.8%	45.2%	0.0%	**53.6%**	**53.6%**	**53.6%**
Cooling-Other	97.8%	97.8%	97.8%	46.7%	7.4%	**59.4%**	**59.4%**	**59.4%**
Custom, Process & Other	92.4%	92.4%	92.4%	3.9%	34.8%	**121.0 %**	**121.0%**	**121.0%**
VFD's	83.9%	83.9%	83.9%	24.7%	0.0%	**63.2%**	**63.2%**	**63.2%**
Energy Opportunities								
Lighting	97.4%	97.4%	97.4%	17.5%	6.2%	**86.4%**	**86.4%**	**86.4%**
Custom	75.8%	75.8%	75.8%	3.2%	0.5%	**73.8%**	**73.8%**	**73.8%**
Other	75.8%	75.8%	75.8%	0.0%	0.0%	**75.8%**	**75.8%**	**75.8%**
Small Business Energy Advantage								
Lighting	104%	45.5%	66%	6.3%	0.1%	**97.6%**	**42.7%**	**61.9%**
Refrigeration	100%	100%	100%	0.0%	0.0%	**100.0 %**	**100.0%**	**100.0%**
Custom	100%	100%	100%	5.5%	9.4%	**103.9 %**	**103.9%**	**103.9%**

Notes

Net Annual Measure Savings = (Gross Annual Savings) X (Net Realization %)

Net Realization = (Gross Realization) % X (100% - Free-Ridership % + Spillover %)

UI C&I References

1) Not used

2) 2007 C&I Programs (UI) Free-ridership and Spillover, PA Consulting Group, October 28, 2008.

3) Connecticut Small Business Energy Advantage Year 2007 Impact Evaluation, -The Cadmus Group, Final Report, August 24, 2009

4) NU Cust. Services New Construction Impact Eval. 2000 Measure Installation Table Ex 3 Pg 4, RLW Analytics Final Report Dec. 2002. Custom, Process and Other are the average of CL&P's Other and Process for ECB.

5) NU Custom services Impact Evaluation 2004 Measure Installations, Table Ex1 Pg 1, RLW Analytics Final Report March 2006.

Table 1.3C: Residential Realization Rates – CL&P and UI

Residential Realization Rates used in the listed CL&P and UI Programs

		Gross Realization %						Net Realization %		
Measure	Program	kWh	Winter Seasonal Peak kW	Summer Seasonal Peak kW	Free Ridership %	Spillover %	Installation Rate %	kWh	Winter Seasona l Peak kW	Summer Seasonal Peak kW
5.3.1*	General Service CFL Bulbs	100.0%	100.0%	100.0%	9.2%	15.0%	76.6%	81.0%	81.0%	81.0%
5.3.2	Portable Lamps (N/A Low Income)	100.0%	100.0%	100.0%	3.1%	6.0%	70.0%	72.0%	72.0%	72.0%
5.3.3	Torchiere (N/A Low Income)	100.0%	100.0%	100.0%	3.1%	6.0%	70.0%	72.0%	72.0%	72.0%
5.3.4	Fixture (Hard Wired)	100.0%	100.0%	100.0%	3.1%	6.0%	80.0%	82.3%	82.3%	82.3%
5.3.5	Ceiling Fan & Lights	100.0%	100.0%	100.0%	3.1%	6.0%	80.0%	82.3%	82.3%	82.3%
5.3.15*	Non-General Service CFL Bulbs	100.0%	100.0%	100.0%	9.2%	15.0%	76.6%	81.0%	81.0%	81.0%
N/A	CFL Giveaway Programs	100.0%	100.0%	100.0%	9.2%	15.0%	76.6%	81.0%	81.0%	81.0%

Net Annual Measure Savings = (Gross Annual Savings) X (Net Realization %)

Net Realization = (Gross Realization) % X (100% - Free-Ridership % + Spillover %) X (Installation Rate) %

Residential measures not specified in Table 1.3C have an assumed realization rate of 100%. Efficiency baselines for appliances have changed and therefore data does not exist for these measures.

*Retail product CFL program will be evaluated in 2010. It is anticipated that the Net Realization Rate will decrease as a result of this evaluation.

References

1) Not Used

2) Point of purchase lighting impact evaluation, RLW, 2003

3) Residential Lighting Markdown Impact Evaluation, NMR, January 20, 2009.

7.1.4 TABLE 1.4 LIFETIMES

Table 1.4 Lifetimes
Measure Life
includes equipment life and measure persistence (not savings persistence).
• Equipment Life means the number of years that a measure is installed and will operate until failure, and
• Measure Persistence takes into account business turnover, early retirement of installed equipment, and other reasons measures might be removed or discontinued.

For retrofit/early retirement programs, the measure life will take into account both the expected remaining life of the measure being replaced and the expected changes in baselines over time.

Commercial and Industrial Measures

Description	Retrofit	Lost Opportunity	Operations	Maintenance	RCx
Lighting Systems, including					
Fixtures	13	15	N/A	N/A	N/A
Lamp and Ballast Conversions	13	N/A	N/A	N/A	N/A
Remove Unnecessary Lighting Fixtures	5	N/A	N/A	N/A	N/A
Sweep Controls / EMS Based Controls	10	15*	N/A	N/A	N/A
Occupancy Sensors	9	10*	N/A	N/A	N/A
Automatic Photocell Dimming Systems	9	10	N/A	N/A	N/A
Recircuiting and New Controls	10	N/A	N/A	N/A	N/A
Bi-Level Switching (Demand Reduction)	10	10*	N/A	N/A	N/A
Timer Switch	10	N/A	N/A	N/A	N/A
Reprogramming of EMS Controls	N/A	N/A	5	N/A	8
Fluorescent Lighting system power reduction controls	9	N/A	N/A	N/A	N/A
Building Envelope					
Insulation	25	25	N/A	N/A	N/A
New Windows	N/A	20	N/A	N/A	N/A
Window Film	10	10	N/A	N/A	N/A
Movable Window Insulation	10	10	N/A	N/A	N/A
Roof Spray Cooling	15	15	N/A	N/A	N/A
Cool Roofs	N/A	15	N/A	N/A	N/A
Domestic Hot Water					
Heat Pump Water Heater	12	12	N/A	N/A	N/A
Point-of-Use Water Heater	12	12	N/A	N/A	N/A
Solar Water Heater	20	20	N/A	N/A	N/A
Heat Recovery	15	15	N/A	N/A	N/A
Energy-Efficient Motors	15	20	N/A	N/A	N/A
Heating, Ventilating and Air Condition (HVAC) Systems					
Energy-Efficient Motors	15	20	N/A	N/A	N/A
Variable Speed Drives	13	15	N/A	N/A	N/A
High-Efficiency Unitary Equipment (A/C and Heat Pumps)	13	15	N/A	N/A	N/A

Description	Retrofit	Lost Opportunity	Operations	Maintenance	RCx
Heating, Ventilating and Air Condition (HVAC) Systems (Continued)					
Energy-Efficient Packaged Terminal Units	13	15	N/A	N/A	N/A
Dehumidifiers	13	15	N/A	N/A	N/A
Evaporative Cooling	13	15	N/A	N/A	N/A
2-Speed Motor Control in Rooftop units	13	15	N/A	N/A	N/A
Electric Chillers	17	23	N/A	N/A	N/A
Gas Engine Chillers	13	15	N/A	N/A	N/A
Cool Thermal Storage	15	15	N/A	N/A	N/A
Cooling Tower Alternates	13	15	N/A	N/A	N/A
Air Distribution System Modifications & Conversions	20	20	N/A	N/A	N/A
VAV System Components	13	N/A	N/A	N/A	N/A
Plate/Heat Pipe Type Heat Recovery System	18	18	N/A	N/A	N/A
Rotary Type Heat Recovery System	14	14	N/A	N/A	N/A
Economizer - Air/Water	10	13	N/A	N/A	N/A
Low-Leakage Damper	12	12	N/A	5	N/A
Repair Air Side Economizer	N/A	N/A	N/A	5	N/A
Outdoor Air Damper Adjustment or Modification	N/A	N/A	N/A	5	N/A
Make-up Air Unit for Exhaust Hood	15	15	N/A	N/A	N/A
Paddle Type Air Destratification Fan	10	10	N/A	N/A	N/A
Duct Type Air Destratification System	15	15	N/A	N/A	N/A
Air Curtain	15	15	N/A	N/A	N/A
Water/Steam Distribution System Modifications & Conversions	20	20	N/A	N/A	N/A
Zoned Circulator Pump System	15	N/A	N/A	N/A	N/A
Electric Spot Radiant Heat	10	10	N/A	N/A	N/A
Additional Vessel Insulation	10	10	N/A	N/A	N/A
Additional Pipe Insulation	10	10	N/A	N/A	N/A
Repair Steam/Air Leaks	N/A	N/A	N/A	5	N/A
HVAC Controls					
EMS/Linked HVAC Controls	10	15*	N/A	N/A	8
New/Additional EMS Points	10	15	N/A	N/A	N/A
Single Zone Controls NOT Linked to other Controls	10	N/A	N/A	N/A	N/A
Time Clocks	8	N/A	N/A	N/A	N/A
Modify HVAC Controls	10	N/A	N/A	N/A	8
Repair HVAC Controls	N/A	N/A	N/A	5	N/A
Adjust Scheduling	N/A	N/A	5	N/A	6
Reset Setpoints	N/A	N/A	5	N/A	6
Reprogramming of EMS Controls	N/A	N/A	5	N/A	8
Controls to Eliminate Simultaneous Heating and Cooling	10	N/A	5	N/A	8
Demand Control Ventilation - Single Zone	10	10*	N/A	N/A	8
Demand Control Ventilation - Multi Zone	10	10*	N/A	N/A	N/A
Enthalpy Control Economizer	7	10	N/A	N/A	N/A
Upgrade to dual/comparative Enthalpy Economizer	10	10	N/A	N/A	N/A
Refrigeration					
Industrial Refrigeration Systems/Components	20	20	3	N/A	N/A
Commercial Refrigeration Systems/Components	15	15	3	N/A	N/A
Heat Recovery from Refrigeration System	10	13	N/A	N/A	N/A
Refrigeration Controls	10	10	5	N/A	10

Description	Retrofit	Lost Opportunity	Operations	Maintenance	RCx
Refrigeration (Continued)					
Adjust Scheduling	N/A	N/A	5	N/A	8
Reset Setpoints	N/A	N/A	5	N/A	8
Mechanical Subcooling	15	15	N/A	N/A	N/A
Ambient Subcooling	15	15	N/A	N/A	N/A
Auto Cleaning System for Condenser Tubes	10	10	N/A	N/A	N/A
Hot Gas Bypass for Defrost or Regeneration	10	10	N/A	N/A	N/A
Open or Enclosed Display Cases	15	15	N/A	N/A	N/A
Case Cover	5	5	N/A	N/A	N/A
Polyethylele Strip Curtain	3	3	N/A	N/A	N/A
Motorized Insulated Doors	10	10	N/A	N/A	N/A
Oversized Condensers	15	15	N/A	N/A	N/A
Low Case HVAC Returns	10	10	N/A	N/A	N/A
Demineralized Water for Ice	10	10	N/A	N/A	N/A
Low Emissivity Ceiling Surface	15	15	N/A	N/A	N/A
Additional Pipe Insulation - Refrigeration System	10	10	N/A	N/A	N/A
Additional Vessel Insulation - Refirgeration System	10	10	N/A	N/A	N/A
Process Equipment					
Air Compressor	13	15	N/A	N/A	N/A
Refrigerated Air Dryer	13	15	N/A	N/A	N/A
Variable Frequency Drives	13	15	N/A	N/A	N/A
Repair Steam/Compressed Air Leaks	N/A	N/A	N/A	5	N/A
Add Regulator Valves in Compressed Air System	10	10	N/A	N/A	10
Install Air Compressor No-Loss Condenser Drains	10	10	N/A	10	10
Interlock Air System Solenoid Valves with Machine Operation	10	10	N/A	N/A	10
Interlock Exhaust Fans with Machine Operations	10	10	N/A	N/A	10
Injection Molding Machine Jackets	5	N/A	N/A	N/A	N/A
Compressed Air Distribution and Storage Systems	10	N/A	N/A	N/A	N/A
Plastic Injection Molding Machine	13	15	N/A	N/A	N/A
Energy-Efficient Motors	15	20	N/A	N/A	N/A
Water treatment magnets	10	N/A	N/A	N/A	N/A

Residential Program Measure Lives

	Life in years	
Energy Star Homes		
CFL Bulbs(non general service)[1]		
Rated hours		
8,000	4	
10,000	6	
12,000	7	
15,000	8	
CFL Interior Fixtures (Hardwired)	16	
CFL Exterior Fixtures (Hardwired)	6	
Residential HVAC		
	Retrofit	New
Central Air Systems	18	25
	Retrofit	New
Air Source Heat Pumps	18	25
Geothermal Heat Pumps	18	25
Commissioning for AC Systems	18	
Commissioning for Air Source Heat Pumps	18	
Commissioning for Geothermal Heat Pumps	18	
AC System Tune-up	5	
Electronically Commutated Motor	18	
Duct Sealing (Retrofit)	20	
Duct blaster Test (New Construction)	25	
Residential Products and Services		
CFL Bulbs(non general service)[1]		
Rated hours	Life in years	
8000	4	
10000	6	
12000	7	
15000	8	
Portable Lamps	8	
Torchiere	8	
CFL Interior Fixtures (Hardwired)	16	
CFL Exterior Fixtures (Hardwired)	6	
Ceiling Fan with CFL Lights	16	
Room AC Units	12	
Clothes Washers	11	
Dish Washers	11	
Refrigerators	13	
Freezers	11	
Dehumidifiers	12	

	Life in years
Residential Envelope Measures	
REM Savings (for Energy Star Homes)	
Heating	25
Cooling	25
Dom. Water Heating	25
BOP (Builder Option Plan for Energy Star homes)	
Heating	25
Cooling	25
Dom. Water Heating	25
Blower Door Test	25
High Performance Wall Insulation	25
High Performance Ceiling Insulation	25
Low Income Program Measures	
CFL Bulbs(non general service)[1]	
Rated hours	Life in years
8,000	4
10,000	6
12,000	7
15,000	8
Outdoor Fixtures (Hard-wired)	6
Indoor Fixtures (Hard-wired)	16
Portable lamps	8
Torchiere	8
Outdoor Security Lighting	15
Low Income Program HVAC	
Duct Insulation	20
Duct Sealing	20
Pipe Insulation	15
HVAC Custom Measures	
Existing Equipment (Heating, Central Air or Heat Pumps)	5
New Equipment	18
Window or Sleeve Room AC Units	12
Room AC Units	12
Low Income Products and Services	
Domestic Water Heater Thermostat Setting (Existing Unit)	4
Low Flow Shower Head	5
Water Heater Wrap (Existing Unit)	5
Faucet Aerator	5
Flip Aerator	5

	Life in years
Low Income Program Envelope Measures	
Electrical Outlet Gaskets	15
Door Sweep	5
Door Sealing Kit	5
Air Leak Caulking and Sealing	10
Air leak Sealing with Polyethylene Tape	10
Weatherstripping of Windows	5
Weatherstripping of Doors	5
Insulating Attic Hatchway	25
Broken Window Repair	5
Storm Window Installation	20
Install Ceiling Insulation	25
Install Wall Insulation	25
Blower Door Test	20
Custom Weatherization Default life	20

General Service CFL Measure Life[1]		
CFL Wattage	Equivalent Incandescent Wattage	Measure Life (Years)
42	168	3
41	164	3
40	160	3
39	156	3
38	152	3
37	148	3
36	144	3
35	140	3
34	136	3
33	132	3
32	128	3
31	124	3
30	120	3
29	116	3
28	112	3
27	108	3
26	104	3
25	100	3
24	96	4
23	92	4
22	88	4
21	84	4
20	80	4
19	76	4
18	72	5
17	68	5
16	64	5
15	60	5
14	56	5
13	52	5
12	48	5
11	44	5
10	40	5
9	36	5
8	32	5
7	28	5

[1]"General service" CFL's are defined as standard base bulbs that intended for general service applications as specified in the Energy Independence and Security Act of 2007. "Non-general service" CFLs include, but are not limited to reflector bulbs, 3-way bulbs, and candelabra based bulbs.

7.2.0 TABLE 2.0.0 C&I HOURS

Table 2.0.0: C&I Hours of Use and EFLH

Facility Type	Lighting Hours	Cooling FLHrs	Heating FLHrs	Fan Motor Hours	CHWP & Cooling Towers	Heating Pumps
Auto Related	4,056	837	1,171	4,056	1,878	6,000
Bakery	2,854	681	1,471	2,854	1,445	6,000
Banks, Financial Centers	3,748	797	1,248	3,748	1,767	6,000
Church	1,955	564	1,694	1,955	1,121	6,000
College - Cafeteria	6,376	1,139	594	6,376	2,713	6,000
College - Classes/Administrative	2,586	646	1,537	2,586	1,348	6,000
College - Dormitory	3,066	709	1,418	3,066	1,521	6,000
Commercial Condos	4,055	837	1,172	4,055	1,877	6,000
Convenience Stores	6,376	1,139	594	6,376	2,713	6,000
Convention Center	1,954	564	1,695	1,954	1,121	6,000
Court House	3,748	797	1,248	3,748	1,767	6,000
Dining: Bar Lounge/Leisure	4,182	854	1,140	4,182	1,923	6,000
Dining: Cafeteria / Fast Food	6,456	1,149	574	6,456	2,742	6,000
Dining: Family	4,182	854	1,140	4,182	1,923	6,000
Entertainment	1,952	564	1,695	1,952	1,120	6,000
Exercise Center	5,836	1,069	728	5,836	2,518	6,000
Fast Food Restaurants	6,376	1,139	594	6,376	2,713	6,000
Fire Station (Unmanned)	1,953	564	1,695	1,953	1,121	6,000
Food Stores	4,055	837	1,172	4,055	1,877	6,000
Gymnasium	2,586	646	1,537	2,586	1,348	6,000
Hospitals	7,674	1,308	270	7,674	3,180	6,000
Hospitals / Health Care	7,666	1,307	272	7,666	3,177	6,000
Industrial - 1 Shift	2,857	681	1,470	2,857	1,446	6,000
Industrial - 2 Shift	4,730	925	1,003	4,730	2,120	6,000
Industrial - 3 Shift	6,631	1,172	530	6,631	2,805	6,000
Laundromats	4,056	837	1,171	4,056	1,878	6,000
Library	3,748	797	1,248	3,748	1,767	6,000
Light Manufacturers	2,857	681	1,470	2,857	1,446	6,000
Lodging (Hotels/Motels)	3,064	708	1,418	3,064	1,521	6,000
Mall Concourse	4,833	938	978	4,833	2,157	6,000
Manufacturing Facility	2,857	681	1,470	2,857	1,446	6,000
Medical Offices	3,748	797	1,248	3,748	1,767	6,000
Motion Picture Theatre	1,954	564	1,695	1,954	1,121	6,000
Multi-Family (Common Areas)	7,665	1,306	273	7,665	3,177	6,000
Museum	3,748	797	1,248	3,748	1,767	6,000
Nursing Homes	5,840	1,069	727	5,840	2,520	6,000
Office (General Office Types)	3,748	797	1,248	3,748	1,767	6,000
Office/Retail	3,748	797	1,248	3,748	1,767	6,000
Parking Garages & Lots	4,368	878	1,094	4,368	1,990	6,000
Penitentiary	5,477	1,022	817	5,477	2,389	6,000
Performing Arts Theatre	2,586	646	1,537	2,586	1,348	6,000

Facility Type	Lighting Hours	Cooling FLHrs	Heating FLHrs	Fan Motor Hours	CHWP & Cooling Towers	Heating Pumps
Police / Fire Stations (24 Hr)	7,665	1,306	273	7,665	3,177	6,000
Post Office	3,748	797	1,248	3,748	1,767	6,000
Pump Stations	1,949	563	1,696	1,949	1,119	6,000
Refrigerated Warehouse	2,602	648	1,533	2,602	1,354	6,000
Religious Building	1,955	564	1,694	1,955	1,121	6,000
Residential (Except Nursing Homes)	3,066	709	1,418	3,066	1,521	6,000
Restaurants	4,182	854	1,140	4,182	1,923	6,000
Retail	4,057	837	1,171	4,057	1,878	6,000
School / University	2,187	594	1,637	2,187	1,205	6,000
Schools (Jr./Sr. High)	2,187	594	1,637	2,187	1,205	6,000
Schools (Preschool/Elementary)	2,187	594	1,637	2,187	1,205	6,000
Schools (Technical/Vocational)	2,187	594	1,637	2,187	1,205	6,000
Small Services	3,750	798	1,247	3,750	1,768	6,000
Sports Arena	1,954	564	1,695	1,954	1,121	6,000
Town Hall	3,748	797	1,248	3,748	1,767	6,000
Transportation	6,456	1,149	574	6,456	2,742	6,000
Warehouse (Not Refrigerated)	2,602	648	1,533	2,602	1,354	6,000
Waste Water Treatment Plant	6,631	1,172	530	6,631	2,805	6,000
Workshop	3,750	798	1,247	3,750	1,768	6,000

7.2.1 TABLE 2.1.1B EMERGING LIGHTING TECHNOLOGIES

Table 2.1.1.B: Emerging Technology Lighting Fixtures

Fixture Type
Ceramic Metal Halide
Super T8 Lamp and Ballast Combination
Induction
Low wattage MH
LED for interior lighting

7.2.2 TABLE 2.1.1C BLDG AREA LIGHT POWER

Table 2.1.1.C: Building Area Lighting Power Densities

Ashrae 90.1-2004 TABLE 9.5.1 Lighting Power Densities Using the Building Area Method	
Building Area Type (see note)	Lighting Power Density (W/ft2)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Healthcare-Clinic	1.0
Hospital/Healthcare	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theatre	1.2
Multi-Family	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theatre	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

Note: In cases where both general building area type and a specific building area type are listed, the specific building area type shall apply.

7.2.3 TABLE 2.1.1D SPACE-BY-SPACE LIGHT POWER

Table 2.1.1.D: Space-by-Space Lighting Power Densities (From ASHRAE 90.1-2007)

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method

Common Space Types[a]	LPD, W/ft²	Building-Specific Space Types	LPD, W/ft²
Office—Enclosed	1.1	Gymnasium/Exercise Center	
Office—Open Plan	1.1	Playing Area	1.4
Conference/Meeting/Multipurpose	1.3	Exercise Area	0.9
Classroom/Lecture/Training	1.4	Courthouse/Police Station/Penitentiary	
For Penitentiary	1.3	Courtroom	1.9
Lobby	1.3	Confinement Cells	0.9
For Hotel	1.1	Judges' Chambers	1.3
For Performing Arts Theater	3.3	Fire Stations	
For Motion Picture Theater	1.1	Engine Room	0.8
Audience/Seating Area	0.9	Sleeping Quarters	0.3
For Gymnasium	0.4	Post Office—Sorting Area	1.2
For Exercise Center	0.3	Convention Center—Exhibit Space	1.3
For Convention Center	0.7	Library	
For Penitentiary	0.7	Card File and Cataloging	1.1
For Religious Buildings	1.7	Stacks	1.7
For Sports Arena	0.4	Reading Area	1.2
For Performing Arts Theater	2.6	Hospital	
For Motion Picture Theater	1.2	Emergency	2.7
For Transportation	0.5	Recovery	0.8
Atrium—First Three Floors	0.6	Nurses' Station	1.0
Atrium—Each Additional Floor	0.2	Exam/Treatment	1.5
Lounge/Recreation	1.2	Pharmacy	1.2
For Hospital	0.8	Patient Room	0.7
Dining Area	0.9	Operating Room	2.2
For Penitentiary	1.3	Nursery	0.6
For Hotel	1.3	Medical Supply	1.4
For Motel	1.2	Physical Therapy	0.9
For Bar Lounge/Leisure Dining	1.4	Radiology	0.4
For Family Dining	2.1	Laundry—Washing	0.6
Food Preparation	1.2	Automotive—Service/Repair	0.7
Laboratory	1.4	Manufacturing	
Restrooms	0.9	Low Bay (<25 ft Floor to Ceiling Height)	1.2
Dressing/Locker/Fitting Room	0.6	High Bay (≥25 ft Floor to Ceiling Height)	1.7
Corridor/Transition	0.5	Detailed Manufacturing	2.1
For Hospital	1.0	Equipment Room	1.2
For Manufacturing Facility	0.5	Control Room	0.5
Stairs—Active	0.6	Hotel/Motel Guest Rooms	1.1
Active Storage	0.8	Dormitory—Living Quarters	1.1
For Hospital	0.9	Museum	
Inactive Storage	0.3	General Exhibition	1.0
For Museum	0.8	Restoration	1.7
Electrical/Mechanical	1.5	Bank/Office—Banking Activity Area	1.5

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method *(continued)*

Common Space Types[a]	*LPD*, W/ft²	Building-Specific Space Types	*LPD*, W/ft²
Workshop	1.9	Religious Buildings	
Sales Area [for accent lighting, see Section 9.6.2(b)]	1.7	Worship Pulpit, Choir	2.4
		Fellowship Hall	0.9
		Retail	
		Sales Area [for accent lighting, see Section 9.6.3(c)]	1.7
		Mall Concourse	1.7
		Sports Arena	
		Ring Sports Area	2.7
		Court Sports Area	2.3
		Indoor Playing Field Area	1.4
		Warehouse	
		Fine Material Storage	1.4
		Medium/Bulky Material Storage	0.9
		Parking Garage—Garage Area	0.2
		Transportation	
		Airport—Concourse	0.6
		Air/Train/Bus—Baggage Area	1.0
		Terminal—Ticket Counter	1.5

[a] In cases where both a common space type and a building-specific type are listed, the building specific space type shall apply.

7.2.4 TABLE 2.2.1A CHILLER EFFICIENCIES

Table 2.2.1.A: Chiller Baseline and Compliance Efficiencies

Water-cooled Centrifugal			**Water-Cooled Screw & Scroll**			**Air-Cooled**		
	Maximum IPLV, kW/ton			Maximum IPLV, kW/ton			Maximum IPLV, EER	
Tons less than	Baseline	Compliance	Tons less than	Baseline	Compliance	Tons	Baseline	Compliance
<100	0.67	0.610	<100	0.677	0.640	<100	10.41	12.1
125	0.67	0.610	125	0.677	0.620	100	10.41	12.010
150	0.60	0.570	150	0.677	0.610	111	10.41	11.910
175	0.60	0.570	175	0.633	0.590	121	10.41	11.810
200	0.60	0.570	200	0.633	0.570	131	10.41	11.710
225	0.60	0.570	225	0.633	0.540	141	10.41	11.610
250	0.60	0.570	250	0.633	0.540	151	10.41	11.510
275	0.60	0.570	275	0.633	0.540	161	10.41	11.510
300	0.60	0.530	300	0.633	0.540	171	10.41	11.410
300 and over	0.55	0.530	325	0.573	0.540	181	10.41	11.310
			350	0.573	0.530	191	10.41	11.210
			375	0.573	0.530	201	10.41	11.110
			400	0.573	0.530	211	10.41	11.010
			425	0.573	0.530	221	10.41	10.910
			450	0.573	0.530	231	10.41	10.810
			475	0.573	0.530	241	10.41	10.710
			500	0.573	0.530	251	10.41	10.610
			525	0.573	0.520	261	10.41	10.510
			550	0.573	0.520	271	10.41	10.410
			575	0.573	0.520	281	10.41	10.310
			600	0.573	0.520	291	10.41	10.310
			625	0.573	0.510	301	10.41	10.210
			650 and over	0.573	0.510	311	10.41	10.110
						321	10.41	10.010
						331 and over	10.41	9.910

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7.2.5 TABLE 2.2.1B CHILLER RATING CONDITIONS

Table 2.2.1.B: Chiller ARI Rating Conditions

CHILLER RATINGS			
TABLE 3. - ENTERING CONDENSER FLUID TEMPERATURES AT PART LOAD I-P SYSTEM			
% LOAD	1998 STANDARD		
	WC °F ECWT	AC °F EDB	EC °F EWB
100%	85	95	75
75%	75	80	68.75
50%	65	65	62.5
25%	65	55	56.25

WC = water-cooled
AC = air-cooled
EC = evaporative cooled

ECWT = entering condenser water temperature
EDB = entering air dry bulb temperature
EWB = entering air wet bulb temperature

Table 6. ARI Standard 550/590-98 is reprinted below to show the ARI Standard Rating Condition. This chart is reprinted with permission from ARI:

CHILLER RATINGS			
TABLE 6. STANDARD RATING CONDITIONS			
	Water-Cooled	Evaporatively-Cooled	Air-Cooled
CONDENSER WATER			
Entering	85°F		
Flow Rate	3.0 gpm/ton		
CONDENSER FOULING FACTOR ALLOWANCE			
Water Side	0.00025 h ft ^{2} ° F/Btu		
Air-Side		0 h ft^2 °F/Btu	0 h ft^2 °F/Btu
ENTERING AIR			
Dry Bulb			95°F
Wet Bulb		75°F	
EVAPORATOR WATER			
Leaving	44°F		
Flow Rate	2.4 gpm/ton		
EVAPORATOR FOULING FACTOR ALLOWANCE			
Water-Side	0.0001 h ft^2 °F/Btu		
Refrigerant-Side	0 h ft^2 °F/Btu		
CONDENSERLESS			
		Water or Evaporatively Cooled	Air-Cooled
Saturated Discharge		105°F	125°F
Liquid Refrigerant		98°F	105°F
Barometric Pressure - 29.92 in. of Hg			

7.2.6 TABLE 2.2.1C CHILLER PART-LOAD EFFICIENCIES

Table 2.2.1.C: Chiller Part-Load Efficiencies

Water-Cooled Centrifugal

Load	<150 Tons kW/Ton	>=150 Tons &<300 Tons kW/Ton	>=300 Tons kW/Ton
100%	0.703	0.630	0.580
75%	0.635	0.571	0.524
50%	0.673	0.602	0.549
25%	0.807	0.717	0.666
IPLV	0.670	0.600	0.550

Air-Cooled

Load	<150 Tons EER	>=150 Tons EER
100%	9.560	9.560
75%	10.349	10.349
50%	10.894	10.894
25%	8.879	8.879
IPLV	10.410	10.410

Water-Cooled Screw & Scroll

Load	<150 Tons kW/Ton	>=150 Tons &<300 Tons kW/Ton	>=300 Tons kW/Ton
100%	0.790	0.718	0.639
75%	0.642	0.601	0.546
50%	0.679	0.634	0.571
25%	0.815	0.756	0.693
IPLV	0.677	0.633	0.573

7.2.7 TABLE 2.3 COOLING EFFICIENCIES REQUIRED

Table 2.3

The baseline efficiencies are the same as required by Ashrae Std 90.1-2004.

Unitary and Split Systems - A/C		
Btu/h	**Baseline**	**Minimum Compliance**
< 65,000	13 SEER	***To Be Determined***
≥ 65,000 < 135,000	11 EER	***To Be Determined***
≥ 135,000 < 240,000	10.8 EER	***To Be Determined***
≥ 240,000 < 375,000	9.8 EER	***To Be Determined***
≥ 375,000 < 760,000	9.8 EER	***To Be Determined***
≥ 760,000	9.5 EER	***To Be Determined***

Unitary and Split Systems - Air source Heat Pumps		
Btu/h	**Baseline**	**Minimum Compliance**
< 65,000	13 SEER	***To Be Determined***
≥ 65,000 < 135,000	11 EER	***To Be Determined***
≥ 135,000 < 240,000	10.6 EER	***To Be Determined***
≥ 240,000 < 375,000	9.5 EER	***To Be Determined***
≥ 375,000 < 760,000	9.5 EER	***To Be Determined***
≥ 760,000	9.5 EER	***To Be Determined***