focus on energy℠

Partnering with Wisconsin utilities

Wisconsin Focus on Energy
TECHNICAL REFERENCE MANUAL

January 2015

Public Service Commission of Wisconsin
610 North Whitney Way
Madison, WI 53707

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Executive Summary

Under its contract with the Public Service Commission of Wisconsin (the PSC) to evaluate the Focus on Energy programs, the Evaluation Team[1]—in coordination with the Program Administrator, the Program Implementers, and PSC staff—compiled this Technical Reference Manual (TRM). The information contained in this document summarizes the consensus calculations of the electric and natural gas energy savings, and the electric demand reductions, achieved from installing energy efficiency and renewable energy technologies that are supported by Focus on Energy programs. This TRM is publicly available online at http://www.focusonenergy.com/about/evaluation-reports.

The values presented in this TRM fall into one of two categories:

- Deemed Savings – specific per-unit savings (or demand reduction) values that have been accepted by the Program Administrator, Program Implementers, Evaluator, and the PSC because the measures and the uses for the measures are consistent, and sound research supports the savings achieved.
- Savings Algorithms – equations for calculating savings (or demand reductions) based on project- and measure-specific details. This TRM makes these calculations transparent by identifying and justifying all relevant formulas, variables, and assumptions.

This TRM is also a reference guide as to how measures are classified in Focus on Energy's tracking database, SPECTRUM. This document is revised twice annually to account for changes to programs and/or technologies.

The Evaluation Team leveraged many different primary and secondary sources to derive the calculation algorithms, variable assumptions, and measure descriptions contained in this TRM. These sources include available best practices and industry standards; on-site evaluation, measurement, and verification (EM&V) of savings from Focus on Energy projects; engineering desk reviews; and reviews of practices used in other jurisdictions. To best represent the Wisconsin climates and demographics, as well as program implementation practices, these energy-savings calculations account for state-specific factors such as climate zones, building codes, and market penetrations.

Update Process

The TRM is updated twice each year, in January and August. The January update reflects the savings that will be in effect for the forthcoming calendar year. The August update incorporates savings updates from evaluation findings that will be effective for the following calendar year. The present edition presents deemed savings and inputs effective for CY 2015.

[1] The Evaluation Team consists of Cadmus, Nexant, St. Norbert College Strategic Research Institute, and TecMarket Works.

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Annual updates ensure the TRM remains relevant and useful by:

- Presenting validated savings calculations for any new measures Focus on Energy has begun offering through its programs since the last update;
- Eliminating measures that are no longer being offered through Focus on Energy programs; and
- Updating information on existing measures to reflect new research findings and technology changes.

Two processes are in place for updating the TRM and ensuring that those updates are timely, comprehensive, and accurate. All content updates are integrated into the existing document and changes are indicated in the Revision History table included for each measure entry.

1. Updates to savings calculations for existing measures are only made in the August TRM revision. As part of the annual impact evaluation, the Evaluation Team identifies whether measures' recommended savings could be informed by evaluation findings and/or the presence of new research. The Evaluation Team works with the Program Administrator and the PSC to determine whether the findings are significant enough to merit a full review of the measure savings. Further review is typically pursued for those measure(s) that make a significant contribution to overall program savings, as well as when a lengthy period of time has elapsed since the measure was last reviewed, and/or if there is uncertainty regarding the accuracy of the existing savings calculations.

   In June of each year, the Evaluation Team issues the results of its review, including any proposed revisions to savings calculations or other aspects of the existing TRM content. Program Implementation staff, the Program Administrator, and PSC staff review the proposed updates to achieve consensus on final revisions to be published in the August TRM.

   By publishing all changes to existing measures in the August update, the TRM is able to inform the Program Administrator and Program Implementers as they undertake program planning for the upcoming year.

2. Focus on Energy Program Implementers may propose adding new measures or changing the definition of existing measures at any time during the year, by preparing a draft workpaper that follows the structure of a TRM entry. These workpapers are reviewed by members of the Evaluation Team, the Program Administrator, and PSC staff to ensure that the proposed savings calculations are fully and adequately justified. Key criteria for assessing whether workpapers meet this standard include:

   a. A clear definition of the measure;

   b. A clear description of how the measure saves energy;

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c. A complete description of the calculation algorithms used to calculate savings, which identifies all variables and, where relevant, identifies the standard values to be used as inputs; and
d. Citation of all data to valid sources.

The initial workpaper may be revised to ensure that all criteria are met and to achieve consensus on a final savings recommendation. Workpapers that pass all levels of the review receive formal approval from the PSC.

New measures and revised savings calculations take effect for the programs immediately after the workpaper is approved. Similarly, existing measures are deactivated as soon as they are no longer offered. As a result, the TRM does not serve as a comprehensive list of active measures or savings calculations at every point during the year.

Measure additions and deactivations completed during the first half of the calendar year are incorporated into the August update. The January TRM update addresses additions and deactivations that occur later in the preceding year. The January update is limited to additions and deletions and does not incorporate any changes to continuing measures.

Navigating the TRM

Focus on Energy savings (including demand reductions) are calculated, and incentives are paid, by measure. Measures are defined as a specific product, technology, or service offered through one or more Focus on Energy programs, for which definable savings can be identified. Some TRM entries describe the savings for a single measure. Other entries address a group of related measures whose savings are calculated in a consistent way, such as measures which offer the same type of lighting product in different sizes or wattages.

TRM entries are grouped by technology and function, based on the group designations used to classify measures in SPECTRUM. Most groups are based on technology, including a lighting group with subcategories addressing CFLs, LEDs, and other specific lighting technologies. Some groups also cover key end uses for technologies, such as laundry or food service. These classifications are used for planning purposes and to categorize savings outcomes in evaluation reports.

Measure Detail Structure

Each entry describes the measure and its savings using the following format:

An introductory **Measure Detail Table** summarizes all of the measure savings and characteristics including the formal name of the measure and any information necessary to include the measure in SPECTRUM. The measure detail table also identifies two key characteristics that guide how savings are calculated.

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First, the detail table identifies all sectors in which the measure is offered, which include:[2]

a. Residential- single family homes;
b. Residential- multifamily dwellings (such as apartment buildings and condominiums);
c. Commercial facilities;
d. Industrial facilities;
e. Agriculture facilities; and
f. Schools and government facilities.

In many cases, the energy savings calculated for a measure will be the same for each sector in which it is used. However, this can vary when there is reason to assume that the measure is used differently by different customer sectors. For example, research has confirmed that, on average, homeowners, commercial businesses, and industrial facilities use the same lighting product for different amounts of time and at different times of the day, resulting in different annual electricity savings and demand reductions.

Second, the table documents the measure type, which identifies the process by which savings are calculated. Each Focus on Energy measure is one of the following three measure types:

a. *Prescriptive* measures have a specific deemed savings value that can be applied to each project within a given sector where the measure is used. This measure type is most commonly used for products that are manufactured and used consistently by all participants, such as light bulbs and appliances.
b. *Custom* measures have savings that vary by project. This applies to more complex, multifaceted measures whose energy-use factors are likely to be different for each project, such as changes to industrial processes. TRM entries for custom measures do not identify savings values, but instead specify the savings algorithm that should be used to calculate savings for each project and the source and calculation method used for algorithm inputs.
c. *Hybrid* measures, like custom measures, have savings that vary by project, and are treated like custom measures in the TRM. The distinction between hybrid and custom measures is that the value of custom incentives also varies by project, while hybrid incentives are the same for each project.

1. The next three sections describe the measure(s) and how they achieve energy savings. The **Measure Description** defines the product, technology, or service. The **Description of Baseline Condition** identifies the less efficient product or service it is assumed the customer would purchase in the absence of Focus on Energy programs and incentives, while the **Description of Efficient Condition** identifies how the measure incented through Focus on Energy is more

[2] Because measures that are incented through a markdown on the retail price at the store cannot be clearly assigned to a sector, they are assigned to the residential sector based on the program design.

efficient than the baseline. Measures achieve energy savings and/or demand reductions based on the difference in energy and demand use between the baseline and efficient conditions.

2. Formulas are provided to specify the energy savings and demand reduction calculations. The **Annual Energy-Savings Algorithm** identifies how to calculate electricity and/or natural gas savings achieved per year. The **Summer Coincident Peak Savings Algorithm** identifies the formula used to calculate reductions in electric demand, under the assumption that peak electric demand in Wisconsin occurs weekday afternoons (1:00 p.m. to 4:00 p.m.) in the months of June, July, and August. The **Lifecycle Energy-Savings Algorithm** identifies the formula used to convert annual electricity and/or natural gas savings to the lifecycle savings achieved over the expected useful life (EUL) of the measure. In addition to describing the algorithms used, all three sections specify the value of variables used in the calculation. These inputs may include assumptions about usage behavior or other variables obtained through research. For custom and hybrid measures, the algorithms also note which inputs should be calculated on a project-by-project basis, from sources such as engineering reviews, modeling inputs, or on-site measurements.
3. Savings calculated through those formulas are often reported in the **Measure Detail Table**. However, in some cases—such as calculations for multiple related measures—there are too many separate savings calculations to concisely include in the Measure Detail Table. In those cases, a **Deemed Savings Table** is provided following the algorithm sections to describe all completed savings calculations. In some cases, an **Assumptions** section may also be added to describe in greater detail the process used for selecting and/or calculating algorithm inputs.
4. All factual statements and figures made throughout the measure write-up include a superscript citation. The **Sources** section lists those citations numerically. For public sources such as published studies, hyperlinks and publication information are provided for the original source. More details on data cited to internal sources, such as historical Focus on Energy data or measure-specific market research, can be obtained from program staff. Initial inquiries can be directed to Joe Fontaine at the PSC, (608) 266-0910, joe.fontaine@wisconsin.gov.
5. The **Revision History Table** lists all the revision dates for that TRM entry and briefly describes the changes. In addition to documenting all changes, the table shows any workpaper versions completed before the first edition of the TRM was released in August 2014.

Acknowledgements

Many individuals and companies have made valuable contributions to compiling and validating the TRM, as well as to preparing the measure write-ups and savings calculations that preceded the first edition. Special thanks go to:

- Vanessa Barbarisi, Charlie Bicknell, and John Walczyk from Cadmus
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- Program Implementers include:
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- Carol Stemrich, Joe Fontaine, and Denise Schmidt from the PSC of Wisconsin

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Business (Nonresidential) Measures

The Business Portfolio delivers energy efficiency and renewable energy programs to Wisconsin's nonresidential utility customers. Customers eligible to participate in these programs include commercial and industrial firms, agricultural producers, schools, and local governments. With the programs, Focus on Energy aims to help nonresidential customers meet their unique and complex electricity and natural gas needs as efficiently as possible. Focus on Energy accomplishes this by providing information, financial incentives, and support for implementing energy-efficient technologies. These technologies include, but are not limited to, efficient lighting, heating and cooling systems, motors and drives, appliances, renewable energy systems, and custom products specific to key industries, such as food service and agricultural production.

The Targeted Markets portfolio for calendar year 2014 includes six programs that were designed to meet the needs of different types of nonresidential customers.

Three programs were designed to serve nonresidential customers with different levels of energy use.

1. The **Small Business Program** serves small business customers with relatively low energy use, providing free direct installation of energy-saving measures, such as CFLs and exit signs, and offering incentives for the installation of additional energy-saving measures.
2. The **Large Energy Users Program** serves customers with high energy use, such as large industrial firms and large commercial facilities, providing implementation support and incentives designed to meet each user's specific energy needs.
3. The **Business Incentive Program** offers product-based and custom incentives for customers whose energy demand ranges between 100 and 1,000 kW per month.

In addition, two programs offer support for markets with specialized needs. The **Chains & Franchises Program** offers incentives and support designed for customers who have five or more facilities in the State of Wisconsin, such as retail businesses and restaurants. The **Agriculture, Schools and Government Program** offers specialized incentives and support to address the needs of public facilities and agricultural producers.

Nonresidential customers who are building new facilities can receive support from the **Design Assistance Program**, which connects customers, builders, and developers with experts who can provide energy-saving recommendations, and provides incentives to customers who incorporate those recommendations into their new construction.

Finally, the **Renewable Energy Competitive Incentive Program** offers incentives for the installation of a renewable energy technology through a competitive Request for Proposal.

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Agriculture

Energy Efficient or Energy Free Livestock Waterer

	Measure Details
Measure Master ID	Waterer, Livestock, < 250 Watts, 2660 Waterer, Livestock, Energy Free, 3018
Measure Unit	Watering Unit
Measure Type	Prescriptive
Measure Group	Agriculture
Measure Category	Livestock Waterer
Sector(s)	Agriculture
Annual Energy Savings (kWh)	Varies by measure
Peak Demand Reduction (kW)	0 (winter use only)
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by measure
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10[1]
Incremental Cost	MMID 2660 = $710.33; MMID 3018 = $741
Important Comments	

Measure Description

Electrically heated waterers are commonly used to provide clean water for livestock during winter months when temperatures may drop below freezing. Baseline efficiency waterers typically have no insulation and require large heating elements to prevent water from freezing. Energy-efficient livestock waterers have at least two inches of insulation, which allows for the use of much smaller heating elements (less than 250 watts). Energy-free waterers have at least two inches of insulation and no heating element, as they use ground source water to prevent freezing.

Description of Baseline Condition

The heating element for a baseline unit is typically at least 750 watts, but may be 1,500 watts or larger. Retrofit waterer installations, both energy efficient and energy free, use a baseline of 1,100 watts. New construction waterer calculations use a baseline of 500 watts.

Description of Efficient Condition

Efficient or low energy livestock waterers must have a minimum of two inches of insulation. The heating element for an efficient unit will be a maximum of 250 watts. The energy-free unit may not have an electric heating element installed, but instead uses ground source heating. The new waterer must be able to serve the same herd size as the existing equipment. For new construction, the livestock waterer must be energy free.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * HOURS$

Where:

$Watts_{BASE}$	=	Power consumption of baseline measure equipment (1,100 watts for retrofit and 500 watts for new installation)
$Watts_{EE}$	=	Power consumption of efficient measure equipment (250 watts for energy-efficient retrofit and 0 watts for energy-free installation)
1,000	=	Kilowatt conversion factor
HOURS	=	Average annual run hours of heater (= 3,040). Annual operation is used as a conservative estimate of the number of hours below 32°F annually throughout the State of Wisconsin. This is consistent with TMY3 bin data.

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} – Watts_{EE}) /1,000 * CF$

Where:

CF	=	Coincidence factor (= 0)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 10 years)[1]

Deemed Savings

Average Annual Deemed Savings

Type	MMID	Sector	kWh
Energy Efficient Livestock Waterer	2660	Agriculture	2,584
Energy Free Retrofit Livestock Waterer	3018	Agriculture	3,344
Energy Free New Construction Livestock Waterer	3018	Agriculture	1,520

Lifecycle Energy Savings

Type	MMID	Sector	kWh
Energy Efficient Livestock Waterer	2660	Agriculture	25,840
Energy Free Retrofit Livestock Waterer	3018	Agriculture	33,440
Energy Free New Construction Livestock Waterer	3018	Agriculture	15,200

Peak Demand Deemed Savings

Type	MMIDs	kWh
All Livestock Waterers	2660 and 3018	0

Assumptions

No peak demand (kW) savings are associated with this measure because heaters are generally only used during winter months.

Source

1. Wisconsin PSC EUL database, 2013. See Appendix C.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/01/2013	Transition to new template

Circulation Fan, High Efficiency, Ag

	Measure Details
Measure Master ID	Circulation Fan, High Efficiency, Ag, 2253
Measure Unit	Per Fan
Measure Type	Hybrid
Measure Group	Agriculture
Measure Category	Other
Sector(s)	Agriculture
Annual Energy Savings (kWh)	Varies
Peak Demand Reduction (kW)	Varies
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$150
Important Comments	

Measure Description

Agriculture circulation fans are designed to destratify air, reduce animal heat stress, control insects, dry surfaces, and cool people and animals. Generally, agricultural-grade air circulating fans are corrosion resistant and designed for easy cleaning.

Description of Baseline Condition

The baseline condition is an air circulation fan used within an agricultural building. SPECTRUM averages the parameters for three fan diameter size groupings: 24-35 inches, 36-47 inches, and 48-71 inches. The baseline unit demand is based on the fan size groupings, at 450 watts, 620 watts, and 1,160 watts, respectively.

Description of Efficient Condition

To qualify for a prescriptive incentive, each circulation fan must undergo third-party testing and be rated through the Bioenvironmental and Structural System Lab at the University of Illinois or through the Air Control and Movement Association International Lab.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (CFM_{EE} / VER_{EE} – CFM_{BASE} / VER_{BASE}) * HOURS$

Where:

CFM_{EE} = New efficient unit flow @ 0.10 SP (CFM)[2]

VER_{EE} = New efficient unit ventilating efficiency ratio (CFM/watt) @ 0.10 SP

CFM_{BASE} = Baseline unit flow @ 0.10 SP (CFM)

VER_{BASE} = Baseline unit ventilating efficiency ratio (CFM/watt) @ 0.10 SP

HOURS = Annual hours of operation (= 2,935)[3]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (CFM_{EE} / VER_{EE} – CFM_{BASE} / VER_{BASE})*CF$

Where:

CF = Coincidence factor (= 1.0)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Deemed savings from Illinois Technical Reference Manual Version 2.0 dated 6/7/2013, referencing Illinois Act On Energy Commercial TRM No. 2010-4 dated 5/31/2011. Uses mid-size fan parameters (36-47” diameter) to represent average installed condition.
3. Deemed savings from Illinois Technical Reference Manual Version 2.0 dated 6/7/2013, referencing Illinois Act On Energy Commercial TRM No. 2010-4 dated 5/31/2011.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/05/2012	Original
02	Franklin Energy Services	04/01/2013	Updates by PI

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Boilers & Burners

Boiler Plant Retrofit, Hybrid Plant, >1 MMBh

	Measure Details
Measure Master ID	Boiler Plant Retrofit, Hybrid Plant, >1 MMBh, 3275
Measure Unit	Per MBh
Measure Type	Prescriptive
Measure Group	Boilers and Burners
Measure Category	Boiler
Sector(s)	Commercial, Industrial, Schools & Government
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	1.54
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	30.79
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	$25.65
Important Comments	

Measure Description

High efficiency sealed combustion, condensing, and modulating (HESCCM) boilers operate by taking advantage of condensing in an effort to decrease energy consumption. Condensing boilers are designed to capture latent heat by condensing water vapor in the exhaust stream. For a boiler to properly condense, its return water temperature should be kept below 120°F. In order to capture as much latent heat as possible, condensing boilers are made from stainless steel or other corrosion-resistant materials.

Mid-efficiency boilers use forced draft or induced draft power burners, instead of atmospheric draft, to push or pull gases through the firebox and heat exchanger. Because these boilers have relatively high efficiencies and relatively low flue gas temperatures, they are often constructed with stainless steel or other corrosion-resistant materials to tolerate condensation in the boiler.

This measure applies to the entire boiler plant. The summation of the capacity for all heating equipment must be greater than 1,000 MBh. This measure combines high- and mid-efficiency boilers in a boiler plant to take advantage of both condensing boilers (when return water temperatures are low enough for condensing) and mid-efficiency boilers (when return water temperatures do not allow for condensing). The upgraded plant must have at least 50% high-efficiency boilers.

Description of Baseline Condition

The baseline is for multiple 300-1,000 MBh boilers with a thermal efficiency of 80%, according to the 2010 Deemed Savings Manual.[2]

Description of Efficient Condition

The efficient condition is for the entire boiler plant to have capacity for all heating equipment that is greater than 1,000 MBh. This measure combines the high-and mid-efficiency boilers in a boiler plant to take advantage of both condensing boilers and mid-efficiency boilers. The upgraded plant must have at least 50% high-efficiency boilers with the following requirements:

- High-efficiency boilers must have TE ≥ 90%
- Mid-efficiency boilers must have TE ≥ 85%
- Boiler plant must be >1,000 MBh
- Boilers must be capable of capacity modulation
- Boilers must be used for space heating (HVAC), not for industrial purposes or domestic water heating
- Redundant or back-up boilers do not qualify

Annual Energy-Savings Algorithm

$Therms_{SAVED} = (C_Q * BOF * HDD * 24 / \Delta T) * (TE_Q / TE_B - 1) / 100$

Where:

C_Q	=	Input capacity of qualifying unit in MBh (= 1)
BOF	=	Boiler oversize factor (= 77%[3])
HDD	=	Heating degree days (= 7,616, see table below)
24	=	Conversion factor, hours per day
ΔT	=	Design temperature difference (= 80°F[3])
TE_Q	=	Assumed thermal efficiency of mid- and high-efficiency boilers (= 87%)
TE_B	=	Thermal efficiency of baseline boilers (= 80%)
100	=	Conversion factor from MBtus to therms

Location	HDD[3]
Milwaukee	7,276
Green Bay	7,725
Wausau	7,805
Madison	7,599
La Crosse	7,397
Minocqua	8,616
Rice Lake	8,552
Statewide Weighted	**7,616**

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 20 years)[1]

Assumptions

Equipment efficiency used for the deemed savings assumed as 87% TE.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, MMID 2208.
2. PA Consulting Group Inc., Public Service Commission of Wisconsin, *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual*, Final Report: March 22, 2010.
3. Calculated from TMY3 weather files of the seven Wisconsin locations using *ASHRAE Estimation of Degree-Days: Fundamentals*, Chapter 14. Statewide weighted values calculated using 2010 US Census data for Wisconsin.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	03/19/2012	Original
02	Franklin Energy Services	04/01/2013	Updates by the PI

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Boiler Plant Retrofit, Mid-Efficiency Plant, 1-5 MMBh

	Measure Details
Measure Master ID	Boiler Plant Retrofit, Mid-Efficiency Plant, 1-5 MMBh, 2209
Measure Unit	Per MBh
Measure Type	Prescriptive
Measure Group	Boilers & Burners
Measure Category	Boiler
Sector(s)	Commercial, Industrial, Schools & Government
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	1.10
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	21.99
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	$16.43
Important Comments	

Measure Description

Mid-efficiency boilers use forced draft or induced draft power burners, instead of atmospheric draft, to push or pull gases through the firebox and heat exchanger. Because these boilers have relatively high efficiencies and relatively low flue gas temperatures, they are often constructed with stainless steel or other corrosion-resistant materials to tolerate condensation in the boiler. This measure is for the entire boiler plant: the capacity for all heating equipment must fall within 1,000 MBh and 5,000 MBh.

Description of Baseline Condition

The baseline is for multiple 300-1,000 MBh boilers with a thermal efficiency of 80%, according to the 2010 Deemed Savings Manual.[2]

Description of Efficient Condition

The upgraded plant must meet the following requirements:

- Mid-efficiency boilers must have a TE ≥ 85%
- Boiler plant must be between 1,000 MBh and 5,000 MBh
- Boilers must be capable of capacity modulation
- Boiler must be used for space heating (HVAC), not for industrial purposes or domestic water heating
- Redundant or back-up boilers do not qualify

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Annual Energy-Savings Algorithm

The following equation is based on the Focus on Energy Business Incentive Program deemed savings for boilers that have TE ≥ 85%.

$Therms_{SAVED} = (C_Q * BOF * HDD * 24 / \Delta T) * (TE_Q / TE_B - 1) / 100$

Where:

C_Q	=	Input capacity of qualifying unit in MBh (= 1)
BOF	=	Boiler oversize factor (= 77%)[3]
HDD	=	Heating degree days (= 7,616, see table below)
24	=	Conversion factor, hours per day
ΔT	=	Design temperature difference (= 80°F)[3]
TE_Q	=	Assumed thermal efficiency of qualifying unit (= 85%)
TE_B	=	Thermal efficiency of baseline unit (= 80%)
100	=	Conversion factor from MBtus to therms

Location	HDD[3]
Milwaukee	7,276
Green Bay	7,725
Wausau	7,805
Madison	7,599
La Crosse	7,397
Minocqua	8,616
Rice Lake	8,552
Statewide Weighted	**7,616**

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 20 years)[1]

Assumptions

Equipment efficiency used for the deemed savings assumed is 85% TE.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. PA Consulting Group Inc., Public Service Commission of Wisconsin, *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual*, Final Report: March 22, 2010.
3. Calculated from TMY3 weather files of the seven Wisconsin locations using *ASHRAE Estimation of Degree-Days: Fundamentals*, Chapter 14. Statewide weighted values calculated using 2010 US Census data for Wisconsin.

Revision History

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01	Franklin Energy Services	03/15/2012	Original
02	Franklin Energy Services	04/01/2013	Updates by the PI

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Steam Fittings and Pipe Insulation

	Measure Details
Measure Master ID	Insulation, Steam Fitting, Removable, NG, 2429 Insulation, Steam Piping, NG, 2430
Measure Unit	Per Linear Foot (pipe insulation) Per Fitting (fitting insulation)
Measure Type	Prescriptive
Measure Group	Boilers & Burners
Measure Category	Insulation
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	11.38 (per linear foot pipe insulation) 40.44 (per fitting insulation)
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	113.8 (per linear foot pipe insulation) 404.4 (per fitting insulation)
Water Savings (gal/yr)	0
Effective Useful Life (years)	10[1]
Incremental Cost	MMID 2429 = $45.44; MMID 2430 = $22.76
Important Comments	

Measure Description

Uninsulated steam lines and fittings are a constant source of wasted energy. Adding insulation can typically reduce energy losses by 90% and will help ensure proper steam pressure and temperatures where needed. This measure is only for steam pipes in unconditioned spaces. Unconditioned basements and crawlspaces that are insulated from the conditioned space of the building qualify.

Description of Baseline Condition

The baseline measure is for existing, non-insulated steam pipe or fittings that are part of an HVAC steam distribution system, with 80% boiler efficiency.

Description of Efficient Condition

Insulation must meet all federal and local safety standards and be rated for the temperature of the pipe on which it will be applied. Incentives are not intended for the replacement of existing pipe insulation but only for the insulation of existing bare pipe.

The pipe being insulated must be at least 0.5 inches in diameter and must carry steam as part of an HVAC steam distribution system. Thickness of insulation must meet 2009 IECC standards[4], as outlined in section 5.3.2.8. For steam pipe with a 1.5-inch NPS or smaller, insulation must be at least 1.5 inches thick. For steam pipe with an NPS of greater than 1.5 inches, insulation must be at least 3.0 inches thick.

This is based on insulation with a K-value that does not exceed 0.27 Btu per inch/h*ft^2*°F. Installation must include a protective jacket around the insulation.

Annual Energy-Savings Algorithm

$Therms_{SAVED\_PIPE} = PipeInsul_{SAVED} * LF$

$PipeInsul_{SAVED} = Pipe_{BARE} - Pipe_{INSUL}$

Where:

$PipeInsul_{SAVED}$	=	Annual energy savings through insulating in therms per linear foot of pipe (= 11.38 Therms/ft/yr)
$Pipe_{BARE}$	=	Annual energy consumption for uninsulated pipe calculated by 3E Plus software
$Pipe_{INSUL}$	=	Annual energy consumption for insulated pipe calculated by 3E Plus software
LF	=	Total linear feet of pipe (= 1)

$Therms_{SAVED\_FITTING} = FittingInsul_{SAVED} * NF$

$FittingInsul_{SAVED} = Fitting_{BARE} - Fitting_{INSUL}$

Where:

$FittingInsul_{SAVED}$	=	Annual energy savings through insulating in therms per fitting (= 40.44 Therms/fitting/yr)
NF	=	Number of fittings (= 1)
$Fitting_{BARE}$	=	Annual energy consumption for uninsulated fitting calculated by 3E Plus software
$Fitting_{INSUL}$	=	Annual energy consumption for uninsulated fitting calculated by 3E Plus software

Savings were calculated using the assumptions listed below and 3E Plus v4.0 software, distributed by NAIMA.[3] The 3E Plus software was used to calculate heat loss rates for bare and insulated pipe thickness per foot. The difference in heat loss is multiplied by the assumed hours of operation and divided by the boiler efficiency and Btu to therm conversion to calculate annual gas savings in therms.

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 10 years)[1]

Assumptions

The pipe or fitting will be hot for 4,000 hours per year.

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The pipe has an NPS size of 2 inches. A fitting is equivalent to approximately 3.55 feet of 2-inch pipe.

The system application for this calculation is Pipe – Horizontal/Vertical. With the dimensional standard of ASTM C 585 Rigid/Flexible.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. 2008 Database for Energy Efficient Resources, Cost Values and Summary Documentation, Updated June 2, 2008.
3. This program is available through NAIMA at http://www.pipeinsulation.org/.
4. 2009 IECC standards.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	03/20/2012	New measure

1 South Pinckney• Suite 340 • Madison WI 53703
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Compressed Air, Vacuum Pumps

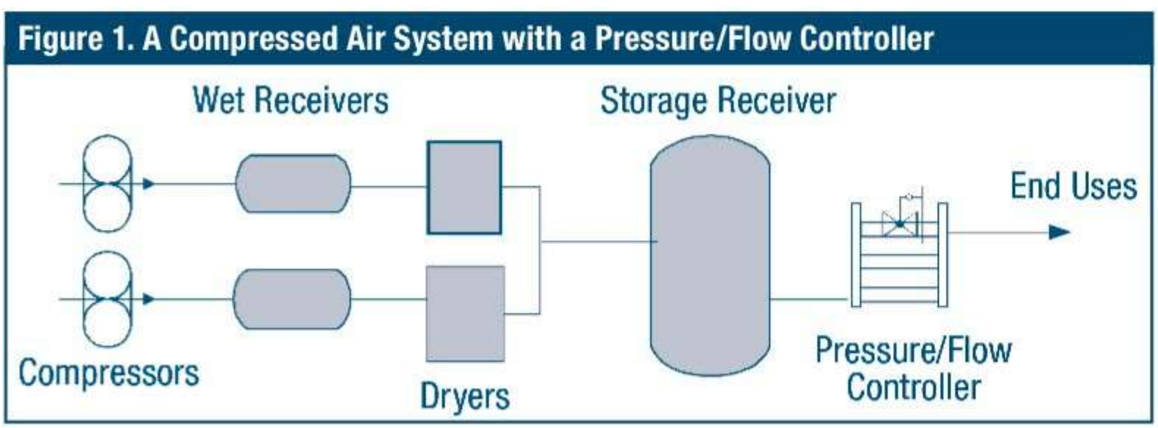
Compressed Air Controller, Pressure/Flow Controller

	Measure Details
Measure Master ID	Compressed Air Controller, Pressure/Flow Controller, 2255
Measure Unit	Compressed Air System
Measure Type	Hybrid
Measure Group	Compressed Air, Vacuum Pumps
Measure Category	Controls
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	178 per system
Peak Demand Reduction (kW)	0.035 per system
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	2,670 per system
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$151.13
Important Comments	

Measure Description

One piece of equipment that can greatly increase the control of an air storage system is a pressure/flow controller. These units, also called demand valves, precision flow controllers, or pilot-operated regulators, are precision pressure regulators that allow the airflow to fluctuate while maintaining a constant pressure to the facility's air distribution piping network.

A Compressed Air System with a Pressure/Flow Controller[2]



Installing a pressure/flow controller on the downstream side of an air storage receiver creates a pressure differential entering and leaving the vessel. This pressure differential stores energy in the form of readily available compressed air, which can be used to supply the peak air demand for short-duration events, in place of using more compressor hp to feed this peak demand.

The benefits of having a pressure/flow controller include:

- Reducing kW of peak demand, especially with multiple-compressor configurations.
- Saving kWh by allowing compressor to run at most efficient loads, then turn itself off in low/no demand periods.
- Saving kWh by reducing plant air pressure to the minimum allowable. This leads to reduced loads on the electric motors and greater efficiency of the system. For every 2 psi reduced in the system, 1% of energy is saved.
- Maintaining a reduced, constant pressure in the facility wastes less air due to leakage, and less volume is required by the compressor.
- Ensuring quality control of the process by the constant pressure. Machines can produce enhanced product quality when pressure is allowed to fluctuate.

Description of Baseline Condition

The baseline conditioning is having no existing pressure/flow controller and an existing compressed air system with a total compressor motor capacity ≥ 50 hp.

Description of Efficient Condition

To qualify for an incentive, the facility must have a compressed air system with motor capacity ≥ 50 hp, and a pressure/flow controller must be installed on the main pressure header. This measure is not to replace drop-line regulators or filter-regulator lubricators.

Annual Energy-Savings Algorithm

kWh_{SAVED} = HP * 0.746 kW/hp / Motor Eff. * Load Factor * HOURS * % decrease

Where:

HP = Compressor motor size (hp)

Motor Eff. = Compressor motor efficiency (= 95%)[3]

Load Factor = Average load on compressor motor (= 89%)[3]

HOURS = Average annual run hours (= 5,083)[4]

% decrease = Percentage decrease in power input (= 5%)[5]

Summer Coincident Peak Savings Algorithm

kW_{SAVED} = HP * 0.746 kW/hp / Motor Eff. * Load Factor * % decrease * CF

Where:

CF = Coincidence factor (= 1)

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Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Industrial Technologies Program. *Compressed Air Tip Sheet #9.* August 2004.
3. Cascade Energy. Proposed Standard Savings Estimation Protocol for Ultra-Premium Efficiency Motors. November 5, 2012.
4. United States Department of Energy Office of Energy Efficiency & Renewable Energy. *United States Industrial Electric Motor Systems Market Opportunities Assessment*. Pg 42. December 2002.
5. United States Department of Energy. *Improving Compressed Air System Performance*: A Sourcebook for Industry. Pg. 20. November 2003.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	03/19/2012	Original
02	Franklin Energy Services	04/01/2013	Updated by the PI

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Compressed Air, Cycling Thermal Mass Air Dryers

	Measure Details
Measure Master ID	Compressed Air, Cycling Thermal Mass Air Dryers, 2264
Measure Unit	per CFM
Measure Type	Hybrid
Measure Group	Compressed Air, Vacuum Pumps
Measure Category	Dryer
Sector(s)	Industrial, Commercial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Calculated
Peak Demand Reduction (kW)	Calculated
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Calculated
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$10.20
Important Comments	

Measure Description

When air is compressed, it is typically saturated with moisture, which may cause corrosion or contamination if it condenses in a compressed air system. Compressed air dryers remove moisture from the compressed air system. Refrigerated dryers are the most common,[2] which remove moisture by cooling the air and causing water vapor to condense. Cycled refrigerated dryers turn on and off, or use a VFD to operate only as needed. Non-cycling dryers will continue to consume energy when drying is not needed.

Description of Baseline Condition

The baseline for this measure is a non-cycling refrigerated thermal mass air dryer.

Description of Efficient Condition

New dryers must be properly sized to meet the needs of the compressed air system in order to qualify. New dryers must be cycling or VFD-controlled refrigerated dryers. This measure is only for the replacement of non-cycled refrigerated dryers with cycled refrigerated dryers. The addition of controls to existing dryers does not qualify. The replacement of desiccant, deliquescent, heat-of-compression, membrane, or other types of dryers does not qualify.

Annual Energy-Savings Algorithm

kWh_{SAVED} = SF * LF * CFM * HOURS

Where:

SF	=	Savings factor in kW/CFM, see table below[3]
LF	=	Load factor (= 89%)[4]
CFM	=	Cubic feet per minute; the rated capacity of air dryer (actual capacity)
HOURS	=	Average annual run hours (= 5,083)[5]

Dryer Capacity in CFM	Savings Factor (kW/CFM)
< 100	0.00474
≥ 100 and < 200	0.00359
≥ 200 and < 300	0.00316
≥ 300 and < 400	0.00290
≥ 400	0.00272

Summer Coincident Peak Savings Algorithm

kW_{SAVED} = SF * LF * CFM * CF

Where:

CF	=	Coincidence factor (= 1)[6]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE}$ = kWh_{SAVED} * EUL

Where:

EUL	=	Effective useful life (= 15 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. United States Department of Energy. Compressed Air Challenge, Improving Compressed Air System Performance: a Sourcebook for Industry. Pg. 11. November 2003.
3. Massachusetts Technical Resource Manual for Estimating Savings from Energy Efficiency Measures. Average of values, pg. 217. October 2010.
4. Proposed Standard Savings Estimation Protocol for Ultra-Premium Efficiency Motors, Cascade Energy, November 5, 2012.

5. United States Department of Energy Office of Energy Efficiency & Renewable Energy. United States Industrial Electric Motor Systems Market Opportunities Assessment. Pg 42. December 2002.
6. Franklin Energy Services, LLC. Personal communications regarding engineering approximation.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	03/19/2012	Original
02	Franklin Energy Services	04/01/2013	Updates by the PI

Compressed Air Heat Recovery, Space Heating

	Measure Details
Measure Master ID	Compressed Air Heat Recovery, Space Heating, 2257
Measure Unit	Horsepower
Measure Type	Hybrid
Measure Group	Compressed Air, Vacuum Pumps
Measure Category	Energy Recovery
Sector(s)	Commercial, Industrial, Schools & Government
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	58 per HP
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	870 per HP
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	Varies by project
Important Comments	

Measure Description

The majority of the energy consumed by industrial air compressors is converted to heat, which can be recovered. Air compressor heat recovery systems are designed to capture waste heat and use it for space heating, water heating, or process heating. These systems can be installed on both air- and water-cooled compressors. For air-cooled compressors, ductwork and fans may be installed to send cool air across the compressor's after-cooler and oil cooler. The cool air absorbs heat from the compressor and gets ducted to where it is needed. For water-cooled compressors, a water-to-air or water-to-water heat exchanger may be used.

Heat recovery systems installed for backup or redundant air compressors do not qualify. The project must result in an estimated net reduction in facility Btus to be eligible. The static pressure in the area where the compressor is enclosed must remain the same, since a reduction in static pressure may reduce compressor efficiency. If outside air is used, anti-freeze protection must be considered.

Description of Baseline Condition

The baseline is a compressor without a heat recovery system.

Description of Efficient Condition

The efficient condition is a compressor with a heat recovery system.

Annual Energy-Savings Algorithm

$Therms_{SAVED}$ = HR * BHP * 2,545 * HOURS * Load Factor / 100,000

Where:

HR	=	Heat recoverable as a percentage of brake hp (= 50%)[2]
BHP	=	Compressor motor size, brake horsepower
2,545	=	Conversion factor Btu to BHP/hour
HOURS	=	Average annual run hours (= 5,083)[3]
Load Factor	=	Average load on compressor motor (= 89%)[4]
100,000	=	Conversion from Btus to therms

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE}$ = $Therms_{SAVED}$ * EUL

Where:

EUL	=	Effective useful life (= 15 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Bonneville Power Administration. Compressed Air System Energy Efficiency Measure Information Sheet. May 2006.
3. United States Department of Energy Office of Energy Efficiency & Renewable Energy. *United States Industrial Electric Motor Systems Market Opportunities Assessment*. Pg 42. December 2002.
4. Cascade Energy. Proposed Standard Savings Estimation Protocol for Ultra-Premium Efficiency Motors. November 5, 2012.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/28/2012	New measure

Compressed Air Mist Eliminators

	Measure Details
Measure Master ID	Compressed Air Mist Eliminators, 2258
Measure Unit	Horsepower
Measure Type	Hybrid
Measure Group	Compressed Air, Vacuum Pumps
Measure Category	Filtration
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	71 per HP
Peak Demand Reduction (kW)	0.014 per HP
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	710 per HP
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10[1]
Incremental Cost	$21.55 per HP
Important Comments	

Measure Description

Large compressed air systems require air filtration for proper operation. These filters remove oil mist from the supply air of lubricated compressors, protecting the distribution system and end-use devices. While these filters are important to the operation of the system, they do have a pressure drop across them, and thus require a slightly higher operating pressure. Typical coalescing oil filters will operate with a 2 psig to 10 psig pressure drop. Mist eliminator air filters operate at a 0.5 psig pressure drop that increases to 3 psig over time before replacement is recommended.

This reduction in pressure drop allows the compressed air system to operate at a reduced pressure and, in turn, reduces the energy consumption of the system. In general, the energy consumption will decrease by 1% for every 2 psig the operating pressure is reduced.[2] Lowering the operating pressure has the secondary benefit of decreasing the demand of all unregulated usage, such as leaks and open blowing.

The equipment is mist eliminator air filters. The compressed air system must be greater than 50 hp to qualify, and the mist eliminator must have less than a 1 psig pressure drop and replace a coalescing filter.

Description of Baseline Condition

The baseline measure is a standard coalescing filter.

Description of Efficient Condition

The efficient condition is a mist eliminator air filter that replaces a standard coalescing filter.

Annual Energy-Savings Algorithm

kWh_{SAVED} = HP * 0.746 / Motor Eff. * Load Factor * HOURS * % Savings

% Savings = $Total_{PR}$ * RS

Where:

HP	=	Compressor motor size (hp)
0.746	=	Conversion factor from HP to kW
Motor Eff.	=	Compressor motor efficiency (= 95%)[2]
Load Factor	=	Average load on compressor motor (= 89%)[2]
HOURS	=	Average annual run hours (= 5,083)[3]
% Savings	=	Percentage of energy saved (= 2%)[4]
$Total_{PR}$	=	Total pressure reduction from replacing filter (= 4 psig)[4]
RS	=	Percentage of energy saved for each psig reduced (= 0.5%)[5]

Summer Coincident Peak Savings Algorithm

kW_{SAVED} = HP * 0.746 / Motor Eff. * Load Factor * % Savings * CF

Where:

CF	=	Coincidence factor (= 1; compressed air systems run during peak demand)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE}$ = kWh_{SAVED} * EUL

Where:

EUL	=	Effective useful life (= 10 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Cascade Energy. Proposed Standard Savings Estimation Protocol for Ultra-Premium Efficiency Motors. November 5, 2012.
3. United States Department of Energy Office of Energy Efficiency & Renewable Energy. *United States Industrial Electric Motor Systems Market Opportunities Assessment*. Pg 42. December 2002.
4. Sullair Corporation. *Compressed Air Filtration and Mist Eliminators Datasheet*. Available online: http://www.amcompair.com/products/brochures/sullair_brochures/_Sullair%20filtration.pdf.
5. United States Department of Energy. *Improving Compressed Air System Performance*: A Sourcebook for Industry. Pg. 20. November 2003.

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Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	03/19/2012	Original

Compressed Air Nozzles, Air Entraining

	Measure Details
Measure Master ID	Compressed Air Nozzles, Air Entraining, 2259
Measure Unit	Nozzle
Measure Type	Prescriptive
Measure Group	Compressed Air, Vacuum Pumps
Measure Category	Nozzle
Sector(s)	Commercial, Industrial, Schools & Government
Annual Energy Savings (kWh)	4,800
Peak Demand Reduction (kW)	1.8
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	72,000
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$36.42
Important Comments	

Measure Description

Engineered nozzles, also known as air entraining nozzles, reduce the amount of compressed air required for cleaning, cooling, and drying, and for blowoff applications. These nozzles use the coanda effect to pull in free air and accomplish tasks for up to 70% less compressed air. Engineered nozzles often replace simple copper tubes, and have the added benefits of reducing noise due to the use of laminar air flow and producing a safer workplace due to the elimination of potential skin contact with high pressure air.

Description of Baseline Condition

The baseline for this savings estimate is a standard efficiency compressed air system operating at an efficiency of 0.16 kW/scfm[2] for a minimum of 2,000 hours per year. Compressed air pipe flow rates are standard.[3]

Description of Efficient Condition

Nozzles must be engineered and usage must be 2,000 hours or greater to qualify.

Annual Energy-Savings Algorithm

kWh_{SAVED} = Eff * (Open Flow – Eng. Flow) * HOURS

Where:

Eff	=	Efficiency of standard air compressor (= 0.16 kW/scfm)
Open Flow	=	Flow of copper pipe nozzle (= 21 scfm)
Eng. Flow	=	Flow of engineered nozzle (= 6 scfm)
HOURS	=	Average annual run hours (= 2,000)

Summer Coincident Peak Savings Algorithm

kW_{SAVED} = Eff * (Open Flow – Eng. Flow) * CF

Where:

CF = Coincidence factor (= 0.75)[4]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE}$ = kWh_{SAVED} * EUL

Where:

EUL = Effective useful life (= 15 years)[1]

Assumptions

The nozzle flow rates are averages based on available published data from engineered nozzle manufacturers.

The savings assume a 1/8-inch diameter open tube.[3]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. United States Department of Energy. *Improving Compressed Air System Performance.* Pgs 48-49.
3. Franklin Energy Services, LLC. Personal communications regarding engineering approximation based on field observation.
4. Technical Reference Manual for Ohio Senate Bill 221 Energy Efficiency and Conservation Program and 09-512-GE-UNC. October 15, 2009.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/24/2012	Original
02	Franklin Energy Services	03/15/2013	Updated

1 South Pinckney• Suite 340 • Madison WI 53703
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Compressed Air System Leak Survey and Repair

	Measure Details
Measure Master ID	Compressed Air System Leak Survey and Repair Year 1, 2261 Compressed Air System Leak Survey and Repair Year 2, 2262 Compressed Air System Leak Survey and Repair Year 3, 2263
Measure Unit	CFM
Measure Type	Hybrid
Measure Group	Compressed Air, Vacuum Pumps
Measure Category	Tune-up / Repair / Commissioning
Sector(s)	Agriculture, Commercial, Industrial, Schools & Government
Annual Energy Savings (kWh)	Calculated
Peak Demand Reduction (kW)	Calculated
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Calculated
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	4[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

For the compressed air system survey and repair measure, the facility's compressed air system is analyzed and areas with opportunity to reduce leakage and energy consumption and gain efficiency through an improved equipment control strategy or equipment replacement are identified.

Description of Baseline Condition

The baseline condition is determined by surveying the existing compressed air system. This involves identifying the number and type of compressors used; their nominal hp, scfm, or psig; and the controls associated with each compressor.

Description of Efficient Condition

In order to qualify for an incentive the customer must repair one leak for every five connected compressor horsepower. If less than one leak per every five horsepower is identified, then all identified leaks must be repaired. The customer may provide a written explanation for a leak that cannot be repaired and may still qualify for an incentive. The customer must provide a leak log in the form of a spreadsheet so that the number of repairs and associated savings can be checked and calculated using the method outlined below.

Annual Energy-Savings Algorithm

This is a hybrid measure and is designed to determine the kWh losses associate with the distribution air system leaks. The required inputs will calculate the estimated system CFM capacity and the associated CFM losses associated with the number of identified leaks. A leak survey will provide the input values for the leak sizes and quantities. The annual energy savings and percentage of existing system losses, along with the grant calculations, are provided as outputs. The general calculation methodology is:

kWh_{SAVED} = (10,655 * [($/kWh) / 0.06] / 104 * OpPressure * (HOURS / 8,760) * ΔCFM Loss) / ($/kWh)))

ΔCFM Loss = #ofLeaks * (CFM/leak)

Where:

10,655	=	Cost of 104 CFM compressed air leak @ $0.06/kWh operating 8,760 hours
$/kWh	=	Unit rate for electricity (assumed $0.06 or participant input)
104	=	Total CFM loss from 1/4 inch leak @ 100 psig
OpPressure	=	Adjustment factor for current operating pressure (table look-up)
HOURS	=	Average annual run hours (participant input)
ΔCFM Loss	=	Total CFM lost in whole system, (Look-Up Table for CFM)
#ofLeaks	=	Number of leaks at each orifice size
CFM/leak	=	CFM of air lost at particular orifice size from dB reading (table look-up (Decibel dB vs CFM))

Adjustment Factor for Operating Pressure (100psig = 1.0)									
OpPressure (psig)	70	75	80	85	90	95	100	110	125
Factor	0.725	0.7625	0.8	0.85	0.90	0.95	1.00	1.10	1.20

Look-Up Table for CFM									
Leak Orifice Size (in)	70	75	80	85	90	95	100	110	125
1/64”	0.29	0.31	0.32	0.34	0.36	0.38	0.40	0.44	0.48
1/32”	1.16	1.21	1.26	1.36	1.46	1.51	1.55	1.75	1.94
1/16”	4.66	4.95	5.24	5.48	5.72	6.02	6.31	6.99	7.66
1/8”	18.62	19.69	20.76	21.93	23.10	24.16	25.22	27.94	30.65
1/4”	74.40	78.75	83.10	87.55	92.00	96.45	100.90	111.55	122.20
3/8”	167.80	177.50	187.20	196.90	206.60	216.80	227.00	251.25	275.50
1/2”	296.00	309.00	322.00	350.50	379.00	397.00	415.00	460.50	506.00

Decibel (dB) vs. CFM[2]					
Digital Reading	100 PSIG	75 PSIG	50 PSIG	25 PSIG	10 PSIG
10 dB	0.5	0.3	0.2	0.1	0.05
20 dB	0.8	0.9	0.5	0.3	0.15
30 dB	1.4	1.1	0.8	0.5	0.4
40 dB	1.7	1.4	1.1	0.8	0.5
50 dB	2.0	2.8	2.2	2.0	1.9
60 dB	3.6	3.0	2.8	2.6	2.3
70 dB	5.2	4.9	3.9	3.4	3.0
80 dB	7.7	6.8	5.6	5.1	3.6
90 dB	8.4	7.7	7.1	6.8	5.3
100 dB	10.6	10.0	9.6	7.3	6.0

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 4 years)[1]

Assumptions

Efficiency of Compressor Types:

- Single-Stage: 3.8 cfm/hp
- Two-stage: 4.8 cfm/hp
- Rotary: 5.2 cfm/hp

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Compressed Air Ultrasonic Leak Detection Guide. Available online: http://www.plantsupport.com/download/UCAGuide.pdf.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/06/2012	Original
02	Franklin Energy Services	04/01/2013	Updates by the PI

Compressed Air Condensate Drains, No Loss Drain

	Measure Details
Measure Master ID	Compressed Air Condensate Drains, No Loss Drain, 2254
Measure Unit	Drain
Measure Type	Prescriptive
Measure Group	Compressed Air, Vacuum Pumps
Measure Category	Other
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	1,525
Peak Demand Reduction (kW)	0.24
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	30,500
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	$624.10
Important Comments	

Measure Description

Air condensate drains, also referred to as traps, allow for water in the form of condensation to be removed from compressed air systems. Undrained water may interfere with the flow of compressed air and may also corrode the piping or tank.

Manual or automatic drains may be used. A manual drain is typically a simple valve that is opened by an operator. Level-operated mechanical drains are automatic and should not waste air if properly maintained, but they do require maintenance. Electrically operated solenoid drains use a timing device to open an orifice for a programmed amount of time, regardless of the level of condensate. Each of these types of drains may waste compressed air, and each can be replaced with no air-loss drains that automatically remove condensate without waste.

Description of Baseline Condition

The baseline for this measure is a timed solenoid drain.

Description of Efficient Condition

The efficient condition is a no loss air drain used in a system with load/no-load, variable speed, variable displacement, or centrifugal compressors. Load/no-load compressors must have adequate storage for drains to be eligible. Manual drains, lever-operated mechanical drains, and solenoid drains are not eligible for incentives. No loss drains must be rated to remove the necessary amount of condensate without any loss of compressed air.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = SF * HOURS$

Where:

SF	=	Saving factor in kW/drain (= 0.3)[2]
HOURS	=	Average annual run hours (= 5,083)[3]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = SF * CF$

Where:

CF	=	Coincidence factor (= 0.80)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 20 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. TecMarket Works. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs. October 15, 2010. Pgs 193-194.
3. United States Department of Energy Office of Energy Efficiency & Renewable Energy. *United States Industrial Electric Motor Systems Market Opportunities Assessment*. December 2002. Pg 42.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	03/19/2012	Original
02	Franklin Energy Services	04/01/2013	Updates by the PI

Domestic Hot Water

Water Heater, High Usage, ≥ 2 EF, Heat Pump Storage, Electric, NG

	Measure Details
Measure Master ID	Water Heater, High Usage, ≥90% TE, NG, 3045 Water Heater, High Usage, ≥2 EF, Heat Pump Storage, Electric, 3047
Measure Unit	Equipment
Measure Type	Hybrid
Measure Group	Domestic Hot Water
Measure Category	Water Heater
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Calculated
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	Calculated
Lifecycle Energy Savings (kWh)	Calculated
Lifecycle Therm Savings (Therms)	Calculated
Water Savings (gal/yr)	0
Effective Useful Life (years)	13[4]
Incremental Cost	MMID 3047 = $2,893, MMID 3045 = $7,303
Important Comments	

Water Heater, High Usage, ≥0.82 EF, Tankless, NG

	Measure Details
Measure Master ID	Water Heater, High Usage, ≥0.82 EF, Tankless, NG, 3046
Measure Unit	Equipment
Measure Type	Hybrid
Measure Group	Domestic Hot Water
Measure Category	Water Heater
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Calculated
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	Calculated
Lifecycle Energy Savings (kWh)	Calculated
Lifecycle Therm Savings (Therms)	Calculated
Water Savings (gal/yr)	0
Effective Useful Life (years)	14[4]
Incremental Cost	$1,120
Important Comments	

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Measure Description

The proposed measure would substitute for a less-efficient, code-compliant baseline DHW heater that would deliver hot water at the same temperature and flow rate as the baseline water heater using less energy.

Description of Baseline Condition

It is assumed that new DHW heaters are only installed when the existing unit has failed, or is judged to have reached its end-of-life condition. Therefore, the baseline unit is a new conventional electric or gas storage water heater intended for service in commercial and industrial buildings. Per the "Market Transformation Efforts for Water Heating Efficiency" report from ACEEE, the following efficiency ratings are assumed:

- Electric DHW Heater: 0.90 EF
- Gas DHW Heater: 0.59 EF

High usage applications are required to meet the annual operation and usage requirements for one or more of the categories below:

Category	Sub Category	Annual Operation (Minimum)	Usage (Minimum)
Food Service	Full Service Restaurant Fast Food	Days/Year (≥300)	Meals/Day (≥ 300)
	Cafeteria	Days/Year (≥175)	Meals/Day (≥ 300)
Lodging	Dormitory	Days/Year (≥200)	Beds (≥ 50)
	Hotel/Motel	Days/Year (≥300)	Rooms or Beds (≥ 30)
Healthcare	Hospital	Days/Year (≥300)	Beds (≥ 30)
	Nursing Home	Days/Year (≥300)	Beds (≥ 30)
Laundry	Laundromat	Days/Year (≥300)	Washes/Day (≥ 30)
Food Sales	Super Market	Days/Year (≥300)	Not Applicable

Description of Efficient Condition

New energy-efficient DHW heater types covered by this document are:

Qualifying Natural Gas Equipment:

- 0.82 EF[2] Natural Gas Tankless Water Heaters
  - To be able to heat water 70°F or more virtually instantaneously, most gas tankless water heaters have gas inputs of 100,000 Btu/hour and higher. Their major advantage is that they have no standby heat losses, which have to be made up by the heater firing whenever the water temperature drops below a set-point. In addition, they are typically installed close to the location where hot water is needed, which minimizes losses from the hot-water delivery piping.

- 90% Thermal Efficiency[2] Condensing Natural Gas Storage Water Heaters
  - Condensing gas storage water heaters are designed to capture the latent heat from water vapor created when natural gas is burned. Conventional gas storage water heaters allow the water vapor to leave the device, and therefore the latent heat is not captured, which means condensing gas heaters have a higher efficiency. Because flue gases have been significantly cooled, condensing gas water heaters require use of a fan to propel combustion products gases through the exhaust flue.

Qualifying Electric Equipment:

- 2.0 EF[1] ENERGY STAR-Qualified Integrated Heat Pump Water Heaters
- 2.0 EF[1] Add-On Heat Pump Water Heaters

It should be noted that the EF rating was developed for residential water heaters, per a DOE rulemaking process, and therefore is based on a test profile intended to be representative of the water usage pattern in a typical residence. There is a general consensus that this profile is not appropriate for rating either the newer types of DHW heaters or the storage type, and a DOE-sponsored committee is currently in the process of developing a better test procedure and profile.

High usage condensing natural gas storage water heaters are not rated with an EF score. For calculation purposes an EF of 0.8 is used for condensing storage water heaters in high usage applications.

Annual Energy-Savings Algorithm

$Btu_{SAVED} = GPY * 8.33 * 1.0 * 60 * [(1/EF_{BASELINE}) – (1/EF_{EFFICIENT})]$

For electric water heaters: $kWh_{SAVED} = Btu_{SAVED} / 3,412$

For gas water heaters: $Therms_{SAVED} = Btu_{SAVED} / 100,000$

Where:

GPY	=	Gallons per year of DHW usage, derived from days/year of operation and gallons/day table below
8.33	=	Density of water, pounds per gallon
1.0	=	Specific heat of water, Btu per (pound-°F temperature change)
60	=	Annual average water temperature change produced by the DHW heater, °F
$EF_{BASELINE}$	=	Efficiency metric for Baseline DHW heater
$EF_{EFFICIENT}$	=	Efficiency metric for Efficient DHW heater
3,412	=	Conversion factor, Btu per kWh
100,000	=	Conversion factor, Btu per Therm

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Facility Type	Avg Daily Gallons	Source
Motels and Hotels ≤ 20 rooms/suites 21 to 99 rooms/suites ≥ 100 rooms/suites	 20 per room 14 per room 10 per room	ASHRAE HVAC Applications 2011, Chapter 50, Table 7
Dormitories	12.7 per student	ASHRAE HVAC Applications 2011, Chapter 50, Table 7 (average of 13.1 for male dormitory and 12.3 for female dormitory)
Hospital	50 per bed	http://smud.apogee.net/comsuite/content/ces/?id=971 (lists a range of 25 to 90 gallons/day/bed, used 50, which is conservative of 57.5 midpoint)
Nursing Homes	18.4 per bed	ASHRAE HVAC Applications 2011, Chapter 50, Table 7
Food Service Full Service Restaurant Cafeteria Fast Food	 2.4 per meal 2.4 per meal 350 per day	Full Service and cafeteria: ASHRAE HVAC Applications 2011, Chapter 50, Table 7 Fast food: ASHRAE HVAC Applications 2011, Chapter 50, page 50.15 (lists range of 250 to 500, use 350 which is just under midpoint of the range).
Supermarket	650 per day	ASHRAE HVAC Applications 2011, Chapter 50, page 50.15 (lists range of 300 to 1000, use average of 650)
Laundry	21 per wash	ASHRAE HVAC Applications 2011, Chapter 50, page 50.12 (for low flow clothes washer)

Summer Coincident Peak Savings Algorithm

Demand savings are calculated for the time when the local utility is experiencing its peak system demand, which – for summer-peaking utilities – typically occurs between 1:00 and 4:00 pm on the hottest non-holiday weekday afternoon during the months of June, July or August. Demand savings are a function of building type because they are a function of whether – at the time of interest – the units are operating intermittently to compensate for heat losses through the tank and surrounding insulation, or operating at a constant level to heat incoming water that is replacing hot water that is being used at a high rate. A careful study to analyze demand savings in various facility types has not been performed, largely because it is recognized that the savings will be quite small. For this reason, and because the power rating of storage-type electric water heaters is the same for the Baseline and Efficient models, zero demand savings are assumed for all storage-type heaters. For heat pump DHW heaters, there will be savings because the power ratings are different.

Electric and Gas Storage DHW Heaters

$kW_{SAVED} = 0$

Electric Heat Pump DHW Heaters

$kW_{SAVED} = CF * FUF * kW_{BASELINE} * [(1/EF_{BASELINE}) – (1/EF_{EFFICIENT})]$

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Where:

CF = Coincidence factor (ratio of expected power demand at the time of utility system peak system demand to the maximum connected load of an item of equipment). See assumed values for various facility types in the table on the next page.

FUF = Facility utilization factor (ratio of facility utilization at the time of utility system peak system demand to the maximum facility utilization at the time). This parameter will be a function of facility type. For dormitories, it should reflect dormitory occupancy during summer months relative to maximum occupancy. Similarly for other facility types, the factor should account for summer weekday occupancy factors that affect DHW usage. See the set of typical FUF values in the table below that can be used if project-specific values are not available.

$kW_{BASELINE}$ = Power rating of the baseline DHW heater

$EF_{BASELINE}$ = Efficiency metric for baseline DHW heater

$EF_{EFFICIENT}$ = Efficiency metric for efficient DHW heater

Coincidence Factors and Facility Utilization Factors

Facility Type	CF	FUF
Dormitories	0.25	0.30
Schools		
Elementary	0.10	0.10
Junior / Middle / High	0.25	0.40
Motels & Hotels *	0.25	1.00
Nursing Homes	0.35	1.00
Hospital (assume same values as nursing home)	0.35	1.00
Office Buildings	0.15	0.90
Food Service	0.40	1.00
Apartment Houses	0.25	0.90
Supermarkets	0.15	1.00
Laundry	0.50	1.00

*Excludes restaurants, kitchens, and laundries

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 13 years[4] for NG storage, = 14 years[4] for NG tankless and electric heat pump)

Sources

1. "Market Transformation Efforts for Water Heating Efficiency," by Jacob Talbot, ACEEE Report A121, American Council for an Energy-Efficient Economy, January 2012.
2. ASHRAE Handbook, HVAC Applications, Chapter 50 - "Service Water Heating", American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., 2011.
3. Sacramento Municipal Utility District, Energy Library / Facility Types / Healthcare / Hospitals: http://smud.apogee.net/comsuite/content/ces/?id=971, accessed November 12, 2014.
4. Focus on Energy Equipment Life Study 2009, Similar Measure consensus.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/01/2013	Revised measure
02	Franklin Energy Services	11/07/2014	Added additional building categories to the measure

Food Service

Dishwasher, ENERGY STAR® Commercial

	Measure Details
Measure Master ID	Dishwasher: Low Temp: Door Type, 2280 (Electric) and 2293 (NG) Multi Tank Conveyor, 2294 (Electric) and 2295 (NG) Single Tank Conveyor, 2296 (Electric) and 2297 (NG) Under Counter, 2298 (Electric) and 2299 (NG) Pots/Pans Type, 3140 (NG) High Temp: Electric Booster, Door Type, 2281 (Electric) and 2282 (NG) Electric Booster, Multi Tank Conveyor, 2283 (Electric) and 2284 (NG) Electric Booster, Single Tank Conveyor, 2285 (Electric) and 2286 (NG) Electric Booster, Under Counter, 2287 (Electric) and 2288 (NG) Electric Booster, Pots/Pans Type, 3137 (NG) Gas Booster, Door Type, 2289 (NG) Gas Booster, Single Tank Conveyor, 2291 (NG) Gas Heat, Gas Booster, Under Counter, 2292 (NG) Gas Booster, Pots/Pans Type, 3138 (NG)
Measure Unit	Dishwasher
Measure Type	Prescriptive
Measure Group	Food Service
Measure Category	Dishwasher, Commercial
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by measure
Peak Demand Reduction (kW)	Varies by measure
Annual Therm Savings (Therms)	Varies by measure
Lifecycle Energy Savings (kWh)	Varies by measure
Lifecycle Therm Savings (Therms)	Varies by measure
Water Savings (gal/yr)	Varies by measure
Effective Useful Life (years)	10[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

On average, ENERGY STAR-qualified commercial dishwashers are 25% more efficient than conventional dishwashers in both energy and water use. The reduction in water use results in additional water-heating energy savings.

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The ENERGY STAR rating applies to commercial under-counter dishwashers; single-tank door type dishwashers; pot, pan, and utensil dishwashers; single- and multiple-tank conveyor dishwashers; and flight-type dishwashers. To meet ENERGY STAR criteria, commercial dishwashers must meet criteria for idle energy use rates and the volume of water consumed per rack.

Dishwasher measures are for higher temperature and lower temperature machines in door type, multitank conveyer, single-tank conveyor, and under-counter machines. Water heater configurations are for electric water heaters with an electric booster heater, natural gas water heaters with an electric booster heater, and natural gas water heaters with a natural gas booster heater. This measure does not apply to flight-type dishwashers, as these units are custom.

Description of Baseline Condition

The baseline condition for commercial dishwashers is based on values found in ENERGY STAR's commercial kitchen equipment calculator;[2] the values are based on the EPA FSTC research on available commercial dishwasher models in 2013.[3]

Description of Efficient Condition

The efficient condition for commercial dishwashers is defined by the ENERGY STAR v2.0 Requirements for Commercial Dishwashers.[2]

Annual Energy-Savings Algorithm

$kWh_{SAVED} = \Delta kWh/yr_{WATER\ HEATER} + \Delta kWh/yr_{BOOSTER\ HEATER} + \Delta kWh/yr_{IDLE}$

$Therms_{SAVED} = \Delta Therms/yr_{WATER\ HEATER} + \Delta Therms/yr_{BOOSTER\ HEATER}$

$Gallons_{SAVED} = Gallons/yr_{BASE} – Gallons/yr_{EE}$

Fuel Type	Machine Type	Algorithm
Electric	Water Heater	$\Delta kWh/yr_{WATER\ HEATER} = Gallons_{SAVED} * kWh/gallon_{WATER\ HEATER}$
	Booster Heater	$\Delta kWh/yr_{BOOSTER\ HEATER} = Gallons_{SAVED} * kWh/gallon_{BOOSTER\ HEATER}$
Gas	Water Heater	$\Delta Therms/yr_{WATER\ HEATER} = Gallons_{SAVED} * Therms/gallon_{WATER\ HEATER}$
	Booster Heater	$\Delta Therms/yr_{BOOSTER\ HEATER} = Gallons_{SAVED} * Therms/gallon_{BOOSTER\ HEATER}$

Fuel Type	Machine Type	Energy Use
Electric	Water Heater	$kWh/gallon_{WATER\ HEATER} = \Delta T_{WH} * C_{WATER} * \rho_{WATER} / \eta_{ELECTRIC} / 3,412$
	Booster Heater	$kWh/gallon_{WATER\ HEATER} = \Delta T_{BH} * C_{WATER} * \rho_{WATER} / \eta_{ELECTRIC} / 3,412$
Gas	Water Heater	$Therms/gallon_{WATER\ HEATER} = \Delta T_{WH} * C_{WATER} * \rho_{WATER} / \eta_{GAS} / 100,000$
	Booster Heater	$Therms/gallon_{BOOSTER\ HEATER} = \Delta T_{WH} * C_{WATER} * \rho_{WATER} / \eta_{GAS} / 100,000$

$\Delta kWh/yr_{IDLE} = (kW_{BASE\ IDLE} * DY * (HD – RD * WT_{BASE} / 60)) – (kW_{EE\ IDLE} * DY * (HD – RD * WT_{EE} / 60))$

$Gallons/yr_{BASE} = GPR_{BASE} * DY * RD$

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$Gallons/yr_{EE} = GPR_{EE} * DY * RD$

Where:

GPR_{BASE}	=	Gallons per rack of baseline equipment[2]
GPR_{EE}	=	Gallons per rack of ENERGY STAR equipment[2]
RD	=	Number of racks of dishes washed each day[2]
DY	=	Days per year of dishwasher operation (= 365)[2]
HD	=	Hours per day of dishwasher operation (= 18)[2]
WT	=	Washtime (= length of wash cycles in minutes, from table below)
$\eta_{ELECTRIC}$	=	Electric conversion efficiency (= 98%)[4]
η_{GAS}	=	Gas conversion efficiency (= 76%)[4]
C_{WATER}	=	Specific heat of water (= 1 Btu/pound/°F)
ρ_{WATER}	=	Density of water (= 8.33 lbs/cubic foot)
100,000	=	Conversion factor from Btu to therms
3,412	=	Conversion factor from Btu to kWh
ΔT_{WH}	=	Temperature rise the water heater delivers (= 70°F)[2]
ΔT_{BH}	=	Temperature rise the booster heater delivers (= 40°F)[2]
$kW_{BASE\ IDLE}$	=	kW consumed by baseline when on but not in a wash cycle (from table below)[2]
$kW_{EE\ IDLE}$	=	kW consumed by efficient equipment when on but not in a wash cycle (from table below)[2]

Measure Type	GPR_{BASE}	GPR_{EE}	$kW_{BASE\ IDLE}$	$kW_{EE\ IDLE}$	WT_{BASE}	WT_{EE}	RD
Low Temperature							
Under Counter	1.73	1.19	0.50	0.50	2.0	2.0	75
Stationary Single-Tank Door	2.10	1.18	0.60	0.60	1.5	1.5	280
Single-Tank Conveyor	1.31	0.79	1.60	1.50	0.3	0.3	400
Multiple Tank Conveyor	1.04	0.54	2.00	2.00	0.3	0.3	600
High Temperature							
Under Counter	1.09	0.86	0.76	0.50	2.0	2.0	75
Stationary Single-Tank Door	1.29	0.89	0.87	0.70	1.0	1.0	280
Single-Tank Conveyor	0.87	0.70	1.93	1.50	0.3	0.3	400
Multiple Tank Conveyor	0.97	0.54	2.59	2.25	0.2	0.2	600
Pot, Pan, and Utensil	0.70	0.58	1.20	1.20	3.0	3.0	280

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = DSav_{DW} * CF$

Where:

$DSav_{DW}$ = Summer demand savings per purchased ENERGY STAR dishwasher (= 0.0225)[5]

CF = Coincident factor (= 1; this is already embedded in the summer peak demand reduction estimate as $DSav_{DW}$)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

$Gallons_{LIFECYCLE} = Gallons_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 10 years)[1]

Deemed Savings

Savings With Electric Water Heater and Booster Heater

	MMID	Baseline		ENERGY STAR		Savings	
		Electric (kWh)	Gas (therm)	Electric (kWh)	Gas (therm)	Electric (kWh)	Gas (therm)
Low Temperature							
Under Counter	2298 (Electric) 2299 (NG)	11,085	0	8,508	0	2,577	0
Stationary Single-Tank Door	2280 (Electric) 2293 (NG) 3140 (Pots/Pans)	39,824	0	23,433	0	16,392	0
Single-Tank Conveyor	2296 (Electric) 2297 (NG)	42,687	0	28,868	0	13,819	0
Multitank Conveyor	2294 (Electric) 2295 (NG)	50,656	0	31,567	0	19,090	0
High Temperature (with electric booster heater)							
Under Counter	2287 (Electric) 2288 (NG)	12,474	0	9,278	0	3,196	0
Stationary Single-Tank Door	2281 (Electric) 2282 (NG) 2761 (Pots/Pans)	40,351	0	28,325	0	12,027	0
Single-Tank Conveyor	2285 (Electric) 2286 (NG)	46,069	0	36,758	0	9,311	0
Multitank Conveyor	2283 (Electric) 2284 (NG)	73,321	0	45,538	0	27,784	0
Pot, Pan, and Utensil	3137	21,351	0	17,991	0	3,360	0

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	MMID	Baseline		ENERGY STAR		Savings	
		Electric (kWh)	Gas (therm)	Electric (kWh)	Gas (therm)	Electric (kWh)	Gas (therm)
High Temperature (with gas booster heater)							
Under Counter	2292	9,502	131	6,933	103	2,569	28
Stationary Single-Tank Door	2289	27,218	578	19,264	399	7,954	179
Single-Tank Conveyor	2291	33,415	557	26,577	448	6,838	109
Multitank Conveyor	2290	52,159	931	33,757	518	18,403	413
Pot, Pan, and Utensil	3138	14,224	314	12,086	260	2,138	54

Savings With Natural Gas Water Heater and Booster Heater

	MMID	Baseline		ENERGY STAR		Savings	
		Electric (kWh)	Gas (therm)	Electric (kWh)	Gas (therm)	Electric (kWh)	Gas (therm)
Low Temperature							
Under Counter	2298 (Electric) 2299 (NG)	2,829	363	2,829	250	0	113
Stationary Single-Tank Door	2280 (Electric) 2293 (NG) 3140 (Pots/Pans)	2,409	1,647	2,409	925	0	721
Single-Tank Conveyor	2296 (Electric) 2297 (NG)	9,344	1,467	8,760	885	584	582
Multitank Conveyor	2294 (Electric) 2295 (NG)	10,950	1,747	10,950	907	0	840
High Temperature (with electric booster heater)							
Under Counter	2287 (Electric) 2288 (NG)	7,272	229	5,174	181	2,098	48
Stationary Single-Tank Door	2281 (Electric) 2282 (NG) 2761 (Pots/Pans)	17,368	1,012	12,468	698	4,900	314
Single-Tank Conveyor	2285 (Electric) 2286 (NG)	23,925	975	18,941	784	4,984	190
Multitank Conveyor	2283 (Electric) 2284 (NG)	36,288	1,630	24,921	907	11,367	723
Pot, Pan, and Utensil	3137	8,879	549	7,657	455	1,222	94

High Temperature (with gas booster heater)							
Under Counter	2292	4,300	360	2,829	284	1,471	76
Stationary Single-Tank Door	2289	4,234	1,590	3,407	1,097	827	493
Single-Tank Conveyor	2291	11,271	1,531	8,760	1,232	2,511	299
Multitank Conveyor	2290	15,126	2,561	13,140	1,426	1,986	1,135
Pot, Pan, and Utensil	3138	1,752	863	1,752	715	0	148

Annual Water Savings

	MMID	Baseline (Gallons/yr)	ENERGY STAR (Gallons/yr)	Savings (Gallons/yr)
Low Temperature				
Under Counter	2298 (Electric) 2299 (NG)	47,359	32,576	14,783
Stationary Single-Tank Door	2280 (Electric) 2293 (NG) 3140 (Pots/Pans)	214,620	120,596	94,024
Single-Tank Conveyor	2296 (Electric) 2297 (NG)	191,260	115,340	75,920
Multitank Conveyor	2294 (Electric) 2295 (NG)	227,760	118,260	109,500
High Temperature				
Under Counter	Electric Booster Heater: 2287 (Electric) 2288 (NG) Gas Booster Heater: 2292	29,839	23,543	6,296
Stationary Single-Tank Door	2281 (Electric) 2282 (NG) 2761 (Pots/Pans)	131,838	90,958	40,880
Single-Tank Conveyor	Electric Booster Heater: 2285 (Electric) 2286 (NG) Gas Booster Heater: 2291	127,020	102,200	24,820
Multitank Conveyor	Electric Booster Heater: 2283 (Electric) 2284 (NG)	212,430	118,260	94,170
Pot, Pan, and Utensil	Electric Booster Heater: 3137 Gas Booster Heater: 3138	71,540	59,276	12,264

Assumptions

For peak demand savings, the HOU is assumed to be the total HOU and is not differentiated from the percentage of time during idle state versus during washing.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. United States Department of Energy. ENERGY STAR Commercial Kitchens Calculator. www.energystar.gov.
3. United State Environmental Protection Agency, Food Service Technology Center.
4. AHRI. RWH research. Most common RE for non-heat pump water heaters: http://www.ahridirectory.org/ahridirectory/pages/rwh/defaultSearch.aspx.
5. Pennsylvania Public Utilities Commission. *Pennsylvania PUC Technical Reference Manual.* June 2013. Demand savings derived using dishwasher load shape.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/01/2013	New measure
02	Franklin Energy Services	02/01/2013	Update to version 2 specification and inclusion of pots and pans

CEE Tier 2 Ice Machines

	Measure Details
Measure Master ID	Ice Machine, CEE Tier 2 Air Cooled: Self Contained, 0-499 lbs/day, 3414 Ice Making Head, 0-499 lbs/day, 3416 Ice Making Head, 500-999 lbs/day, 3417 Ice Making Head, ≥1,000 lbs/day, 3418 Remote Condensing, 0-499 lbs/day, 3422 Remote Condensing, 500-999 lbs/day, 3423 Remote Condensing, ≥1,000 lbs/day, 3424 Water Cooled: Self Contained, 0-499 lbs/day, 3415 Ice Making Head, <500 lbs/day, 3419 Ice Making Head, 500-999 lbs/day, 3420 Ice Making Head, ≥1,000 lbs/day, 3421
Measure Unit	Per Ice Machine
Measure Type	Prescriptive
Measure Group	Food Service
Measure Category	Ice Machine
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by machine type and size
Peak Demand Reduction (kW)	Varies by machine type and size
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by machine type and size
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	53[4]
Effective Useful Life (years)	10[3]
Incremental Cost	Varies by measure, see Appendix D (MMIDs 2388-2418)
Important Comments	

Measure Description

Commercial ice machines are used in restaurants, hospitals, hotels, schools, offices and grocery stores. CEE Tier 2 ice machines are, on average, 10% more efficient than standard models. These machines are designed with more efficient compressors. Investing in more energy efficient ice machines can save hundreds of dollars per year. Additionally, CEE Tier 2 ice machines use approximately 25% less water than standard ice machines.

Description of Baseline Condition

The baseline is a standard ice machine that meets the Energy Policy Act of 2005.

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Description of Efficient Condition

New units must be CEE Tier 2 ice machines with a harvest rate based on operation at standard rating conditions per AHRI Standard 810.

Annual Energy-Savings Algorithm

Based on the harvest rate for various CEE categories of ice machines, each qualifying ice machine must meet an energy use limit based on kWh/100 lbs of ice. The savings is derived from subtracting the CEE Tier 2 energy limits from the baseline Energy Policy Act of 2005 ice machine energy usage. The savings based on each harvest rate category are weighted based on the number of qualifying CEE Tier 2 units from the January 2014 Qualified Products List to provide an overall measure savings for the Measure Descriptions listed above.

$kWh_{SAVED} = (\Delta kWh/100 \text{ lb of ice})/100 * (H * DutyCycle) * 365$

$\Delta kWh/100 \text{ lb of ice} = \Delta B + (\Delta A * H * DutyCycle)$

$\Delta B = B_{BASE} - B_{CEE\ TIER\ 2}$

$\Delta A = A_{BASE} - A_{CEE\ TIER\ 2}$

Where:

100	=	Factor to normalize from 100 lb of ice to each lb of ice
H	=	Harvest rate of ice, lb ice
DutyCycle	=	Percentage of annual average ice machine duty cycle
365	=	Number of days per year
ΔB	=	Constant to calculate kWh consumption per 100 lbs of ice as a function of harvest rate (algorithm represents maximum energy consumption for the category), found in “CEE Tier 2 Ice Machines Calculation_FES_BIP_CSF_LEU_03.18.14”
ΔA	=	Coefficient to calculate kWh consumption per 100 lbs of ice as a function of harvest rate (algorithm represents maximum energy consumption for the category), found in “CEE Tier 2 Ice Machines Calculation_FES_BIP_CSF_LEU_03.18.14”

Summer Coincident Peak Savings Algorithm

Annual energy savings per ice machine measure divided by hours per year.

$kW_{SAVED} = kWh_{SAVED} / HOURS$

Where:

HOURS = Annual hours per year (= 8,760)[2]

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Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 10 years)[3]

Deemed Savings

Annual Deemed Savings

Measure	MMID	kWh	kW
Ice Machine, CEE Tier 2, Air Cooled, Self Contained, 0-499 lbs/day	3414	853	0.0974
Ice Machine, CEE Tier 2, Water Cooled, Self Contained, 0-499 lbs/day	3415	856	0.0977
Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, 0-499 lbs/day	3416	543	0.0619
Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, <500 lbs/day	3419	839	0.0957
Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, 0-499 lbs/day	3422	2,752	0.3141
Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, 500-999 lbs/day	3417	2,266	0.2590
Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, 500-999 lbs/day	3420	1,686	0.1925
Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, 500-999 lbs/day	3423	2,735	0.3141
Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, ≥1,000 lbs/day	3418	1,427	0.1631
Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, ≥1,000 lbs/day	3421	1,686	0.1920
Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, ≥1,000 lbs/day	3424	2,164	0.2469

Lifecycle Deemed Savings

Measure	MMID	Lifecycle kWh
Ice Machine, CEE Tier 2, Air Cooled, Self Contained, 0-499 lbs/day	3414	8,529
Ice Machine, CEE Tier 2, Water Cooled, Self Contained, 0-499 lbs/day	3415	8,560
Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, 0-499 lbs/day	3416	5,425
Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, <500 lbs/day	3419	8,387
Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, 0-499 lbs/day	3422	27,517
Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, 500-999 lbs/day	3417	22,660
Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, 500-999 lbs/day	3420	16,862
Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, 500-999 lbs/day	3423	27,346
Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, ≥1,000 lbs/day	3418	14,267
Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, ≥1,000 lbs/day	3421	16,860
Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, ≥1,000 lbs/day	3424	21,643

Assumptions

Harvest Rate, H. The harvest rates are determined based on the category for the High Efficiency Specifications for Commercial Ice Machines for various types of air cooled and water cooled units for CEE Tier 2 specifications.[1]

Sources

1. CEE Commercial Kitchens Initiative. High Efficiency Specifications for Commercial Ice Machines, Effective Date July 1, 2011. Consortium for Energy Efficiency.
2. 24 hours/day x 7 days/week x 52 weeks/yr = 8,760 hours from State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0 Update Date: March 22, 2010. PA Consulting Group Inc.
3. State of Wisconsin Public Service Commission Wisconsin Focus on Energy Evaluation Business Programs: Measure Life Study Final Report August 25, 2009 PA Consulting Group Inc.
4. Consortium for Energy Efficiency. Average Daily Potable Water Consumption at CEE Tiers. Provided by Kim Erickson, CEE.
5. Consortium for Energy Efficiency. Commercial Ice Machines Specification Revision Technical Analysis. Data obtained from Autoquotes® July 2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/2014	New measure
02	Franklin Energy Services	03/18/2014	Update to measure

ENERGY STAR® Commercial Combination Ovens (Gas or Electric)

	Measure Details
Measure Master ID	Oven, Combination, ENERGY STAR, Electric, 3118 Oven, Combination, ENERGY STAR, NG, 3119
Measure Unit	Per Oven
Measure Type	Prescriptive
Measure Group	Food Service
Measure Category	Oven
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	15,096
Peak Demand Reduction (kW)	3.446
Annual Therm Savings (Therms)	1,103
Lifecycle Energy Savings (kWh)	181,146
Lifecycle Therm Savings (Therms)	13,237
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[8]
Incremental Cost	$4,300
Important Comments	

Measure Description

A combination oven is a self-contained device that functions as a hot air convection (oven mode), saturated and superheated steam heating (steam mode), and combination convection/steam mode for moist heating. The convection/stem mode performs steaming, baking, roasting, rethermalizing, and proofing of various food products. The combination oven can also be referred to as a combination oven/steamer, combi, or combo.

Description of Baseline Condition

Baseline equipment is assumed to be a new combination oven that does not meet ENERGY STAR V2.0 performance specification. Data analysis were provided by the CEE and a dataset was provided by the EPA FSTC and manufacturers from December 2011 through July 2012.

Description of Efficient Condition

Efficient condition is any commercial combination oven that is on the ENERGY STAR Commercial Combination Ovens qualified products list,[1] per the ENERGY STAR V2.0 performance specification for gas and electric combination ovens.[2]

Annual Energy-Savings Algorithms

Electric Combination Oven:

$$kWh_{SAVED} = (Wh/day_{BASELINE} - Wh/day_{EE}) * DPY / 1{,}000$$

$$Wh/day_{EE} = Wh/day_{CONVECTION, EE} + Wh/day_{STEAM, EE} + Wh/day_{PREHEAT, EE}$$

$Wh/day_{CONVECTION, EE} = (1-\%_{STEAM}) * \{(m * E_{CONVECTION}) / \eta_{CONVECTION, EE} + [E_{IDLE-CONVECTION, EE} * (t_{DAY} - m/PC_{CONVECTION, EE} – nP * t_{PREHEAT}/60)]\}$

$Wh/day_{STEAM, EE} = \%_{STEAM} * \{(m * E_{STEAM}) / \eta_{STEAM,EE} + [E_{IDLE-STEAM, EE} * (t_{DAY} - m/PC_{STEAM, EE} – nP * t_{PREHEAT}/60)]\}$

$Wh/day_{PREHEAT, EE} = E_{PREHEAT, EE} * nP$

$Wh/day_{BASELINE} = Wh/day_{CONVECTION, BASELINE} + Wh/day_{STEAM, BASELINE} + Wh/day_{PREHEAT, BASELINE}$

$Wh/day_{CONVECTION, BASELINE} = (1-\%_{STEAM}) *\{(m * E_{CONVECTION}) / \eta_{CONVECTION, BASELINE} + [E_{IDLE-CONVECTION, BASELINE} * (t_{DAY} - m/PC_{CONVECTION, BASELINE} – nP * t_{PREHEAT}/60)]\}$

$Wh/day_{STEAM, BASELINE} = \%_{STEAM} * \{(m* E_{STEAM}) / \eta_{STEAM,BASELINE} + [E_{IDLE-STEAM, BASELINE} * (t_{DAY} - m/PC_{STEAM,BASELINE} – nP * t_{PREHEAT}/60)]\}$

$Wh/day_{PREHEAT, BASELINE} = E_{PREHEAT, BASELINE} * nP$

<u>Gas Combination Oven:</u>

$Therms_{SAVED} = (Btu/day_{BASELINE} – Btu/day_{EE}) * DPY / 100{,}000$

$Btu/day_{EE} = Wh/day_{CONVECTION, EE} + Wh/day_{STEAM, EE} + Wh/day_{PREHEAT, EE}$

$Btu/day_{CONVECTION, EE} = (1-\%_{STEAM}) * \{(m* E_{CONVECTION}) / \eta_{CONVECTION, EE} + [E_{IDLE-CONVECTION, EE} * (t_{day} - m/PC_{CONVECTION, EE} – nP * t_{PREHEAT}/60)]\}$

$Btu/day_{STEAM, EE} = \%_{STEAM} * \{(m * E_{STEAM}) / \eta_{STEAM, EE} + [E_{IDLE-STEAM, EE} * (t_{DAY} - m/PC_{STEAM, EE} – nP * t_{PREHEAT}/60)]\}$

$Btu/day_{PREHEAT, EE} = E_{PREHEAT,EE} * nP$

$Btu/day_{BASELINE} = Btu/day_{CONVECTION, BASELINE} + Btu/day_{STEAM,BASELINE} + Btu/day_{PREHEAT, BASELINE}$

$Btu/day_{CONVECTION, BASELINE} = (1-\%_{STEAM}) * \{(m * E_{CONVECTION}) / \eta_{CONVECTION, BASELINE} + [E_{IDLE-CONVECTION, BASELINE} * (t_{DAY} - m/PC_{CONVECTION, BASELINE} – nP * t_{PREHEAT}/60)]\}$

$Btu/day_{STEAM, BASELINE} = \%_{STEAM} * \{(m* E_{STEAM}) / \eta_{STEAM, BASELINE} + [E_{IDLE-STEAM, BASELINE} * (t_{DAY} - m/PC_{STEAM,BASELINE} – nP * t_{PREHEAT}/60)]\}$

$Btu/day_{PREHEAT, BASELINE} = E_{PREHEAT,BASELINE} * nP$

Where:

DPY	=	Days of operation per year (= 365)[3]
1,000	=	Kilowatt conversion factor
100,000	=	Conversion factor from Btu to therms
$\%_{STEAM}$	=	Percentage of time in steam mode (= 50%)[3]
m	=	Estimated mass of food cooked per day, in pounds (= 250)[3]

$E_{CONVECTION}$ = Energy absorbed by food product: cooking by convection (= 73.2 Wh/lb = 250 Btu/lb)[4]

E_{STEAM} = Energy absorbed by food product: cooking by steam (= 30.8 Wh/lb = 105 Btu/lb)[4]

η = Cooking energy efficiency, from table below[3]

	Electric		Gas	
	Baseline	EE	Baseline	EE
$\eta_{CONVECTION}$	65%	70%	35%	44%
η_{STEAM}	40%	50%	20%	38%

E_{IDLE} = ENERGY STAR idle energy rate, from table below[3]

	Electric (W)		Gas (Btu/h)	
	Baseline	EE	Baseline	EE
$E_{IDLE, CONVECTION}$	3,750	2,500	20,000	11,000
$E_{IDLE, STEAM}$	12,500	6,000	12,500	6,000

t_{DAY} = Estimated operating time per day, in hours (= 12)[3]

PC = Production capacity, in lbs/hour, from table below[3]

	Baseline	EE
$PC_{CONVECTION}$	100	125
PC_{STEAM}	150	200

$t_{PREHEAT}$ = Estimated preheat time, in minutes/preheat (= 15)[3]

nP = Estimated number of preheats/day (= 1)[3]

$E_{PREHEAT}$ = Measured preheat energy; energy used per preheat, from table below[2]

	Baseline	EE
$E_{PREHEAT, ELECTRIC}$ (Watts)	3,750	2,000
$E_{PREHEAT, STEAM}$ (Btu)	22,000	16,000

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = kWh_{SAVED} * (CF / HOU)$

Where:

CF = Coincidence factor (= 1)

HOU = Annual hours-of-use (= 4,380)[3]

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Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 12 years)[8]

Assumptions

The default values given in calculators from the ENERGY STAR FSTC were used for savings calculation variables.

Sources

1. United States Department of Energy. ENERGY STAR product finder: Commercial Combination Ovens.
2. United States Department of Energy. Version 2.0 ENERGY STAR performance specification for gas and electric combination ovens.
3. Food Service Technology Center. Life-Cycle & Energy Cost Calculator: Combination Ovens. http://www.fishnick.com/saveenergy/tools/calculators/.
4. United States Department of Energy. ENERGY STAR Commercial Kitchen Equipment Calculator.
5. United States Department of Energy. ENERGY STAR Commercial Kitchen Equipment Calculator: Oven Calcs Tab.
6. United States Department of Energy. ENERGY STAR Commercial Kitchen Equipment Calculator: Steam Cooker Calcs Tab.
7. Southern California Gas Company. *08-07-022 Applications for Approval of Gas Energy Efficiency Programs and Budgets for Years 2009-2011.* “Food Service Products List Prices 11-07-05” http://www.socalgas.com/regulatory/A0807022.shtml.
8. Wisconsin PSC EUL database, 2013. See Appendix C, similar MMIDs 2485-2488.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/31/2013	New measure

Oven, Convection, ENERGY STAR, Electric

	Measure Details
Measure Master ID	Oven, Convection, ENERGY STAR, Electric, 2485
Measure Unit	Per Full Size Oven
Measure Type	Prescriptive
Measure Group	Food Service
Measure Category	Oven
Sector(s)	Commercial
Annual Energy Savings (kWh)	2,083
Peak Demand Reduction (kW)	0.48
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	24,998
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[5]
Incremental Cost	$50
Important Comments	

Measure Description

A convection oven is a self-contained device that functions as a hot air convection (oven mode), saturated and superheated steam heating (steam mode), and combination convection/steam mode for moist heating. The convection/stem mode performs steaming, baking, roasting, rethermalizing, and proofing of various food products. Savings adjustment for existing active measure based on ENERGY STAR Version 2.1 specification taking effect January 1, 2014.[2]

Description of Baseline Condition

The average cooking energy efficiency of electric full-size convection ovens is 65%. The average idle rate of electric full-size convection ovens is 2 kW.

Description of Efficient Condition

The minimum cooking energy efficiency of ENERGY STAR electric full-size convection ovens is 71%. The maximum idle rate of ENERGY STAR electric full-size convection ovens is 1.6 kW.

Annual Energy-Savings Algorithm

Per the energy formula on page 4-48 of the Deemed Savings Manual 1.0:

$$kWh_{SAVED} = (E_{DAY,\ BASELINE} - E_{DAY,\ ENERGY\ STAR}) * OpDay$$

$$E_{DAY} = [(LB_{FOOD} * E_{FOOD})/Efficiency] + IdleRate * [OpHrs - (LB_{FOOD}/PC) - (T_{PREHT}/60)] + E_{PREHT}$$

Where:

E_{DAY} = Daily energy consumption (kWh or Btu), calculated

LB_{FOOD} = Pounds of food cooked per day (lb), values in table below

E_{FOOD} = ASTM Energy to Food (kWh/lb or Btu/lb), values in table below

Efficiency = ASTM Heavy Load Cooking Energy Efficiency (%), values in table below

IdleRate = Idle energy rate (kW or Btu/hr), values in table below

OpDays = Operating days per year, values in table below

OpHrs = Operating hours per day, values in table below

PC = Production capacity (lb/hr), values in table below

T_{PREHT} = Preheat time (min), values in table below

60 = Conversion from minutes to hours

E_{PREHT} = Preheat energy (kWh or Btu), values in table below

Oven Fuel	Parameter	Baseline Model	ENERGY STAR Model	Source
Electric or Gas	Preheat Time (min)	15	15	Deemed
	Operating Hrs/Day	12	12	3
	Operating Days/Year	365	365	3
	Pounds of Food Cooked per Day	100	100	3
Electric	Production Capacity (lb/h)	90	90	3
	Preheat Energy (kWh)	1.5	1	4
	Idle Energy Rate (kW)	2	1.6	3
	Cooking Energy Efficiency (%)	65%	71%	3
	ASTM Energy to Food (kWh/lb)	0.0732	0.0732	3
Gas	Production Capacity (lb/h)	83	86	3
	Preheat Energy (Btu))	19,000	11,000	4
	Idle Energy Rate (Btu/h)	15,100	12,000	3
	Cooking Energy Efficiency (%)	44%	46%	3
	ASTM Energy to Food (Btu/lb)	250	250	3

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (E_{DAY, BASELINE} – E_{DAY, ENERGY STAR}) / OpHrs$

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 12 years)[5]

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Sources

1. Business Programs, Deemed Savings Manual V1.0, March 22, 2010.
2. ENERGY STAR Commercial Ovens Program Requirements, Version 2.1.
3. ENERGY STAR Commercial Kitchen Equipment Calculator.
4. Food Service Technology Center Electric Convection Oven Life-Cycle Cost Calculator.
5. Food Service Technology Center Gas Convection Oven Life-Cycle Cost Calculator.
6. United States Department of Energy. ENERGY STAR product finder: Commercial Combination Ovens.
7. Deemed Savings Manual 1.0. Table below replaces Table 4-36 on page 4-51 to reflect new Version 2.1 specification criteria, pages 4-48 & 4-49

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/27/2014	Amended workpaper to reflect ENERGY STAR Version 2.1, which took effect January 1, 2014

Oven, Convection, ENERGY STAR, NG

	Measure Details
Measure Master ID	Oven, Convection, ENERGY STAR, NG, 2486
Measure Unit	Per Full Size Oven
Measure Type	Prescriptive
Measure Group	Food Service
Measure Category	Oven
Sector(s)	Commercial, Industrial, Agriculture, Schools and Government
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	156
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	1,872
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[5]
Incremental Cost	$50
Important Comments	

Measure Description

A convection oven is a self-contained device that functions as a hot air convection (oven mode), saturated and superheated steam heating (steam mode), and combination convection/steam mode for moist heating. The convection/stem mode performs steaming, baking, roasting, rethermalizing, and proofing of various food products.

Description of Baseline Condition

The average cooking energy efficiency of gas full-size convection ovens is 44%. The average idle rate of gas full-size convection ovens is 15,100 Btu per hour.

Description of Efficient Condition

The minimum cooking energy efficiency of ENERGY STAR electric full-size convection ovens is 46%. The maximum idle rate of ENERGY STAR gas full-size convection ovens is 12,000 Btu per hour.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (E_{DAY,\ BASELINE} – E_{DAY,\ ENERGY\ STAR}) * OpDay * (1/100,000)$

$E_{DAY} = [(LB_{FOOD} * E_{FOOD})/Efficiency] + IdleRate * [OpHrs – (LB_{FOOD}/PC) – (T_{PREHT}/60)] + E_{PREHT}$

Where:

E_{DAY} = Daily energy consumption (kWh or Btu), calculated

1/100,000 = Btu to therms conversion

LB_{FOOD} = Pounds of food cooked per day (lb), values in table below

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E_{FOOD}	=	ASTM Energy to Food (kWh/lb or Btu/lb), values in table below
Efficiency	=	ASTM Heavy Load Cooking Energy Efficiency (%), values in table below
IdleRate	=	Idle energy rate (kW or Btu/hr), values in table below
OpDays	=	Operating days per year, values in table below
OpHrs	=	Operating hours per day, values in table below
PC	=	Production capacity (lb/hr), values in table below
T_{PREHT}	=	Preheat time (min), values in table below
60	=	Conversion from minutes to hours
E_{PREHT}	=	Preheat energy (kWh or Btu), values in table below

Oven Fuel	Parameter	Baseline Model	ENERGY STAR Model	Source
Electric or Gas	Preheat Time (min)	15	15	Deemed
	Operating Hrs/Day	12	12	3
	Operating Days/Year	365	365	3
	Pounds of Food Cooked per Day	100	100	3
Electric	Production Capacity (lb/h)	90	90	3
	Preheat Energy (kWh)	1.5	1	4
	Idle Energy Rate (kW)	2	1.6	3
	Cooking Energy Efficiency (%)	65%	71%	3
	ASTM Energy to Food (kWh/lb)	0.0732	0.0732	3
Gas	Production Capacity (lb/h)	83	86	3
	Preheat Energy (Btu)	19,000	11,000	4
	Idle Energy Rate (Btu/h)	15,100	12,000	3
	Cooking Energy Efficiency (%)	44%	46%	3
	ASTM Energy to Food (Btu/lb)	250	250	3

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 12 years)[5]

Sources

1. Business Programs, Deemed Savings Manual V1.0, March 22, 2010.
2. ENERGY STAR Commercial Ovens Program Requirements, Version 2.1.
3. ENERGY STAR Commercial Kitchen Equipment Calculator.
4. Food Service Technology Center Electric Convection Oven Life-Cycle Cost Calculator.

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5. Food Service Technology Center Gas Convection Oven Life-Cycle Cost Calculator.
6. United States Department of Energy. ENERGY STAR product finder: Commercial Combination Ovens.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/27/2014	Amended work paper to reflect ENERGY STAR Version 2.1, which took effect January 1, 2014

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Commercial Refrigerator, ENERGY STAR

	Measure Details
Measure Master ID	Refrigerator, Chest, Glass Door < 15 cu ft, ENERGY STAR, 2521 15-29 cu ft, ENERGY STAR, 2522 30-49 cu ft, ENERGY STAR, 2523 50+ cu ft, ENERGY STAR, 2524 Refrigerator, Chest, Solid Door < 15 cu ft, ENERGY STAR, 2525 15-29 cu ft, ENERGY STAR, 2526 30-49 cu ft, ENERGY STAR, 2527 50+ cu ft, ENERGY STAR, 2528 Refrigerator, Vertical, Glass Door < 15 cu ft, ENERGY STAR, 2529 15-29 cu ft, ENERGY STAR, 2530 30-49 cu ft, ENERGY STAR, 2531 50+ cu ft, ENERGY STAR, 2532 Refrigerator, Vertical, Solid Door < 15 cu ft, ENERGY STAR, 2533 15-29 cu ft, ENERGY STAR, 2534 30-49 cu ft, ENERGY STAR, 2535 50+ cu ft, ENERGY STAR, 2536
Measure Unit	Per Refrigerator
Measure Type	Prescriptive
Measure Group	Food Service
Measure Category	Refrigerator / Freezer - Commercial
Sector(s)	Commercial, Industrial, Agriculture, Schools and Government
Annual Energy Savings (kWh)	Varies by size and door type
Peak Demand Reduction (kW)	Varies by size and door type
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by size and door type
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[4]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Installation of ENERGY STAR refrigeration equipment that meets the ENERGY STAR Version 3.0 performance specification, effective October 1, 2014. ENERGY STAR Commercial Solid Door and Glass

Door Refrigerators are designed to be more energy efficient than standard units. ENERGY STAR Commercial Solid Door and Glass Door Refrigerators utilize higher efficiency ECM evaporator and condenser fan motors, hot gas anti-sweat heater or high-efficiency compressors.

Description of Baseline Condition

The baseline condition is U.S. Department of Energy Commercial Refrigeration Equipment standards effective January 10, 2010.[2]

Description of Efficient Condition

The efficient condition is certified ENERGY STAR Version 3.0 vertical and horizontal closed door equipment.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (kWh_{BASELINE} - kWh_{ENERGY\ STAR}) * Days$

Where:

$kWh_{BASELINE}$ = Daily baseline unit consumption, see table below

$kWh_{ENERGY\ STAR}$ = Daily qualifying unit consumption, see table below

Days = Annual days of operation, deemed (= 365)

Unit Type	Door Type	Size (cu. ft.)	Daily Baseline Consumption	Daily Qualifying Consumption	Annual Energy Savings (kWh)	On Peak Savings (kW)	Lifecycle Energy Savings (kWh)
Vertical Closed Refrigerators	Solid	0 < V < 15	0.10V + 2.04	0.02V + 1.60	430	0.0491	5,160
		15 ≤ V < 30	0.10V + 2.04	0.09V + 0.55	620	0.0708	7,440
		30 ≤ V < 50	0.10V + 2.04	0.01V + 2.95	1,063	0.1214	12,756
		50 ≤ V	0.10V + 2.04	0.06V + 0.45	1,564	0.1785	18,768
	Transparent	0 < V < 15	0.12V + 3.34	0.10V + 1.07	890	0.1016	10,680
		15 ≤ V < 30	0.12V + 3.34	0.15V + 0.32	865	0.0987	10,380
		30 ≤ V < 50	0.12V + 3.34	0.06V + 3.02	1,031	0.1177	12,372
		50 ≤ V	0.12V + 3.34	0.08V + 2.02	1,461	0.1668	17,532
Horizontal Closed Refrigerators *	Solid	All volumes	0.10V + 2.04	0.06V + 0.60	726	0.0828	8,712
	Transparent		0.12V + 3.34				

* EPA provided a masked data set for the horizontal closed refrigerators and freezers that did not distinguish the solid door units from the transparent door horizontal units. The baseline used was the solid door daily baseline consumption equation to be conservative in savings estimates for the horizontal closed unit type.

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = kWh_{SAVED}/HOURS$

Where:

HOURS = Hours-of-use, deemed (= 8,760)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 12 years)[4]

Deemed Savings

Measure Master Name	MMID	Deemed Savings Values		
		kWh - Annual	kWh - Lifecycle	kW
Refrigerator, Chest, Glass Door, < 15 cu ft, ENERGY STAR	2521	726	8,712	0.0828
Refrigerator, Chest, Glass Door, 15-29 cu ft, ENERGY STAR	2522	726	8,712	0.0828
Refrigerator, Chest, Glass Door, 30-49 cu ft, ENERGY STAR	2523	726	8,712	0.0828
Refrigerator, Chest, Glass Door, 50+ cu ft, ENERGY STAR	2524	726	8,712	0.0828
Refrigerator, Chest, Solid Door, < 15 cu ft, ENERGY STAR	2525	726	8,712	0.0828
Refrigerator, Chest, Solid Door, 15-29 cu ft, ENERGY STAR	2526	726	8,712	0.0828
Refrigerator, Chest, Solid Door, 30-49 cu ft, ENERGY STAR	2527	726	8,712	0.0828
Refrigerator, Chest, Solid Door, 50+ cu ft, ENERGY STAR	2528	726	8,712	0.0828
Refrigerator, Vertical, Glass Door, < 15 cu ft, ENERGY STAR	2529	890	10,680	0.1016
Refrigerator, Vertical, Glass Door, 15-29 cu ft, ENERGY STAR	2530	865	10,380	0.0987
Refrigerator, Vertical, Glass Door, 30-49 cu ft, ENERGY STAR	2531	1,031	12,372	0.1177
Refrigerator, Vertical, Glass Door, 50+ cu ft, ENERGY STAR	2532	1,461	17,532	0.1668
Refrigerator, Vertical, Solid Door, < 15 cu ft, ENERGY STAR	2533	430	5,160	0.0491

Measure Master Name	MMID	Deemed Savings Values		
		kWh - Annual	kWh - Lifecycle	kW
Refrigerator, Vertical, Solid Door, 15-29 cu ft, ENERGY STAR	2534	620	7,440	0.0708
Refrigerator, Vertical, Solid Door, 30-49 cu ft, ENERGY STAR	2535	1,063	12,756	0.1214
Refrigerator, Vertical, Solid Door, 50+ cu ft, ENERGY STAR	2536	1,564	18,768	0.1785

Sources

1. ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers, Version 3.0.
2. U.S. Department of Energy Commercial Refrigeration Equipment Standards, effective January 20, 2010.
3. Masked data set for commercial refrigerators and freezers, provided by EPA, May 2013.
4. ENERGY STAR Commercial Kitchen Equipment Lifecycle Cost Savings Calculator.
5. Wisconsin PSC EUL database, 2013. See Appendix C.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/28/2014	Revision to existing measures to incorporate ENERGY STAR Version 3.0

Commercial Freezers, ENERGY STAR

	Measure Details
Measure Master ID	Freezer, Chest, Glass Door < 15 cu ft, ENERGY STAR, 2321 15-29 cu ft, ENERGY STAR, 2322 30-49 cu ft, ENERGY STAR, 2323 50+ cu ft, ENERGY STAR, 2324 Freezer, Chest, Solid Door < 15 cu ft, ENERGY STAR, 2325 15-29 cu ft, ENERGY STAR, 2326 30-49 cu ft, ENERGY STAR, 2327 50+ cu ft, ENERGY STAR, 2328 Freezer, Vertical, Glass Door < 15 cu ft, ENERGY STAR, 2329 15-29 cu ft, ENERGY STAR, 2330 30-49 cu ft, ENERGY STAR, 2331 50+ cu ft, ENERGY STAR, 2332 Freezer, Vertical, Solid Door < 15 cu ft, ENERGY STAR, 2333 15-29 cu ft, ENERGY STAR, 2334 30-49 cu ft, ENERGY STAR, 2335 50+ cu ft, ENERGY STAR, 2336
Measure Unit	Per Freezer
Measure Type	Prescriptive
Measure Group	Food Service
Measure Category	Refrigerator / Freezer - Commercial
Sector(s)	Commercial, Industrial, Agricultural, Schools and Government
Annual Energy Savings (kWh)	Varies by size and door type
Peak Demand Reduction (kW)	Varies by size and door type
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by size and door type
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	
Effective Useful Life (years)	12[4]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Installation of ENERGY STAR refrigeration equipment that meets the ENERGY STAR Version 3.0 performance specification, effective October 1, 2014. Revision to existing deemed savings that used

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ENERGY STAR Version 2.0 as the performance specification. ENERGY STAR has since created a Version 3.0 specification that took effect October 1, 2014. ENERGY STAR Commercial Solid Door and Glass Door Freezers are designed to be more energy efficient than standard units. ENERGY STAR Commercial Solid Door and Glass Door Freezers utilize higher efficiency ECM evaporator and condenser fan motors, hot gas anti-sweat heater or high-efficiency compressors.

Description of Baseline Condition

The baseline condition is U.S. Department of Energy Commercial Refrigeration Equipment standards effective January 10, 2010.[2]

Description of Efficient Condition

The efficient condition is certified ENERGY STAR Version 3.0 vertical and horizontal closed freezers.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (kWh_{BASELINE} - kWh_{ENERGY\ STAR}) * Days$

Where:

$kWh_{BASELINE}$ = Daily baseline unit consumption, see table below

$kWh_{ENERGY\ STAR}$ = Daily qualifying unit consumption, see table below

Days = Annual days of operation, deemed (= 365)

Unit Type	Door Type	Size (cu. ft.)	Daily Baseline Consumption Equation	Daily Qualifying Consumption Equation	Annual Energy Savings (kWh)	On Peak Savings (kW)	Lifecycle Energy Savings (kWh)
Vertical Closed Freezers	Solid	0 < V < 15	0.4V + 1.38	0.25V + 1.55	447	0.051	5,364
		15 ≤ V < 30	0.4V + 1.38	0.20V + 2.30	1,204	0.1374	14,448
		30 ≤ V < 50	0.4V + 1.38	0.25V + 0.80	2,557	0.2919	30,684
		50 ≤ V	0.4V + 1.38	0.14V + 6.30	4,602	0.5254	55,224
	Transparent	0 < V < 15	0.75V + 4.10	0.56V + 1.61	1,266	0.1445	15,192
		15 ≤ V < 30	0.75V + 4.10	0.30V + 5.50	3,134	0.3578	37,608
		30 ≤ V < 50	0.75V + 4.10	0.55V - 2.00	5,422	0.6189	65,064
		50 ≤ V	0.75V + 4.10	0.32V + 9.49	8,351	0.9533	100,212
Horizontal Closed Freezers*	Solid	All volumes	0.4V + 1.38	0.10V + 0.20	672	0.0767	8,064
	Transparent		0.75V + 4.10				

* EPA provided a masked data set for the horizontal closed refrigerators and freezers that did not distinguish the solid door units from the transparent door horizontal units. The baseline used was the solid door daily baseline consumption equation to be conservative in savings estimates for the horizontal closed unit type.

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = kWh_{SAVED}/HOURS$

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Where:

HOURS = Hours-of-use, deemed (= 8,760)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 12 years)[4]

Deemed Savings

Measure Master Name	MMID	Deemed Savings		
		kWh - Annual	kWh - Lifecycle	kW
Freezer, Chest, Glass Door, < 15 cu ft, ENERGY STAR	2321	672	8,064	0.0767
Freezer, Chest, Glass Door, 15-29 cu ft, ENERGY STAR	2322	672	8,712	0.0767
Freezer, Chest, Glass Door, 30-49 cu ft, ENERGY STAR	2323	672	8,712	0.0767
Freezer, Chest, Glass Door, 50+ cu ft, ENERGY STAR	2324	672	8,712	0.0767
Freezer, Chest, Solid Door, < 15 cu ft, ENERGY STAR	2325	672	8,712	0.0767
Freezer, Chest, Solid Door, 15-29 cu ft, ENERGY STAR	2326	672	8,712	0.0767
Freezer, Chest, Solid Door, 30-49 cu ft, ENERGY STAR	2327	672	8,712	0.0767
Freezer, Chest, Solid Door, 50+ cu ft, ENERGY STAR	2328	672	8,712	0.0767
Freezer, Vertical, Glass Door, < 15 cu ft, ENERGY STAR	2329	1,266	15,192	0.1445
Freezer, Vertical, Glass Door, 15-29 cu ft, ENERGY STAR	2330	3,134	37,608	0.3578
Freezer, Vertical, Glass Door, 30-49 cu ft, ENERGY STAR	2331	5,422	65,064	0.6189
Freezer, Vertical, Glass Door, 50+ cu ft, ENERGY STAR	2332	8,351	100,212	0.9533
Freezer, Vertical, Solid Door, < 15 cu ft, ENERGY STAR	2333	447	5,364	0.051
Freezer, Vertical, Solid Door, 15-29 cu ft, ENERGY STAR	2334	1,204	14,448	0.1374
Freezer, Vertical, Solid Door, 30-49 cu ft, ENERGY STAR	2335	2,557	30,684	0.2919
Freezer, Vertical, Solid Door, 50+ cu ft, ENERGY STAR	2336	4,602	55,224	0.5254

Sources

1. ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers, Version 3.0.
2. U.S. Department of Energy Commercial Refrigeration Equipment Standards, effective January 20, 2010.
3. Masked data set for commercial refrigerators and freezers, provided by EPA, May 2013.
4. ENERGY STAR Commercial Kitchen Equipment Lifecycle Cost Savings Calculator.
5. Wisconsin PSC EUL database, 2013. See Appendix C.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/28/2014	Revision to existing measures to incorporate ENERGY STAR Version 3.0

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Economizer, RTU Optimization

	Measure Details
Measure Master ID	Economizer, RTU Optimization, 3066
Measure Unit	Per Ton
Measure Type	Hybrid
Measure Group	HVAC
Measure Category	Economizer
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies per ton
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies per ton
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10[4]
Incremental Cost	$155
Important Comments	

Measure Description

A majority of commercial spaces are heated and cooled by packaged rooftop units. This measure is the installation of an air side economizer that offsets or reduces the need for mechanical cooling.

Description of Baseline Condition

The baseline equipment is a packaged rooftop unit with a fixed ventilation rate (fixed damper; no economizer).

Description of Efficient Condition

The efficient equipment includes an economizer controller, actuator, and sensor that provide air side economizing.

Annual Energy-Savings Algorithm

The following algorithm is iterated for and summed over every hour (from April to October, inclusive) that has an outside air dry-bulb temperature greater than or equal to 55°F, the estimated average balance point of the buildings addressed.

$$kWh_{SAVED} = kWh/year_{BASELINE} - kWh/year_{ECONOMIZER}$$

$$kWh/year_{ECONOMIZER} = \Sigma(kW_{HOUR\text{-}INTERVAL\text{-}ECONOMIZER} * 1\ hour)$$

$$kWh/year_{BASELINE} = \Sigma(kW_{HOUR\text{-}INTERVAL\text{-}BASELINE} * 1\ hour)$$

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$kW_{HOUR\text{-}INTERVAL\text{-}ECONOMIZER} = CAP * R_{CAP} * (12 / EER) * Econ_{OPERATING}$

$kW_{HOUR\text{-}INTERVAL\text{-}BASELINE} = CAP * R_{CAP} * (12 / EER)$

Where:

CAP	=	Cooling capacity of equipment, in tons (= varies by equipment; actual equipment values should be used; 1 ton is used for per ton deem savings value provided in this workpaper)
R_{CAP}	=	The cooling load at which the air conditioning compressor is operating, as a percentage/fraction of the full load capacity CAP; interpolated for every hour between (55°F, 0%) and (95°F, 90%).
12	=	Conversion factor from EER to kW/ton
EER	=	Energy efficiency ratio of the rooftop air handling unit, in Btu/(W*hr) (= varies by equipment; default values used for deemed savings values = 9.675)[2]
$Econ_{OPERATING}$	=	Binary variable (1 or 0) that indicates whether or not the economizer is in operation; economizer operates when the outside air temperature (dry-bulb) is between 55°F and 65°F, inclusive
1 hour	=	Duration of time for each hour-long time interval

Summer Coincident Peak Savings Algorithm

Peak demand savings of economizers are assumed to be zero because economizers are not expected to operate during peak hours, due to the outside air temperature constraints; economizers, in this savings algorithm, is defined to operate between outside air dry-bulb temperature of 55°F the estimated building balance point and 65°F the assumed dry bulb equivalent set point, and peak demand hours are likely to be characterized by higher outside air temperature.

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 10 years)[4]

Deemed Savings

The deemed savings were calculated as shown in the table below. The city nearest the participant location should be applied.

WI City	Annual Savings (kWh/yr/ton)	Peak Demand Savings (kW)	Lifecycle Electric Energy Savings (kWh/ton)
Madison	177	0	1,761
Milwaukee	222	0	2,220
Green Bay	229	0	2,293
La Crosse	167	0	1,674
Minocqua	215	0	2,150
Wausau	175	0	1,748
Rice Lake	202	0	2,019

Assumptions

The economizer operates between 55°F and 65°F.

Economizer modulation (mixing of outside air and inside air to match the set point temperature) is not taken into account during the savings analysis.

The fraction of the full capacity that the air conditioning compressor is operating at is assumed to be a linear function of outside air dry-bulb temperature. (0% at 55°F and 90% at 95°F) This assumes correct sizing of the air conditioning unit for each installation, including some extra capacity for cooling beyond 95°F.

The hourly interval weather data for Madison, Milwaukee, Green Bay, La Crosse, and Minocqua, Wausau, and Rice Lake were obtained from TMY 3 data.[3]

Sources

1. Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions. Pg. 47, Dual Enthalpy Economizer. 2013.
2. Straight unweighted average of minimum EER standards for RTUs of cooling capacities greater than 11.25 tons; the International Energy Conservation Code. Table 503.2.3(1). 2009.
3. TMY3 Weather Data: National Solar Radiation Data Base http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html.
4. Wisconsin PSC EUL database, 2013. See Appendix C.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	03/11/2013	New measure

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Energy Recovery Ventilator

	Measure Details
Measure Master ID	Energy Recovery Ventilator, 2314
Measure Unit	CFM
Measure Type	Hybrid
Measure Group	HVAC
Measure Category	Energy Recovery
Sector(s)	Commercial, Industrial, Schools & Government
Annual Energy Savings (kWh)	Calculated
Peak Demand Reduction (kW)	Calculated
Annual Therm Savings (Therms)	Calculated
Lifecycle Energy Savings (kWh)	Calculated
Lifecycle Therm Savings (Therms)	Calculated
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[3]
Incremental Cost	$1,500 per ventilator
Important Comments	

Measure Description

This measure is the installation of an ERV on an HVAC system that provides both heating and cooling to occupied space. ERV systems exchange heat (often both sensible heat and water vapor) between outgoing exhaust air and incoming ventilation air. Under appropriate conditions, this allows for reducing the capacity of the HVAC system, which creates energy savings. Heat and energy recovery wheels are the most commonly applied ERV systems.

Description of Baseline Condition

The baseline is determined from the facility operating hours, current heating/cooling equipment efficiencies, and ERV supply airflow CFM.

Description of Efficient Condition

The efficient condition is an ERV installed on the HVAC system. The system must both heat and cool the space, with minimum cooling hours from 1:00 p.m. to 4:00 p.m., June through August, and heating occurring in the winter. In addition, the following specifications must be met:

- The leaving supply airflow matches that defined in AHRI standard 1060-2005.
- Equipment must be AHRI certified to standard 1060-2005 and bear the AHRI certification symbol for the AHRI air-to-air recovery ventilation equipment certification program based on AHRI 106.
- Qualifying equipment that is independently tested and reported per ASHRAE standard 84-1991 will be accepted.

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Annual Energy-Savings Algorithm

Savings were calculated as the summation of iterations over the full range of temperatures (-30°F to 100°F). The entire range of temperatures was broken into five-degree intervals. Then the energy savings for each temperature interval was calculated. The total savings account for the distribution of the number of hours among the temperature intervals (i.e., number of hours for each five-degree temperature interval).

When in cooling, the following equations were used to determine savings for each temperature interval:[1]

$kWh_{SAVED} = \Sigma\ (\Delta kWh_{TEMP\text{-}INTERVAL})$

$\Delta kWh_{TEMP\text{-}INTERVAL} = [(1/\rho_{AIR} * 60 * V_{SUPPLY} * \eta_{HX\text{-}SUMMER} * (H_{OUT} - H_{RETURN}) / 12{,}000 * \eta_{COOLING}) - kW_{FAN}] * t_{TEMP\text{-}INTERVAL}$

$kW_{FAN} = V_{SUPPLY} * (\Delta P_{HX} + \Delta P_{OTHERS}) / (33{,}013 / 5.202) / \eta_{FANMECH.} / \eta_{FANMOTOR} * 0.746$

When in heating, the following equations were used to determine savings for each temperature interval:

$Therms_{SAVED} = \Sigma\ (\Delta Therms_{TEMP\text{-}INTERVAL})$

$\Delta Therms_{TEMP\text{-}INTERVAL} = ((1.08 * V_{SUPPLY} * \eta_{HX\text{-}WINTER} * (T_{HEATED\ SPACE} - T_{OUTSIDE}) / 100{,}000) / \eta_{HEATING}) * t_{TEMP\text{-}INTERVAL}$

Where:

$t_{TEMP\text{-}INTERVAL}$	=	Number of hours the system operates in the particular temperature interval
$1/\rho_{AIR}$	=	Specific volume of air (ρ_{AIR} = 0.075 lb/cubic foot at 1 atm and 68°F)
60	=	Conversion factor from hours to minutes
V_{SUPPLY}	=	Volume of supply air (= actual or default value of 7,200 CFM)
$\eta_{HX\text{-}SUMMER}$	=	Efficiency of summer heat exchanger (= actual or default value of 74%)
H_{OUT}	=	Enthalpy of outside air in Btu/lb, based on temperature interval
H_{RETURN}	=	Enthalpy of inside air at 75°F, 50% RH (= 28.3 Btu/lb)
12,000	=	Conversion from Btu to tons (of cooling)
$\eta_{COOLING}$	=	Efficiency of the cooling system (= 1.20 kW/ton)
ΔP_{HX}	=	Pressure drop across the heat exchanger (= 0.29 inches of water)
ΔP_{OTHERS}	=	Pressure drop across the filter, louver, inlet, and outlet (= 0.80 inches of water)
33,013	=	Conversion factor from HP to ft-lb/min
5.202	=	Conversion factor from inches of water to lb/square foot
$\eta_{FANMECH}$	=	Fan mechanical efficiency (= actual of default value of 65%)

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$\eta_{FANMOTOR}$ = Fan motor efficiency (= actual or default value of 89.5% for 5 HP fan motor)

0.746 = Conversion factor from HP to kW

1.08 = Conversion factor derived from pounds of air per hour multiplied by the heat capacity of air in Btu/pound – F and 60 minutes per hour. Allows the enthalpy to be determined using the volumetric flowrate of air in cfm and the temperature difference

$\eta_{HX-WINTER}$ = Efficiency of summer heat exchanger (= actual or default value of 73%)

$T_{HEATED\ SPACE}$ = Temperature inside heated space (= 68°F)

$T_{OUTSIDE}$ = Midpoint of the temperature interval outside in Fahrenheit, based on temperature interval

100,000 = Btu to therm conversion

$\eta_{HEATING}$ = Efficiency of the heating system (= 85%)

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = kWh_{SAVED} / HOURS_{COOLING}$

Where:

kWh_{SAVED} = Annual savings during cooling season, based on temperature interval (= 9,615 kWh)

$HOURS_{COOLING}$ = Number of operating hours during cooling (= 1,258)[2]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[3]

Deemed Savings

	Annual Energy Savings	Peak Demand Savings	Lifecycle Energy Savings
Yearlong	72 kWh	-	1,080 kWh
	13,576 Therms	-	203,640 Therms
Cooling	11,867 kWh	9.43 kW	178,005 kWh
	-	-	-
Heating	-11,795 kWh	-	176,925 kWh
	13,576 Therms	-	203,640 Therms

There are negative kWh savings from operating the fan (kWh_{FAN}); when the system is in heating mode, heating savings come from gas savings, whereas the electric energy use increases due to the kWh consumed by the fan. However, the overall Btu savings is net positive.

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Assumptions

Deemed savings values were calculated for a system with a 7,200 CFM supply fan.

All of the assumptions used in the savings calculations, listed in the definition of terms, are from the Focus on Energy Program Energy Recovery Ventilator Calculation input.[1]

The weather intervals and corresponding operating hours in the following tables were used to calculate the deemed savings values.[2]

	Temperature Range (°F)	Range Midpoint (°F)	Hours Operating in Each Temperature Interval (hours)	Enthalpy (Btu/lb)
Cooling	95 to 100	97.5	4.18	42.12
	90 to 95	92.5	20.56	40.57
	85 to 90	87.5	70.72	39.45
	80 to 85	82.5	266.68	35.13
	75 to 80	77.5	421.24	32.40
	70 to 75	72.5	474.69	30.69
Heating	65 to 70	67.5	698.74	28.33
	60 to 65	62.5	877.28	25.22
	55 to 60	57.5	574.89	21.97
	50 to 55	52.5	642.02	19.17
	45 to 50	47.5	466.10	17.11
	40 to 45	42.5	639.90	15.06
	35 to 40	37.5	859.58	12.95
	30 to 35	32.5	730.96	10.99
	25 to 30	27.5	429.07	9.13
	20 to 25	22.5	507.80	7.61
	15 to 20	17.5	388.02	5.87
	10 to 15	12.5	229.07	4.04
	5 to 10	7.5	147.38	2.53
	0 to 5	2.5	95.69	1.30
	-5 to 0	-2.5	93.43	0.08
	-10 to -5	-7.5	79.95	-1.39
	-15 to -10	-12.5	27.69	-2.52
	-20 to -15	-17.5	9.57	-3.90
	-25 to -20	-22.5	3.49	-4.86
	-30 to -25	-27.5	1.31	-6.22

Sources

1. PA Consulting Group Inc. and Public Service Commission of Wisconsin. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual*. Final Report. March 22, 2010.
2. Focus on Energy Program, Energy Recovery Ventilator Calculation.
3. Wisconsin PSC EUL database, 2013. See Appendix C.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/06/2012	Original
02	Franklin Energy Services	04/01/2013	Updates by the PI

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NG Furnace with ECM, 95%+ AFUE (Existing)

	Measure Details
Measure Master ID	NG Furnace with ECM, 95%+ AFUE (Existing), 1981
Measure Unit	Per Unit
Measure Type	Prescriptive
Measure Group	HVAC
Measure Category	Furnace
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	831
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	97.3
Lifecycle Energy Savings (kWh)	14,967
Lifecycle Therm Savings (Therms)	1,751
Water Savings (gal/yr)	0
Effective Useful Life (years)	18[1]
Incremental Cost	$345.93
Important Comments	

Measure Description

Conventional gas furnaces produce by-products, such as water vapor and carbon dioxide. These by-products are usually vented out through a chimney, along with a considerable amount of heat. This occurs not only when the furnace is in use, but also when it is turned off. Newer designs increase energy efficiency by reducing the amount of heat that escapes and by extracting heat from the flue gas before it is vented. These furnaces use much less energy than conventional furnaces.

Description of Baseline Condition

The baseline condition is a conventional furnace with AFUE < 78%

Description of Efficient Condition

The efficient condition is furnaces with AFUE ≥ 95%, a multi-stage burner, variable speed ECM or brushless DC blower motor, and at least two firing stages.

Annual Energy-Savings Algorithm

Therm savings are calculated by finding the difference in energy consumptions between standard efficiency furnaces and high efficiency furnaces. Electric savings are estimated by multiplying the consumption of the efficient furnace in therms by a kWh/therm savings factor.

$$Therms_{SAVED} = CAP * HOURS_{HEATING} * (1/AFUE_{BASE} - 1/AFUE_{EE}) * (1/100)$$

$$kWh_{SAVED} = (kWh/therm) * CAP * HOURS_{HEATING} * (1/100)$$

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Where:

CAP = Actual output capacity of furnace (= 90 MBtu/hour)[2]

$HOURS_{HEATING}$ = Engineering estimate using 20% oversize factor, 80°F design temperature differential, and 7,699 HDD

$AFUE_{BASE}$ = Efficiency rating of standard efficiency furnace, deemed (= 78%)

$AFUE_{EE}$ = Efficiency rating of high-efficiency furnace, deemed (= 95%)

100 = Conversion factor, MBtus per therm

kWh/therm = High-efficiency electric savings factor, deemed (= 0.5 kWh/therm where therm use is based on 100% AFUE system)

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 18 years)[1]

Sources

1. State of Wisconsin Public Service Commission of Wisconsin "Focus on Energy Evaluation: Business Programs: Measure Life Study" Final Report: August 25, 2009 prepared by PA Consulting Group Inc.
2. Cadmus review of small commercial furnace sizes, various utilities.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services		Original workpaper
02	Franklin Energy Services	11/11/2014	Change from furnace size categories (11 measures) to per/MBH (one measure)

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VFD HVAC Applications

	Measure Details
Measure Master ID	VFD, HVAC Fan, 2643 VFD, HVAC Heating Pump, 2644
Measure Unit	Horsepower
Measure Type	Hybrid
Measure Group	HVAC
Measure Category	Motors and Drives
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	880 per horsepower[1]
Peak Demand Reduction (kW)	0.13 per horsepower[2]
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	13,200 per horsepower
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[3]
Incremental Cost	$130 per horsepower
Important Comments	

Measure Description

This measure is a VSD installed on an existing HVAC fan or pump (retrofit only) in a multifamily building. Units must operate a minimum of 2,000 hours annually. This measure only applies to HVAC applications in multifamily buildings. The deemed savings values are based on average motor size of 7.5 hp.

Description of Baseline Condition

The baseline condition is a pump or fan that operates at a constant speed.

Description of Efficient Condition

VSDs physically slow motors' driving pumps and fans in order to achieve reduced flow rates at considerable energy savings. Traditionally, flow rates have been reduced by increasing the head pressure drop in a system and riding the pump or fan curve back to a new flow rate (throttling control). Alternately some systems have bypasses that divert a portion of the flow back to the pump or fan inlet to reduce system flow (bypass control).

This measure is VSDs installed on existing HVAC fans and pumps. The installation of a VSD must accompany the permanent removal or disabling of any throttling devices such as inlet vanes, bypass dampers, and throttling valves. Unit must operate a minimum of 2,000 hours annually. VSDs on new equipment are not eligible. Redundant, back-up units and replacement of existing VSDs do not qualify.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = kWh_{BASE} - kWh_{VSD}$

kWh_{BASE} = ($Watts_{BASE}$ * HOURS) / 1,000

kWh_{VSD} = Σ($Watts_{VSD,i}$ * CAP_i × HOURS) / 1,000

Where:

$Watts_{BASE}$	=	Power draw of baseline motor at constant baseline speed
$Watts_{VSD,i}$	=	Power draw of motor with VSD at capacity *i*
CAP_i	=	Percentage of time motor runs at capacity *i* (CAP_i should add to 100%)
1,000	=	Kilowatt conversion factor
HOURS	=	Annual operating hours

Summer Coincident Peak Savings Algorithm

kW_{SAVED} = kW_{BASE} – kW_{VSD}

kW_{BASE} = $Watts_{BASE}$ * $HOURS_{PEAK}$

kW_{VSD} = Σ($Watts_{VSD,i}$ * $CAP_{i,PEAK}$ * $HOURS_{PEAK}$) / 1,000

Where:

$Watts_{BASE}$	=	Power draw of baseline motor at constant baseline speed
$Watts_{VSD,i}$	=	Power draw of motor with VSD at capacity *i*
$CAP_{i,PEAK}$	=	Percentage of time motor runs at capacity *i* during the peak period ($CAP_{i,PEAK}$ should add to 100%)
$HOURS_{PEAK}$	=	Annual operating hours during peak period

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE}$ = kWh_{SAVED} * EUL

Where:

EUL	=	Effective useful life (= 15 years)[3]

Sources

1. State of Wisconsin Public Service Commission of Wisconsin. Focus on Energy ACES Program. 2008-2010 average project savings for measure (based on an average of 7.5 HP).
2. Michigan Public Service Commission. Department of Licensing and Regulatory Affairs. Michigan Energy Measures Database: http://www.michigan.gov/mpsc/0,1607,7-159-52495_55129---,00.html.
3. Focus on Energy Evaluation - Business Program: Measure Life Study 2009.

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Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/25/2012	Initial draft
02	Franklin Energy Services	03/08/2013	Update based on evaluation comments

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A/C Split or Packaged System, High Efficiency

	Measure Details
Measure Master ID	A/C Split or Packaged System, High Efficiency, 3022
Measure Unit	Per Split System Installed
Measure Type	Hybrid
Measure Group	HVAC
Measure Category	Rooftop Unit / Split System AC
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by capacity
Peak Demand Reduction (kW)	Varies by capacity
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by capacity
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$100 per ton
Important Comments	

Measure Description

This measure is the installation of high-efficiency, unitary packaged and split air conditioning equipment. This measure also applies to replacing an existing unit at the end of its useful life or installing a new unit in a new or existing building.

Description of Baseline Condition

The baseline equipment for new construction or where new equipment is required by code is assumed to be a standard-efficiency packaged or split air conditioner that meets the 2009 IECC energy-efficiency requirements.[2] The rating conditions for the baseline and efficient equipment efficiencies must be equivalent.

Baseline Equipment for New Construction

IECC 2009, Table 503.2.3(1)	Minimum Efficiency[2]
Standard AC Unit < 65 kBtu/hour (5.42 tons)	13.0 SEER
Standard AC Unit ≥ 65 and < 135 kBtu/hour (5.42 to 11.25 tons)	11.2 EER
Standard AC Unit ≥ 135 and < 239 KBtu/hour (11.25 to 20 tons)	11.0 EER
Standard AC Unit ≥ 240 and < 759 kBtu/hour (20 to 63.33 tons)	10.0 EER
Standard AC Unit ≥ 760 kBtu/hour (63.33 tons)	9.7 EER

The baseline equipment for existing buildings is assumed to be a standard-efficiency packaged or split air conditioner that meets the 2006 IECC energy-efficiency requirements.[3] The rating conditions for the baseline and efficient equipment efficiencies must be equivalent.

Baseline Equipment for Existing Building

IECC 2006 Table 503.2.3(1)	Minimum Efficiency
Standard AC Unit < 65 kBtu/hour (5.42 tons)	10.0 SEER
Standard AC Unit ≥ 65 and < 135 kBtu/hour (5.42 to 11.25 tons)	10.3 EER
Standard AC Unit ≥ 135 and < 239 KBtu/hour (11.25 to 20 tons)	9.7 EER
Standard AC Unit ≥ 240 and < 759 kBtu/hour (20 to 63.33 tons)	9.5 EER
Standard AC Unit ≥ 760 kBtu/hour (63.33 tons)	9.2 EER

Description of Efficient Condition

The efficient equipment shall be a high-efficiency packaged air conditioner that exceeds the minimum CEE energy-efficiency requirements.[2]

CEE High Efficiency RTU Efficiencies by Size	Minimum to Qualify
High Eff AC Unit < 65 kBtu/hour (5.42 tons)	15.0 SEER / 12.0 EER
High Eff AC Unit ≥ 65 and < 135 kBtu/hour (5.42 to 11.25 tons)	12.0 EER / 13.8 IEER
High Eff AC Unit ≥ 135 and < 239 KBtu/hour (11.25 to 20 tons)	12.0 EER / 13.0 IEER
High Eff AC Unit ≥ 240 and < 759 kBtu/hour (20 to 63.33 tons)	10.6 EER / 12.1 IEER
High Eff AC Unit ≥ 760 kBtu/hour (63.33 tons)	10.2 EER / 11.4 IEER

Annual Energy-Savings Algorithm

$kWh_{SAVED} = kWh_{BASE} - kWh_{EE}$

Baseline (kWh_{BASE})	
≥ 65 kBtu	kWh_{BASE} = Capacity * RLF * $EFLH_C$ * (1/EER_{BASE}) * (1 kW/1,000)
< 65 kBtu	kWh_{BASE} = Capacity * RLF * $EFLH_C$ * (1/$SEER_{BASE}$) * (1 kW/1,000)
Efficient (kWh_{EE})	
≥ 65 kBtu	kWh_{EE} = Capacity * RLF * $EFLH_C$ * (1/EER_{EE}) * (1 kW/1,000)
< 65 kBtu	kWh_{EE} = Capacity * RLF * $EFLH_C$ * (1/$SEER_{BASE}$) * (1 kW/1,000)

Where:

Capacity = Capacity (size) of the unit, in Btu/hour

RLF = Rated load factor; the peak cooling load/nameplate capacity. This factor compensates for oversizing of the air conditioning unit (= 0.90)

$EFLH_C$ = Cooling equivalent full load hours (see table below for default values)

EER_{BASE} = Energy efficiency ratio of standard efficiency code baseline unit, in Btu/watt-hour

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$SEER_{BASE}$ = Seasonal energy efficiency rating. Factor used on smaller commercial and residential cooling equipment > 65 kBtu. For air conditioning units < 65 kBtu, used SEER instead of EER to calculate kWh_{SAVED}, then converted SEER to EER (11.3/13) to calculate kW saved

EER_{EE} = Energy efficiency ratio of energy-efficient unit, in Btu/watt-hour

Building Type	$EFLH_C$[3]
College	877
Food Sales	749
Food Service	578
Healthcare	803
Hotel/Motel	663
Industrial	519
Office	578
Other	589
Public Assembly	535
Public Services (non-food)	535
Retail	567
School	439
Warehouse	358
Average	**599**

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = kW_{BASE} - kW_{EE}$

Baseline (kW_{BASE})	
≥ 65 kBtu	kW_{BASE} = Capacity * (1kW/1,000) * CF * ($1/EER_{BASE}$)
< 65 kBtu	kW_{BASE} = Capacity (Btu/hour) * (1 kW/1,000) * CF * ($1/SEER_{BASE}$)
Efficient (kW_{EE})	
≥ 65 kBtu	kW_{EE} = Capacity * (1 kW/1,000) * CF * ($1/EER_{EE}$)
< 65 kBtu	kW_{EE} = Capacity * (1 kW/1,000) * CF * ($1/SEER_{EE}$)

Where

CF = Coincidence factor (= 0.8)[4]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[1]

Deemed Savings

Capacity (Btu/hour)	SEER/ EER_{BASE}	SEER/ EER_{EE}	MMID	kWh_{BASE}	kWh_{EE}	kWh_{SAVED}	kW_{BASE}	kW_{EE}	kW_{SAVED}	$kWh_{LIFECYCLE}$
50,000	10	15		2,695.50	1,797.00	899	4.00	2.67	1.33	13,478
100,000	10.3	12.0		5,233.98	4,492.50	742	7.77	6.67	1.10	11,122
187,000	9.7	12.0	3022	10,392.96	8,400.98	1,627	15.42	12.47	2.96	29,880
517,500	9.5	10.6		29,366.76	26,319.27	3,048	43.58	39.06	4.52	45,712
800,000	9.2	10.2		46,878.26	42,282.35	3,315	69.57	62.75	6.82	68,939

Assumptions

The average (mean) value for all building types was used to determine cooling EFLH.

A default value of 0.90 was assumed for the rated load factor.

The deemed savings values were calculated for hypothetical units with capacities equal to the midpoint of each interval found in the IECC 2009 standard, with the exception of those units that are < 65 kBtu/hour (which used 50 kBtu/hour) and ≥ 760 kBtu/hour (which used 800 kBtu/hour).

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, similar A/C measures (MMIDs 123-124, 821-879, 2192-2194).
2. International Energy Conservation Code. Table 503.2.3(1). 2009.

   International Energy Conservation Code. Table 503.2.3(1). 2006.
4. DEER model runs are weather normalized for statewide use by population density.
5. Focus on Energy Business Programs Deemed Savings Manual V1.0. March 22, 2010.
6. Incremental Measure Cost from 2005 DEER D03-078, D03-079, D03-103, D03-104, D03-105.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/01/2013	New measure
02	Franklin Energy Services	11/14/2014	Update to minimum qualification efficiencies

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Steam Trap Repair, >50 PSIG, General Heating

	Measure Details
Measure Master ID	Steam Trap Repair, 50-125 psig, General Heating 7/32" or Smaller, 3269 1/4", 3270 5/16", 3271 3/8" or Larger, 3272 Steam Trap Repair, 126-225 psig, General Heating 7/32" or Smaller, 3520 1/4", 3517 5/16", 3519 3/8" or Larger, 3518 Steam Trap Repair, >225 psig, General Heating 7/32" or Smaller, 3524 1/4", 3521 5/16", 3523 3/8" or Larger, 3522
Measure Unit	Steam Trap
Measure Type	Prescriptive
Measure Group	HVAC
Measure Category	Steam Trap
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	Varies by measure
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	Varies by measure
Water Savings (gal/yr)	0
Effective Useful Life (years)	6[1]
Incremental Cost	Varies, see Appendix D
Important Comments	

Measure Description

Repair failed open steam traps leaking steam into the condensate lines for HVAC only steam systems.

Steam distribution systems contain steam traps, which are automatic valves that remove condensate, air, and other non-condensable gases, while preventing or minimizing steam loss. This measure is for the repair of failed steam traps that are leaking steam within the trap, and are part of an HVAC steam system.

Steam traps that fail in the open position allow steam to escape into the condensate lines before the available heat energy can be used for space heating, wasting the energy used to make the steam. By replacing or repairing traps that have failed in the open position, the wasted heat energy can be conserved.

A steam trap survey and repair log must be completed

The measure specifications are as follows:

- Boiler must be used for space heating, not process applications.
- Repaired traps must be leaking steam, not failed closed or plugged.
- Incentive is available once per year per system.
- Municipal steam systems do not qualify.

A steam trap survey and repair log must be completed. Required information includes a trap ID tag number, location description, nominal steam pressure, trap type, trap condition (functioning, failed open, or failed closed), and orifice size.

Description of Baseline Condition

The baseline for this measure is a stream trap that has failed in the open position and is leaking steam into the condensate line in a high-pressure (>50 psig) steam system. The steam from the boiler must be used for space heating and not for process applications. The boiler is assumed to operate with 80% efficiency. It is important to note that the trap must be failed in the open position and not failed closed or plugged.

Description of Efficient Condition

Replaced or repaired traps that have failed in the open position, utilizing steam heat that was previously wasted./

Annual Energy-Savings Algorithm

W = 24.24 * P_abs *(OD)^2 (Napier's Formula)

$Therms_{SAVED} = 24.24 * D^2 * (P_g + P_{atm}) * h_{fg} * HOURS * DF / 100{,}000 / Eff$

Where:

24.24	=	Constant from Napier equation
D	=	Steam trap orifice diameter in inches (= 7/32, 1/4, 5/16, 3/8)
P_g	=	Gauge pressure in pounds per square inch (= 87.5, 175.5, 226)
P_{atm}	=	Atmospheric pressure at sea level in pounds per square inch (= 14.7)
h_{fg}	=	Latent heat of steam at P_g in Btu/lb (= 887.8, 847.2, 828.7)
HOURS	=	Annual hours of operation, corresponding to the number of hours that the boiler is on and the system is at design pressure (= 4,706 [4])

DF	=	De-rating factor to account for the percentage that the trap is failed open (= 50%[5])
100,000	=	Conversion factor from Btu to Therm
Eff	=	Boiler efficiency, for this calculation, refers to the boiler's combustion efficiency (= 80%)

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 6 years)[1]

Assumptions

The steam trap is assumed to be failed open, for an HVAC steam distribution system operating with a boiler efficiency of 80%.

The following pressures were used to calculate the deemed savings for each pressure range and their corresponding latent heat values:

- 50-125 psig: 87.5 psig; 887.8 Btu/lb
- 126-225 psig: 175.5 psig; 847.2 Btu/lb
- >225 psig: 226 psig; 828.7 Btu/lb

Deemed Savings

Measure Name	MMID	Annual Savings (Therms)	Lifecycle Savings (Therms)
Steam Trap Repair, 50-125 psig, General Heating, 7/32" or Smaller	3269	3,095	18,573
Steam Trap Repair, 50-125 psig, General Heating, 1/4"	3270	4,043	24,258
Steam Trap Repair, 50-125 psig, General Heating, 5/16"	3271	6,317	37,904
Steam Trap Repair, 50-125 psig, General Heating, 3/8" or Larger	3272	9,097	54,581
Steam Trap Repair, 126-225 psig, General Heating, 7/32" or Smaller	3520	5,497	32,984
Steam Trap Repair, 126-225 psig, General Heating, 1/4"	3517	7,180	43,082
Steam Trap Repair, 126-225 psig, General Heating, 5/16"	3519	11,219	67,315
Steam Trap Repair, 126-225 psig, General Heating, 3/8" or Larger	3518	16,156	96,934
Steam Trap Repair, >225 psig, General Heating, 7/32" or Smaller	3524	6,805	40,831
Steam Trap Repair, >225 psig, General Heating, 1/4"	3521	8,888	53,330
Steam Trap Repair, >225 psig, General Heating, 5/16"	3523	13,888	83,328
Steam Trap Repair, >225 psig, General Heating, 3/8" or Larger	3522	19,999	119,992

Sources

1. PA Consulting Group, Focus on Energy Evaluation, Business Programs: Measure Life Study, August 25, 2009.
2. PA Consulting Group, Focus on Energy Evaluation, Business Programs: Incremental Cost Study, October 28, 2009. Assumed to be the same as <50 psi industrial steam trap equipment cost.
3. California Energy Commission, Revised DEER Measure Cost Summary, June 2008.
4. Calculated based on weighted average between F&T and thermostatic steam trap types per State of Wisconsin Public Service Commission – Focus on Energy Evaluation – Business Programs: Deemed Savings Manual V1.0.
5. Enbridge Steam Saver Program 2005.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	11/06/2014	New measure
02	Cadmus	01/15/2015	Updates by technical reviewer

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Air Conditioning Unit Tune Up - Coil Cleaning

	Measure Details
Measure Master ID	Air Conditioning Unit Tune Up - Coil Cleaning, <10 Tons, 3059 >20 Tons, 3060 10-20 Tons, 3061
Measure Unit	Tons of Refrigeration Capacity
Measure Type	Hybrid
Measure Group	HVAC
Measure Category	Tune-up / Repair / Commissioning
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector and cooling capacity
Peak Demand Reduction (kW)	Varies by sector and cooling capacity
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector and cooling capacity
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	3[2]
Incremental Cost	$35 per ton
Important Comments	

Measure Description

This measure is coil cleaning and on packaged AC units operating in commercial applications, applicable for commercial and industrial customers, and applies savings from documented tune-ups for package or split system AC equipment.

Description of Baseline Condition

The baseline condition is an AC system that has fouled condenser coils.

Description of Efficient Condition

The efficient equipment is a unitary or split system AC that has had condenser coil cleaning as part of a tune up.

Annual Energy-Savings Algorithm

Air Conditioning Condenser Coil Cleaning (for AC units < 65,000 Btu/hour, use SEER instead of EER to calculate):

$$kWh_{SAVED} = (EFLH_C * CAPY_C / 1,000) * (1/[EER*CCF] - 1/EER)$$

$$kWh_{SAVED} = (EFLH_C * CAPY_C / 1,000) * (1/[SEER*CCF] - 1/SEER)$$

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Where:

$EFLH_C$ = Equivalent full load hours for mechanical cooling

$CAPY_C$ = Unit capacity, in Btu/hour for cooling

EER = Energy efficiency ratio (for AC and heat pump units < 65,000 Btu/hour, SEER should be used for cooling savings) Use actual participant information

SEER = Seasonal energy efficiency ratio (for AC and heat pump units > 65,000 Btu/hour, EER should be used for cooling savings) Use actual participant information

CCF = Condenser coil fouling COP degradation factor for cooling (= 93.2%)

Summer Coincident Peak Savings Algorithm

Air Conditioning Condenser Coil Cleaning (for AC units < 65,000 Btu/hour, convert SEER to EER to calculate, using 11.3/13 as the conversion factor):

$$kW_{SAVED} = (CF*CAPY_C / 1{,}000)*(1/[EER*CCF]-1/EER)$$

Where:

CF = Coincidence factor (= 0.90)

Lifecycle Energy-Savings Algorithm

$$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$$

Where:

EUL = Effective useful life (= 3 years)[2]

Assumptions

Calculation Variable Assumptions

Component	Type	Value	Source
$CAPY_C$	Variable	Nameplate	Data Gathering
EER	Variable	Nameplate	Data Gathering
$EFLH_C$	Variable	See Equivalent Full Load Hours by Business Type (table below)	2
CCF	Fixed	93.2%	4
CF	Fixed	90%	5

Equivalent Full Load Hours by Business Type

Building Type	$EFLH_C$[8]
College	877
Food Sales	749
Food Service	578
Healthcare	803
Hotel/Motel	663
Industrial	519
Office	578
Other	589
Public Assembly	535
Public Services (non-food)	535
Retail	567
School	439
Warehouse	358
Average	**599**

Sources

1. Regional coincidence factor for cooling demand.
2. Wisconsin PSC EUL database, 2013. See Appendix C, MMID 2671.
3. DEER model runs weather normalized for statewide use by population density.
4. Weighted value for bin charges in table 2 based on SCE program results for C&I buildings with 3,154 units participating. The weighting assumptions will be calibrated annually to reflect Wisconsin findings.
5. Pigg, Scott (Energy Center of Wisconsin). *Central Air Conditioning in Wisconsin*. ECW Report Number 241-1. 2008.
6. DEER Database for Energy Efficiency Resources. 2005.
7. Bureau of Labor Statistics. *Databases, Tables & Calculators by Subject: CPI Inflation Calculator*. Available online: http://www.bls.gov/data/inflation_calculator.htm.
8. DEER model runs are weather normalized for statewide use by population density.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/01/2013	New measure

Air Conditioning Unit Tune Up - Refrigerant Charge Correction

	Measure Details
Measure Master ID	Air Conditioning Unit Tune Up - Refrigerant Charge Correction <10 Tons, 3062 >20 Tons, 3063 10-20 Tons, 3064
Measure Unit	Tons of Refrigeration Capacity
Measure Type	Hybrid
Measure Group	HVAC
Measure Category	Tune-up / Repair / Commissioning
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector and cooling capacity
Peak Demand Reduction (kW)	Varies by sector and cooling capacity
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector and cooling capacity
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Incremental Cost	$35 per ton
Effective Useful Life (years)	10[2]
Important Comments	

Description

This measure is refrigerant charging on packaged AC units operating in commercial applications, applicable for commercial and industrial customers, and applies savings from documented tune-ups for package or split system AC equipment.

Description of Baseline Condition

The baseline condition is an AC system has incorrect refrigerant charge.

Description of Efficient Condition

The efficient equipment is a unitary or split system AC that has had refrigerant charge correction as part of a tune up.

Annual Energy-Savings Algorithm

Air Conditioning Charge Correction: (for AC units < 65,000 Btu/hour, use SEER instead of EER to calculate):

$$kWh_{SAVED} = (EFLH_C * CAPY_C/1,000)*(1/[EER*RCF]-1/EER)$$

$$kWh_{SAVED} = (EFLH_C * CAPY_C/1,000)*(1/[SEER*RCF]-1/SEER)$$

Where:

$EFLH_C$ = Equivalent full load hours for mechanical cooling

$CAPY_C$ = Unit capacity, in Btu/hour for cooling

EER = Energy efficiency ratio (for AC and heat pump units < 65,000 Btu/hour, SEER should be used for cooling savings) Use actual participant information

SEER = Seasonal energy efficiency ratio (for AC and heat pump units > 65,000 Btu/hour, EER should be used for cooling savings) Use actual participant information

RCF = Refrigerant charge COP degradation factor for cooling (= 98.3%)

Summer Coincident Peak Savings Algorithm

Air Conditioning Charge Correction (for AC units < 65,000 Btu/hour, convert SEER to EER to calculate, using 11.3/13 as the conversion factor):

$kW_{SAVED} = (CF*CAPY_C / 1,000)*(1/[EER*RCF]-1/EER)$

Where:

CF = Coincidence factor (= 0.90)[1]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (10 years)[1]

Assumptions

Calculation Variable Assumptions

Component	Type	Value	Source
$CAPY_C$	Variable	Nameplate	Data Gathering
EER	Variable	Nameplate	Data Gathering
$EFLH_C$	Variable	See Equivalent Full Load Hours by Business Type (table below)	2
RCF	Variable	98.3%[9]	3
CF	Fixed	90%	5

Charge Correction Factor Weighting

Correction Needed	Bin Charge	Weighting	RCF
≥-20%	-20%	5%	92%
-5% to -20%	-13%	27%	97%
-5% to 5%	0%	46%	100%
5% to 20%	13%	20%	97%
≥ 20%	20%	2%	92%

Equivalent Full Load Hours by Business Type

Building Type	$EFLH_C$
College	877
Food Sales	749
Food Service	578
Healthcare	803
Hotel/Motel	663
Industrial	519
Office	578
Other	589
Public Assembly	535
Public Services (non-food)	535
Retail	567
School	439
Warehouse	358
Average	**599**

Sources

1. Regional coincidence factor for cooling demand.
2. DEER, Database for Energy Efficiency Resources. EUL Listing. 2008.
3. DEER model runs weather normalized for statewide use by population density.
4. Weighted value for bin charges in table 2 based on SCE program results for C&I buildings with 3,154 units participating. The weighting assumptions will be calibrated annually to reflect Wisconsin findings.
5. Pigg, Scott (Energy Center of Wisconsin). *Central Air Conditioning in Wisconsin*. ECW Report Number 241-1. 2008.
6. DEER Database for Energy Efficiency Resources. 2005.
7. Bureau of Labor Statistics. *Databases, Tables & Calculators by Subject: CPI Inflation Calculator*. Available online: http://www.bls.gov/data/inflation_calculator.htm.

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8. DEER model runs are weather normalized for statewide use by population density.
9. Department of Energy, Weatherization Center. http://www.waptac.org/data/files/website_docs/training/standardized_curricula/curricula_resources/us%20doe_evaluating%20refrigerant%20charge.pdf.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/01/2013	New measure

Cooling System Tune-Up

	Measure Details
Measure Master ID	Chiller System Tune Up, Air Cooled, ≤ 500 Tons, 2666 Chiller System Tune Up, Air Cooled, > 500 Tons, 2667 Chiller System Tune Up, Water Cooled, ≤ 500 Tons, 2668 Chiller System Tune Up, Water Cooled, > 500 Tons, 2669
Measure Unit	Ton
Measure Type	Prescriptive
Measure Group	HVAC
Measure Category	Tune-up / Repair / Commissioning
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	Varies by cooling mechanism
Peak Demand Reduction (kW)	Varies by cooling mechanism
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by cooling mechanism
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	5[1]
Incremental Cost	$35 per ton
Important Comments	

Measure Description

The chiller system tune-up for air and water cooled chillers must be completed in accordance with the chiller system tune-up checklist.

Tune-up Requirements:

- Clean condenser coil/tubes
- Check cooling tower for scale or buildup
- Check contactors condition
- Check evaporator condition
- Check low-pressure controls
- Check high-pressure controls
- Check filter, replace as needed
- Check belt, replace as needed
- Check crankcase heater operation
- Check economizer operation

Measurement Requirements:

- Record system pressure psig
- Record compressor amp draw
- Record liquid line temperature in °F
- Record subcooling and superheat temperatures in °F
- Record suction pressure psig and temperature in °F
- Condenser fan amp draw
- Supply motor amp draw

Description of Baseline Condition

The baseline is air-cooled and water-cooled chillers that operate at a diminished efficiency from design specifications.

Description of Efficient Condition

Chiller system tune-ups are conducted to ensure that equipment is operating at its best and as preventative maintenance in order to extend the life of the equipment. Tune-ups improve the chiller's efficiency and performance and are useful system checks to ensure that regular maintenance keeps the equipment operating as specified.

Annual Energy-Savings Algorithm

Because existing chiller efficiency cannot be determined without extensive testing, ASHRAE 90.1-2007[3] minimum efficiency for chillers will be used for the baseline efficiency.

Minimum Efficiencies from ASHRAE 90.1-2007

Equipment Type	Size Category	Minimum Efficiency
Air Cooled, with Condenser	All capacities	2.80 COP; 3.05 IPLV
Air Cooled, without Condenser	All capacities	3.10 COP; 3.45 IPLV
Water Cooled, Electrically Operated, Positive Displacement (Reciprocating)	All capacities	4.2 COP; 5.05 IPLV
Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)	< 150 tons	4.45 COP; 5.20 IPLV
Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)	≥ 150 tons and < 300 tons	4.90 COP; 5.60 IPLV
Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)	≥ 300 tons	5.50 COP; 6.15 IPLV
Water Cooled, Electrically Operated, Centrifugal	< 150 tons	5.00 COP; 5.25 IPLV
Water Cooled, Electrically Operated, Centrifugal	≥ 150 tons and < 300 tons	5.55 COP; 5.90 IPLV
Water Cooled, Electrically Operated, Centrifugal	≥ 300 tons	6.10 COP; 6.40 IPLV

The annual energy and demand savings are calculated by applying a percentage savings to the baseline consumption. Parametric runs were applied to estimate a deemed savings for this measure.

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Existing Equipment as a Baseline:

$kWh_{SAVED} = (IPLV_{BASLINE\ EXISTING}) * ton * HOURS * \%\ savings$

Where:

$IPLV_{BASLINE\ EXISTING}$	=	Integrated part load value of baseline chiller (Air cooled = 3.05, water cooled = 5.85)[3]
ton	=	Equipment size (air cooled: 50, 100, 150; water cooled: 100, 200, 300)
HOURS	=	Determined from weather bin hours and building design cooling load (~ 1,440)
% savings	=	Percent savings associated with a chiller tune-up (= 5%)[2]

Summer Coincident Peak Savings Algorithm

Existing Equipment as a Baseline:

$kW_{SAVED} = (Full\ Load\ kW/Ton_{BASELINE\ EXISTING} * \%\ savings) * CF * Tons$

Where:

$Full\ Load\ kW/ton_{BASELINE\ EXISTING}$ = Full load power draw of baseline chiller[3]

% savings	=	Percentage of savings associated with a chiller tune-up (= 5%)
CF	=	Coincidence factor (= 0.8)
Tons	=	Full load tons of chiller (varies between 50 and 300 depending on type. Average air cooled = 100, average water cooled = 200)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 5 years)[1]

Deemed Savings

	Measure	
	Air Cooled (MMID 2666 if ≤ 500 Tons; MMID 2667 if > 500 Tons)	Water Cooled (MMID 2668 if ≤ 500 Tons; MMID 2669 if > 500 Tons)
Average Annual Deemed Savings (kWh/yr/ton)	83	44
Peak Demand Reduction (kW/ton)	0.0461	0.0242
Average Lifecycle Deemed Savings (kWh/yr/ton)	415	218

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. United States Department of Energy, Building Technologies Program: Hospitals Benefit by Improving Inefficient Chiller systems white paper, August 2011. The paper found that coil cleaning, the primary savings measure associated with this cooling tune-up measure, reduces annual cooling energy consumption by 5-7%.
3. ASHRAE 90.1-2007 air cooled and water cooled chiller efficiencies. Simple averages were taken from the following sizes (in tons): air cooled 50, 100, 150; water cooled 100, 200, 300. The respective IPLVs were applied: air cooled 3.05, 3.05, 3.05; water cooled 5.25, 5.9, 6.4.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/25/2012	Initial draft
02	Shaw Group	01/08/2013	Updated to new template

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Variable Speed ECM Pump, Domestic Hot Water Recirculation, Heating Water Circulation, and Cooling Water Circulation

	Measure Details
Measure Master ID	Variable Speed ECM Pump, Domestic Hot Water Recirculation < 100 Watts Max Input, MMID 3494 100 - 500 Watts Max Input, MMID 3495 > 500 Watts Max Input, MMID 3496 Variable Speed ECM Pump, Heating Water Circulation < 100 Watts Max Input, MMID 3497 100 - 500 Watts Max Input, MMID 3498 > 500 Watts Max Input, MMID 3499 Variable Speed ECM Pump, Cooling Water Circulation < 100 Watts Max Input, MMID 3500 100 - 500 Watts Max Input, MMID 3501 > 500 Watts Max Input, MMID 3502 Variable Speed ECM Pump, Water Loop Heat Pump Circulation < 100 Watts Max Input, MMID 3503 100 - 500 Watts Max Input, MMID 3504 > 500 Watts Max Input, MMID 3505
Measure Unit	Pump
Measure Type	Prescriptive
Measure Group	HVAC
Measure Category	Variable Speed Drive
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	Varies by measure and wattage
Peak Demand Reduction (kW)	Varies by measure and wattage
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by measure and wattage
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	Varies by measure and wattage, see Appendix D
Important Comments	

Measure Description

ECMs are high-efficiency brushless DC motors. They are typically fractional horsepower motors that have several benefits over the more common PSC fractional horsepower motor. One of these advantages is higher overall efficiency. PSC motors are generally 20% to 60% efficient, depending on their loading, while ECM motor efficiencies range from 70% to 80%. Other advantages include a reduction in the pump motor size, the variable speed capability of the pump, the ability to provide constant flow with varying pressures, a wider range of rpm, and the ability to be controlled by direct digital controls.

Domestic hot water recirculating pumps are commonly used in multifamily and commercial buildings to shorten the amount of time it would otherwise take for hot water to reach the occupants on upper floors and that have long piping runs. These recirculation pumps can be operated continuously or can be controlled by a timer or an aquastat. An aquastat turns on the pump only when the temperature of the return line falls below a certain setpoint. Many of the ECM recirculating pumps currently on the market have integrated aquastat controls and the ability to be controlled and monitored wirelessly.

Heating and cooling water circulation pumps are commonly used in baseboard and radiant floor heating systems, as well as in coils in forced air systems in multifamily and commercial buildings. Cooling loops are often part of heat pump circulation systems. Often the primary and secondary loops run constantly throughout the heating or cooling season. ECM circulator pumps can modulate their speed to match the load.

Description of Baseline Condition

The baseline condition is a standard efficiency, constant volume PSC pump for domestic, heating, or cooling circulation without variable speed capabilities.

Description of Efficient Condition

The efficient condition is a properly sized, high-efficiency ECM pump for domestic, heating, or cooling circulation with variable speed capabilities to match demand.

Savings for this measure are from the reduction in the pump motor size, the variable speed capability of the pump, and the increased efficiency of the ECMs versus the fraction horsepower PSC motors.

Annual Energy-Savings Algorithm

Heating and Cooling Circulation Pumps:

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * HOURS$

$Watts_{BASE} = Watts_{EE} * R$

$HOURS_{HEATING} = HDD * 24 * \Delta T$

$HOURS_{COOLING} = CDD * 24 * \Delta T$

Water Loop Heat Pump Circulation Pumps:

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * (HOURS_{HEATING} + HOURS_{COOLING})$

$Watts_{BASE} = Watts_{EE} * R$

$HOURS_{HEATING} = HDD * 24 * \Delta T$

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$HOURS_{COOLING} = CDD * 24 * \Delta T$

DHW Recirculation Pumps:

$kWh_{SAVED} = (Watts_{BASE} / 1,000 * HOURS_{DHW-BASE}) – (Watts_{EE} / 1,000 * HOURS_{DHW-EE})$

$HOURS_{DHW-BASE} = HOURS_{UNCONTROLLED} * 44.5\% + HOURS_{CONTROLLED} * 55.5\%$

$HOURS_{DHW-EE} = HOURS_{CONTROLLED}$

Where:

$Watts_{BASE}$ = Power consumption of constant speed PSC pump (= 278 watts for < 100 watt VSD ECM pumps, = 1,389 watts for 100 watt to 500 watt VSD ECM pumps, and = 5,556 watts for > 500 watt VSD ECM pumps)

$Watts_{EE}$ = Power consumption of variable speed ECM pump (= 50 watts for < 100 watt VSD ECM pumps, = 250 watts for 100 watt to 500 watt VSD ECM pumps, and = 1,000 watts for > 500 watt VSD ECM pumps)

1,000 = Kilowatt conversion factor

HOURS = Average annual pump run hours ($HOURS_{HEATING}$, $HOURS_{COOLING}$, HOU_{DHW})

R = Ratio of ECM watts to baseline watts based on measured data of comparable efficient and nonefficient pumps (18%)[2]

$HOURS_{HEATING}$ = Average annual pump run hours for heating (= 2,285)

HDD = Heating degree days (= 7,616, see table below)[6]

24 = Conversion factor, hours per day

ΔT = Design temperature difference (= 80°F for heating, = 20°F for cooling (95°F outdoor design - 75°F indoor design)

$HOURS_{COOLING}$ = Average annual pump run hours for cooling (= 678)

CDD = Cooling degree days (= 565, see table below)[6]

$HOURS_{DHW-BASE}$ = Average annual pump run hours for DHW recirculating (= 5,114)

$HOURS_{DHW-EE}$ = Average annual pump run hours for DHW recirculating (= 2,190)[3]

$HOURS_{UNCONTROLLED}$ = Average annual pump run hours for DHW recirculating continuously running (= 8,760)

$HOURS_{CONTROLLED}$ = Average annual pump run hours for DHW recirculating controlled by a timer or an aquastat (= 2,190)[3]

44.5% = Constant[4]

55.5% = Constant[4]

Location	HDD[6]	CDD[6]
Milwaukee	7,276	548
Green Bay	7,725	516
Wausau	7,805	654
Madison	7,599	630
La Cross	7,397	729
Minocqua	8,616	423
Rice Lake	8,552	438
Statewide Weighted	**7,616**	**565**

Summer Coincident Peak Savings Algorithm

The summer coincident peak savings algorithm only applies to cooling circulation pumps and DHW recirculation pumps.

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1,000 * CF$

Where:

CF = Coincidence factor (= 0.299 for chilled water pumps,[5] = 1.0 for DHW pumps)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[1]

Deemed Savings

Energy Savings for DHW Recirculation

Savings	< 100 Watt VSD ECM Pump MMID 3495	100 - 500 Watt VSD ECM Pump MMID 3496	> 500 Watt VSD ECM Pump MMID 3494
Energy Savings (kWh)	1,311	6,555	26,221
Lifecycle Savings (kWh)	19,666	98,329	393,317
Demand Savings (kW)	0.228	1.139	4.556

Energy Savings for Heating Circulation

Savings	< 100 Watt VSD ECM Pump MMID 3497	100 - 500 Watt VSD ECM Pump MMID 3498	> 500 Watt VSD ECM Pump MMID 3499
Energy Savings (kWh)	520	2,602	10,409
Lifecycle Savings (kWh)	7,807	39,035	156,142
Demand Savings (kW)	0.000	0.000	0.000

Energy Savings for Cooling Circulation

Savings	< 100 Watt VSD ECM Pump MMID 3500	100 - 500 Watt VSD ECM Pump MMID 3501	> 500 Watt VSD ECM Pump MMID 3502
Energy Savings (kWh)	154	772	3,089
Lifecycle Savings (kWh)	2,317	11,583	46,330
Demand Savings (kW)	0.068	0.341	1.362

Energy Savings for Water Loop Heat Pump Circulation

Savings	< 100 Watt VSD ECM Pump MMID 3503	100 - 500 Watt VSD ECM Pump MMID 3504	> 500 Watt VSD ECM Pump MMID 3505
Energy Savings (kWh)	675	3,375	13,498
Lifecycle Savings (kWh)	10,124	50,618	202,472
Demand Savings (kW)	0.068	0.341	1.362

Assumptions

Variable Speed ECM Pump, < 100 Watts Max Input

- Wattage inputs for qualifying pumps under 100 watts range from 3 watts to 93 watts. 50 watts was used as a conservative midpoint.

Variable Speed ECM Pump, 100 - 500 Watts Max Input

- Wattage inputs for qualifying pumps between 100 watts and 500 watts range from 130 watts to 500 watts. 250 watts was used as a conservative midpoint.

Variable Speed ECM Pump, > 500 Watts Max Input

- Wattage inputs for qualifying pumps greater than 500 watts range from 587 watts to 2,500 watts. 1,000 watts was used as a conservative midpoint.

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Sources

1. *Pump Life Cycle Costs: A Guide to LCC Analysis for Pumping Systems.* January 2001. Page 4. https://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/pumplcc_1001.pdf. Accessed 6/11/14.
2. The Cadmus Group, Inc. Impact Evaluation of the 2011–2012 ECM Circulator Pump Pilot Program. October 18, 2012. Table 2. Pump Spot Measurements.
3. Hours of use for pumps with an aquastat control in multi-family applications. DHW Recirculation System Control Strategies, Final Report 99-1. NYSERDA, January 1999. Page 3-30.
4. Water Heaters and Hot Water Distribution Systems. Prepared for: California Energy Commission Public Interest Energy Research Program by Lawrence Berkeley National Laboratory. May 2008. P.16 Figure 10: Control Types Installed or Maintained by Contractors.
5. Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 2.0, June 7, 2013, page 235.
6. Full load hours were calculated using an average FLH/Cooling Degree Day from values in *Illinois Statewide Technical Reference Manual* and applying to Wisconsin Cooling Degree Days.
7. Cost Data from manufacturer pricing information for qualifying products. Data gathered and compiled in VSD ECM Pumps Calculation_FES_BIP_CSF_LEU_MESP_11.4.14.xlsx on 6/10/2014.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	11/04/2014	New measures

Lighting

CFL, Reduced Wattage, Pin Based, Replacing CFL

	Measure Details
Measure Master ID	CFL, Reduced Wattage, Pin Based 18 Watt, Replacing CFL, 3031 26 Watt, Replacing CFL, 3032 32 Watt, Replacing CFL, 3033 42 Watt, Replacing CFL, 3034
Measure Unit	Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Fluorescent, Compact (CFL)
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	Varies by wattage
Peak Demand Reduction (kW)	Varies by wattage
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by wattage
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	3[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

RW CFL lamps save energy by reducing the total input wattage of the luminaire as compared to the same luminaire operating with standard wattage lamps. This measure can be applied to common area spaces where there is more than sufficient light available for the tasks in that space using standard wattage CFL lamps, as these are areas where RW CFL lamps can be considered.

Description of Baseline Condition

The baseline equipment is standard wattage, pin-based CFL lamps.

Description of Efficient Condition

The efficient equipment is a RW CFL lamp being used to replace a standard wattage CFL lamp.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Power consumption of baseline measure

$Watts_{EE}$ = Power consumption of efficient measure

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 5,950)[2]

	Type 1	Type 2	Type 3	Type 4
Baseline Measure	18-Watt Pin-Based CFL Lamp	26-Watt Pin-Based CFL Lamp	32-Watt Pin-Based CFL Lamp	42-Watt Pin-Based CFL Lamp
Efficient Measure	14-Watt, 15-Watt, or 16-Watt Pin-Based CFL Lamp	21-Watt or 23-Watt Pin-Based CFL Lamp	27-Watt or 28-Watt Pin-Based CFL Lamp	33-Watt or 38-Watt Pin-Based CFL Lamp
$Watts_{BASE}$	18	26	32	42
$Watts_{EE}$	14, 15, 16	21, 23	27, 28	33, 38

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * CF$

Where:

CF = Coincidence factor (= 0.77)[3]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 3 years)[1]

Deemed Savings

Average Annual Deemed Savings for Pin-Based, Reduced-Wattage CFL Lamps

Measure	MMID	Existing Building
CFL, Reduced Wattage, Pin Based, 18 Watt, Replacing CFL	3031	18 kWh / 0.002 kW
CFL, Reduced Wattage, Pin Based, 26 Watt, Replacing CFL	3032	24 kWh / 0.003 kW
CFL, Reduced Wattage, Pin Based, 32 Watt, Replacing CFL	3033	27 kWh / 0.003 kW
CFL, Reduced Wattage, Pin Based, 42 Watt, Replacing CFL	3034	39 kWh / 0.005 kW

Average Lifecycle Deemed Savings for Pin-Based, Reduced-Wattage CFL Lamps

Measure	MMID	Existing Building
CFL, Reduced Wattage, Pin Based, 18 Watt, Replacing CFL	3031	54 kWh
CFL, Reduced Wattage, Pin Based, 26 Watt, Replacing CFL	3032	72 kWh
CFL, Reduced Wattage, Pin Based, 32 Watt, Replacing CFL	3033	81 kWh
CFL, Reduced Wattage, Pin Based, 42 Watt, Replacing CFL	3034	117 kWh

Assumptions

An average of 33% each of 14-watt, 15-watt, and 16-watt pin-based CFL lamps were used to generate the new measure average energy use for 18-watt lamp replacements.

An average of 50% each of 21-watt and 23-watt pin-based CFL lamps were used to generate the new measure average energy use for 26-watt lamp replacements.

An average of 50% each of 27-watt and 28-watt pin-based CFL lamps were used to generate the new measure average energy use for 32-watt lamp replacements.

An average of 50% each of 33-watt and 38-watt pin-based CFL lamps were used to generate the new measure average energy use for 42-watt lamp replacements.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. ACES. Deemed Savings Desk Review. November 3, 2010.
3. State of Wisconsin Public Service Commission. *Business Programs Deemed Savings Manual V1.0*. Table 3.2 Coincidence Factor for Lighting in Commercial Applications. March 22, 2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/27/2012	New measure

LED Fixture, Replacing 1,000 Watt HID, Exterior

	Measure Details
Measure Master ID	LED Fixture, Replacing 1,000 Watt HID, Exterior, 3407
Measure Unit	Luminaire or Complete Retrofit Kit
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	1,841
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	20,252
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	11[1]
Incremental Cost	$1,214.33[3]
Important Comments	

PSMH/CMH, Replacing 1,000 Watt HID, Exterior

	Measure Details
Measure Master ID	PSMH/CMH, Replacing 1,000 Watt HID, Exterior, 3408
Measure Unit	Luminaire or Complete Lamp and Ballast Retrofit Kit
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	High Intensity Discharge (HID)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	1,364
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	20,466
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[2]
Incremental Cost	$50.83[3]
Important Comments	

Measure Description

LED pole-mount, wall-mount, and flood light luminaires save energy when replacing 1,000-watt HID products by providing a similar lumen output with lower input wattage. These products can be installed on a one-for-one basis to replace 1,000-watt HID luminaires.

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CMH and PSMH 575-watt pole-mount, wall-mount, and flood light luminaires save energy when replacing 1,000-watt HID products by providing a similar lumen output with lower input wattage. These products can be installed on a one-for-one basis to replace 1,000-watt HID luminaires.

Description of Baseline Condition

The baseline measure is 1,000-watt metal halide, high-pressure sodium HID luminaires for existing buildings and new construction buildings.

Description of Efficient Condition

The efficient measure is DLC-listed Pole, Wall and Flood luminaries and complete retrofit kits listed in one of the following DLC categories: 1, 2, 3, 25, 26, 27, 28, which consumes ≤ 650 watts and has a lumen output of ≥ 35,000 initial lumens, 575 watt PSMH or CMH.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = kWh_{1000W\ HID} - kWh_{LED}$

$kWh_{SAVED} = kWh_{1000W\ HID} - kWh_{575W\ PSMH\ or\ CMH}$

Where:

kWh_{LED} = Annual electricity consumption of a Design Lights Consortium listed Pole, Wall and Flood luminaries and complete retrofit kits listed in one of the following DLC categories 1, 2, 3, 25, 26, 27, and 28, which consumes ≤ 650 watts and has a lumen output of ≥ 35,000 initial lumens.

$kWh_{575W\ PSMH\ or\ CMH}$ = Annual electricity consumption of a 575-watt PSMH or CMH lamp and ballast system or complete luminaire

$kWh_{1000W\ HID}$ = Average annual electricity consumption of 1,000-watt metal halide, or high pressure sodium luminaire.

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = (kWh_{1000W\ HID} - kWh_{LED}) * EUL$

$kWh_{LIFECYCLE} = (kWh_{1000W\ HID} - kWh_{575W\ PSMH\ or\ CMH}) * EUL$

Where:

EUL = Effective useful life (15 years)[1, 2]

Deemed Savings

Average Deemed Savings for DLC Listed LED

Savings	MMID	Exterior
Annual kWh	3407	1,841
Lifecycle kWh		20,252

Average Deemed Savings for PSMH or CMH

Savings	MMID	Exterior
Annual kWh	3408	1,364
Lifecycle kWh		20,466

Assumptions

An average of 50% metal halide 1,000W luminaires and 50% high pressure sodium 1,000W luminaires was used to generate the baseline wattage.

4,380 hours run time of fixtures based on an annual average of 12 hours per day from NOAA data[4]. This also includes the times when photocells turn on prior to exact sunset and turn off after exact sunrise accounting for diminished outdoor lighting as well as time clock scheduled lighting.

Applying a controls factor allows for a more conservative estimate of savings. Based on project experience with 1,000w HID baselines, less than 30% of the exterior 1,000w HID fixtures on the market have additional controls that may operate at conditions other than dusk to dawn.

Sources

1. Based on similar measure/technology EUL – SPECTRUM MMID 3107 LED Fixture, Replacing 400 Watt HID, Exterior.
2. Based on similar measure/technology EUL – SPECTRUM MMID 3086 Induction, PSMH/CMH, or Linear Fluorescent, Replacing 400 Watt HID, Exterior.
3. All sources used for gathering pricing data are documented in the attached 1000w HID replacement calculation_FES_BIP_LEU_CSF_SBP_04.01.14.xls calculation workbook.
4. U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research - NOAA Solar Calculator http://www.esrl.noaa.gov/gmd/grad/solcalc/.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/01/2013	New measure

Bi-Level Controls for Interior, Exterior, and Parking Garages

	Measure Details
Measure Master ID	LED Fixture, Bi-level, Stairwell and Passageway, 3097 Linear Fluorescent, Bi-level, Stairwell and Passageway, 3117 Lighting Controls, Bi-level, Exterior and Parking Garage Fixtures, Dusk to Dawn, 3251, 3343 Lighting Controls, Bi-level, Parking Garage Fixtures, 24 Hour, 3252
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	MMID 3097 = Light Emitting Diode (LED) MMID 3117 = Fluorescent, Linear MMIDs 3251, 3252, and 3343 = Controls
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	8[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Numerous existing installations use LED, induction, fluorescent, CMH, and PSMH fixtures to light their high-bay interiors, exteriors, and parking garages. These fixtures commonly operate in full light output 24 hours a day. Bi-level controls and replacement products use ultrasonic and PIR sensors to adjust the light output to a safe but energy-conserving low light level when these spaces become unoccupied. These products save energy by more efficiently lighting spaces based on occupancy.

Description of Baseline Condition

The baseline condition is LED, induction, fluorescent, CMH, and PSMH fixture input wattages with no lighting controls at building interiors, exteriors, and parking garages.

Description of Efficient Condition

The efficient condition is individually controlled light fixtures that may include dimming, stepped dimming, and/or hi-low ballast controls. Control must include a PIR and/or ultrasonic occupancy sensor with a fail-safe feature (fails in “on” position in case of sensor failure). Fixtures must operate in low-standby light level during vacancy and switch to full light output upon occupancy. The fixture cannot exceed 50% of full wattage during unoccupied periods.

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Annual Energy-Savings Algorithm

$kWh_{SAVED} = kWh_{BASE} - kWh_{EE}$

$kWh_{BASE} = Watts_{FIXTURES} * HOU / 1,000$

$kWh_{EE} = Watts_{FIXTURES} * HOU * 0.60/1,000$

Where:

kWh_{BASE}	=	Energy consumption of baseline equipment (standard non-controlled fixture)
kWh_{EE}	=	Energy consumption of efficient equipment (bi-level controlled fixture)
$Watts_{FIXTURES}$	=	Input Watts of the fixture(s) being controlled
1,000	=	Kilowatt conversion factor
0.60	=	40% savings potential from bi-level controls
HOU	=	Hours-of-use, see table below (= 8,760 for parking garages, = table for interior and = 4,380 for exterior)

Sector	Hours-of-Use
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = Watts_{FIXTURES} / 1,000 * SF * CF$

Where:

SF	=	Savings factor (= 40%)
CF	=	Coincidence factor (= 1 for parking, = 0 for exterior, and varies for interior – see table below)

Sector	CF[4]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 8 years)[1]

Deemed Savings

Bi-Level Controls Parking Garage

Savings per Fixture	MMID	All Sectors
kWh	3252	1,135
kW		0.1296
$kWh_{LIFECYCLE}$		9,082

Bi-Level Controls Exterior

Savings per Fixture	MMIDs	All Sectors
kWh	3251 and 3343	568
kW		0
$kWh_{LIFECYCLE}$		4,541

Bi-Level Controls Interior

Savings per Fixture	MMIDs	Commercial	Industrial	Agriculture	Schools & Government
kWh	3097 (LED) and 3117 (fluorescent)	483	615	609	420
kW		0.0998	0.0998	0.0868	0.0829
$kWh_{LIFECYCLE}$		3,867	4,920	4,871	3,358

Assumptions

It is assumed that an exterior lamp is on for a nighttime average of 4,380 hours. 8,760 hours are assumed for 24/7 parking garage. Savings for interior are based on the sector for interior high-bay applications.

While bi-level controls can achieve a 50% reduction in power requirements, a 40% reduction is used for Focus on Energy programs as a conservative estimate. No kW savings is given to exterior lighting due reduced hours of use for the same wattage.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, similar measure MMID 2460.
2. PA Consulting Group Inc. State of Wisconsin Public Service Commission of Wisconsin. Focus on Energy Business Programs: Deemed Savings Manual V1.0. Updated March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.

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Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/31/2012	New measure

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Delamping, T12 to T8, T8 to T8

	Measure Details
Measure Master ID	Delamping, T12 to T8, 4-Foot, 2276 Delamping, T8 to T8, 2277 Delamping, T12 to T8, 8-Foot, 3184, 3320
Measure Unit	Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	MMIDs 2276 and 2277 = Delamping MMID 3184 = Fluorescent, Linear
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by measure and sector
Peak Demand Reduction (kW)	Varies by measure and sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by measure
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10[1]
Incremental Cost	Varies by measures, see Appendix D
Important Comments	

Measure Description

This measure is for the permanent removal of standard T12 and T8 lamps from two, three, and four lamp 4-foot and 8-foot fixtures. Although the savings are not accounted for here, the measure requires:

- Delamped fixtures must also include upgrading the remaining lamps to HPT8 or RWT8 lamps.
- If a qualifying combination of lamps and ballast are installed, delamped fixtures can also qualify for incentives for HPT8 or RWT8 system, for which the incentives relate to the number of lamps found in the delamped fixture.

If the existing fixture contains standard T8 ballasts, the ballast is not required to be replaced. Only the lamps must be upgraded. In this case, the project would qualify only for a reduced watt lamp incentive if reduced watt lamps are used. The project would not qualify for a system upgrade incentive.

Description of Baseline Condition

The baseline condition is a weighted average of two, three, and four lamp T12 and T8 fixtures, see Assumptions section for weighting metrics.

Description of Efficient Condition

The efficient condition is a weighted average of one, two, and three lamp low, normal, and high ballast factor T8 fixtures with 32-watt lamps. See the Assumptions section for weighting metrics.

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Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * HOU$

Where:

$Watts_{BASE}$	=	Watts of baseline equipment (existing standard T12 and T8 fixture(s))
$Watts_{EE}$	=	Power consumption of efficient measure (delamped T8 fixture(s))
1,000	=	Kilowatt conversion factor
HOU	=	Hours-of-use, see table below

Sector	HOU[4]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239
Multifamily	5,950[5]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * CF$

Where:

CF	=	Coincidence factor, see table below

Sector	CF[4]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64
Multifamily	0.77

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 10 years)[1]

Deemed Savings

Average Annual Deemed Savings for Linear Fluorescent Delamping

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov		Multifamily	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW	kWh	kW
Delamping T12 to T8 (4-Foot)	2276	192	0.040	244	0.040	242	0.035	167	0.033	306	0.040
Delamping T8 to T8 (4-Foot)	2277	96	0.020	122	0.020	121	0.017	83	0.017	153	0.020
Delamping T12 to T8 (8-Foot)	3184, 3320	357	0.074	454	0.074	450	0.064	310	0.061	N/A	N/A

Average Lifecycle Deemed Savings for Linear Fluorescent Delamping

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov	Multifamily
		kWh	kWh	kWh	kWh	kWh
Delamping T12 to T8 (4-Foot)	2276	1,920	2,440	2,420	1,670	3,060
Delamping T8 to T8 (4-Foot)	2277	960	1,220	1,210	830	1,530
Delamping T12 to T8 (8-Foot)	3184, 3320	3,570	4,540	4,500	3,100	N/A

Assumptions

Weighting of delamping quantities is based on historical program data.

Baseline:

The baseline condition is a weighted average of two, three, and four lamp T12 and T8 fixtures:

- Delamping T12 to T8 (4-Foot)
  - 2 Lamp (10%)
  - 3 Lamp (30%)
  - T12 - 4 Lamp (60%)
- Delamping T8 to T8
  - 2 Lamp (10%)
  - 3 Lamp (30%)
  - T8 - 4 Lamp (60%)
- Delamping T12 to T8 (8-Foot)
  - T12 - 2 Lamp (80%)
  - HOT12 - 2 Lamp (20%)

<u>Efficient Condition:</u>

- Delamping T12 to T8 (4-Foot)
  - 2 to 1 Lamp (10%)
  - 3 to 1 Lamp (5%)
  - 3 to 2 Lamp (25%)
  - 4 to 2 Lamp (50%)
  - T8 - 4 to 3 Lamp (10%)
- Delamping T8 to T8
  - 2 to 1 Lamp (10%)
  - 3 to 1 Lamp (5%)
  - 3 to 2 Lamp (25%)
  - 4 to 2 Lamp (50%)
  - T8 - 4 to 3 Lamp (10%)
- Delamping T12 to T8 (8-Foot)
  - T8 – 2 Lamp (8-Foot) to 2 Lamp (4-Foot) (100%)

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, MMIDs 2276 and 2277. Other measures assumed to have comparable lifetime.
2. State of Wisconsin Public Service Commission. *Business Programs: Measure Life Study*. Final Report. Evaluated by PA Consulting Group, Inc. August 25, 2009. Appendix B.
3. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.
4. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
5. ACES Deemed Savings Desk Review 11/03/10.

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Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/02/2013	Revised savings
02	Franklin Energy Services	04/19/2013	Adjusted savings to account only for delamping so measure can be paired with a HP or RW measure
03	Franklin Energy Services	04/25/2013	Adjusted savings to align across all sectors, included all sectors.

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Delamping Light Fixtures

	Measure Details
Measure Master ID	Delamping 200 - 399 Watt Fixture, 3001, 3321 Delamping ≥ 400 Watt Fixture, 3002, 3322
Measure Unit	Per Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Delamping
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	13[1]
Incremental Cost	$15
Important Comments	

Measure Description

This measure is to permanently remove existing high-wattage light fixtures from an existing ceiling. De-lamping savings do not include replacements. Customers are responsible for deciding whether de-lamping will maintain adequate light levels.

Description of Baseline Condition

The baseline equipment is 250-watt metal halide and 450-watt metal halide light fixtures.

Description of Efficient Condition

The efficient condition is permanent removal of unneeded light fixtures.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE})\ /1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Watts of baseline measure (high wattage light fixture; either 200-watt or 399-watt light fixture = 299 watts, or ≥ 400-watt light fixture = 463 watts)

$Watts_{EE}$ = Watts of efficient measure (= 0)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use, see table below

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} – Watts_{EE}) /1{,}000 * CF$

Where:

CF = Coincidence factor, see table below

Sector	CF[3]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 13 years)[1]

Deemed Savings

Deemed Savings for Delamping 200-Watt to 399-Watt Light Fixtures

	MMID	Commercial	Industrial	Agriculture	Schools & Government
Annual Energy Savings (kWh)	3001 and 3321	1,115	1,419	1,405	968
Peak Demand Reduction (kW)		0.2302	0.2302	0.2003	0.1914
Lifecycle Energy Savings (kWh)		14,499	18,444	18,261	12,590

Deemed Savings for Delamping ≥ 400-Watt Light Fixtures

	MMID	Commercial	Industrial	Agriculture	Schools & Government
Annual Energy Savings (kWh)	3002 and 3322	1,727	2,197	2,175	1,500
Peak Demand Reduction (kW)		0.3565	0.3565	0.3102	0.2963
Lifecycle Energy Savings (kWh)		22,451	28,560	28,277	19,496

Assumptions

The baseline wattage of the 250-watt metal halide is 299 watts. The baseline wattage of the 400-watt metal halide is 463 watts.[4]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. State of Wisconsin Public Service Commission. *Business Programs Deemed Savings Manual V1.0.* Table 3.2 Lighting Hours of Use in Commercial Applications. March 22, 2010.
3. State of Wisconsin Public Service Commission. *Business Programs Deemed Savings Manual V1.0*. Table 3.2 Coincidence Factor for Lighting in Commercial Applications. March 22, 2010.
4. Ohio Technical Reference Manual prepared by VEIC. August 2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	GDS	01/08/2013	New measure
02	GDS	02/18/2013	Updated

HID, Reduced Wattage, Replacing HID, Interior, Exterior, Parking Garage

	Measure Details
Measure Master ID	HID, Reduced Wattage Interior: Replacing 1,000 Watt HID, 3067 Replacing 175 Watt HID, 3068 Replacing 250 Watt HID, 3070 Replacing 320 Watt HID, 3072 Replacing 400 Watt HID, 3073 Exterior: Replacing 1,000 Watt HID, 3036 Replacing 400 Watt HID, 3037 Replacing 320 Watt HID, 3038 Replacing 250 Watt HID, 3039 Replacing 175 Watt HID, 3040 Parking Garage: Replacing 175 Watt HID, 3069 Replacing 250 Watt HID, 3071
Measure Unit	Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	High Intensity Discharge (HID)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	4[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

RW HID direct replacement lamps save energy by reducing the total input wattage of the luminaire as compared to the same luminaire operating with standard wattage HID lamps. This measure can be applied in spaces where standard wattage HID lamps are being used. These RW HID products have a similar or equivalent lumen output to the lamps that they replace, which allows them to be installed anywhere that standard wattage HID lamps are found.

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Description of Baseline Condition

The baseline is standard 175-watt, 250-watt, 320-watt, 400-watt, and 1,000-watt HID lamps.

Description of Efficient Condition

The efficient condition is 145-watt, 150-watt, 205-watt, 220-watt, 260-watt, 330-watt, 360-watt, and 860-watt RW HID lamps.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Wattage of baseline (standard wattage HID lamp), see table below

$Watts_{EE}$ = Wattage of efficient equipment (RW direct replacement HID lamp), see table below

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 4,380 for exterior and 8,760 for parking garages, see table below for interior)

Wattages Used for Deemed Savings Calculations

Measure	$Watts_{BASE}$	$Watts_{EE}$
Exterior RW HID Lamp 1,000-Watt Replacement	1,079	928.8
Interior HID Lamp 1,000-Watt Replacement	1,079	928.8
Exterior RW HID Lamp 400-Watt Replacement	455	396.75
Interior HID Lamp 400-Watt Replacement	455	396.75
Exterior RW HID Lamp 320-Watt Replacement	356	299
Interior HID Lamp 320-Watt Replacement	356	299
Exterior RW HID Lamp 250-Watt Replacement	293	250.75
PG HID Lamp 250-Watt Replacement	293	250.75
Interior HID Lamp 250-Watt Replacement	293	250.75
Exterior RW HID Lamp 175-Watt Replacement	210	177
PG HID Lamp 175-Watt Replacement	210	177
Interior HID Lamp 175-Watt Replacement	210	177

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * CF$

Where:

CF = Coincidence factor (= 0.00 for exterior and 1.0 for parking garages), see table below

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 4 years)[1]

Deemed Savings

Average Annual Deemed Savings for Reduced Wattage HID Direct Replacement Lamps

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW
HID, Reduced Wattage Replacing 1,000-Watt HID, Exterior	3036	658	0	658	0	658	0	658	0
HID, Reduced Wattage Replacing 1,000-Watt HID, Interior	3067	560	0.1157	713	0.1157	706	0.1006	486	0.0961
HID, Reduced Wattage, Replacing 400-Watt HID, Exterior	3037	255	0	255	0	255	0	255	0
HID reduced Wattage, Replacing 400-Watt HID, Interior	3073	217	0.0449	276	0.0449	274	0.0390	189	0.0373
HID, Reduced Wattage, Replacing Lamp 320-Watt HID, Exterior	3038	250	0	250	0	250	0	250	0
HID, Reduced Wattage, Replacing Lamp 320-Watt HID, Interior	3072	213	0.0439	270	0.0439	268	0.0382	185	0.0365
HID, Reduced Wattage Replacing 250-Watt HID, Exterior	3039	185	0	185	0	185	0	185	0
HID, Reduced Wattage Replacing 250-Watt HID, Parking Garage	3071	370	0.0423	370	0.0423	370	0.0423	370	0.0423
HID, Reduced Wattage Replacing 250-Watt HID, Interior	3070	158	0.0325	200	0.0325	198	0.0283	137	0.0270
HID, Reduced Wattage Replacing175-Watt HID, Exterior	3040	145	0	145	0	145	0	145	0

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Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW
HID, Reduced Wattage Replacing175-Watt HID, Parking Garage	3069	289	0.0330	289	0.0330	289	0.0330	289	0.0330
HID, Reduced Wattage Replacing 175-Watt HID, Interior	3068	123	0.0254	157	0.0254	155	0.0221	107	0.0211

Average Lifecycle Deemed Savings for Reduced Wattage HID Direct Replacement Lamps (kWh)

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov
HID, Reduced Wattage Replacing 1,000-Watt HID, Exterior	3036	2,632	2,632	2,632	2,632
HID, Reduced Wattage Replacing 1,000-Watt HID, Interior	3067	2,241	2,851	2,823	1,946
HID, Reduced Wattage, Replacing 400-Watt HID, Exterior	3037	1,021	1,021	1,021	1,021
HID reduced Wattage, Replacing 400-Watt HID, Interior	3073	869	1,106	1,095	755
HID, Reduced Wattage, Replacing Lamp 320-Watt HID, Exterior	3038	999	999	999	999
HID, Reduced Wattage, Replacing Lamp 320-Watt HID, Interior	3072	850	1,082	1,071	738
HID, Reduced Wattage Replacing 250-Watt HID, Exterior	3039	740	740	740	740
HID, Reduced Wattage Replacing 250-Watt HID, Parking Garage	3071	1,480	1,480	1,480	1,480
HID, Reduced Wattage Replacing 250-Watt HID, Interior	3070	630	802	794	547
HID, Reduced Wattage Replacing175-Watt HID, Exterior	3040	578	578	578	578
HID, Reduced Wattage Replacing175-Watt HID, Parking Garage	3069	1,156	1,156	1,156	1,156
HID, Reduced Wattage Replacing 175-Watt HID, Interior	3068	492	626	620	428

Assumptions

Same ballast factors were assumed for each replacement watt product (e.g., a 1.18 ballast factor was used for 250-watt products and their replacements).

The assumptions for exterior replacement lamps were:

- 400-watt metal halide replacement: An average of 50% each of 360-watt RW and 330-watt RW was used to generate the new measure wattage.
- 250-watt HID replacement: An average of 50% each of 220-watt RW and 205-watt RW was used to generate the new measure wattage.
- 175-watt HID replacement: An average of 50% each of 150-watt RW and 145-watt RW was used to generate the new measure wattage.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. State of Wisconsin Public Service Commission. *Business Programs Deemed Savings Manual V1.0.* March 22, 2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/28/2012	New measure
02	Franklin Energy Services	04/19/2013	Proposed fixture wattage for 1,000-watt replacement updated based on manufacturer wattage change (830 watts to 860 watts)

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1-Foot by 4-Foot High Performance Fixture Replacing T8 or T12, 2L

	Measure Details
Measure Master ID	1-Foot by 4-Foot High Performance Fixture Replacing T8 or T12, 2L
Measure Unit	Per Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	13[1]
Incremental Cost	$45[4]
Important Comments	

Measure Description

The High Performance Fixture (HP 1 lamp 1'x4') replacements save energy over standard wattage fluorescent fixtures by increasing the number of lumens per watt and reducing the number of lamps needed to produce appropriate lighting levels. The 1 lamp HP 1'x4' will replace a 2 lamp or greater T12 or T8 fixture.

Description of Baseline Condition

T8 Linear Fluorescent Fixtures (EISA compliant)

2 Lamp T8	58 watts

T12 Linear Fluorescent Fixtures

2 Lamp T12	82 watts

Replaced fixtures are assumed to be 50% T8s and 50% T12s in 2015.

Description of Efficient Condition

The efficient condition uses one 32 watt T8 lamp in combination with a ballast that has a normal ballast factor. The 1'x4' High Performance Fixture uses one 32 watt T8 and a ballast with a 0.88 ballast factor.

HP 1x4 fixture	28 watts

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Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{EX}-Watts_{HP})/1,000 * HOU$

Where:

$Watts_{EX}$	=	Wattage of existing T8 or T12 lamps and ballasts
$Watts_{HP}$	=	Existing wattage of the of HP 2 lamp 1-foot by 4-foot luminaire
1,000	=	Kilowatt conversion
HOU	=	Hours-of-use, see table

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED}= (Watts_{EX}-Watts_{HP})/1,000 * CF$

Where:

CF	=	Coincidence factor, see table

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (=13 years)[4]

Deemed Savings

Average Annual Deemed Savings

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW
HPT8 1-Foot by 4-Foot Replacement 2014-2015	3387	156	0.0322	199	0.0322	197	0.0280	136	0.0267
HPT8 1-Foot by 4-Foot Replacement 2016 and Beyond		111	0.0230	142	0.0230	140	0.0200	97	0.0191

Average Lifecycle Deemed Savings

Measure	2015	2016 and Beyond
Commercial	1,492	1,447
Industrial	1,898	1,841
Agriculture	1,879	1,822
Schools & Government	1,295	1,256

Sources

1. EUL taken from existing HPT8 1 lamp measure in Spectrum, Measure Master Code: 2561.
2. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use and Coincidence Factors by Sector.
3. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use and Coincidence Factors by Sector.
4. Cost Assumptions: Based on Contractor Pricing from Wesco Distribution (July 2013 Quote) for a reflector, lamp and ballast. (Quote Prices Below.) The quote is for material only, labor is estimated at approximately $25 for this product. The Installed Cost was rounded to $75 ($50 Materials + $25 labor).

Revision History

Version Number	Authored by	Date	Description of Change
01	GDS Associates	12/16/2013	New measure

Design Light Consortium Listed 2x4 HELG Fixture

	Measure Details
Measure Master ID	LED Troffer, 2x4, Replacing 4-Foot 3-4 Lamp T8 Troffer, 3111, 3291, 3348
Measure Unit	Luminaire or Complete Retrofit Kit
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	13[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Using LED 2x4 troffers saves energy over 3-lamp or 4-lamp T8 products because they provide a similar lumen output but with lower input wattage. These products can be installed on a one-for-one basis to replace 3-lamp or 4-lamp T8 luminaires.

Description of Baseline Condition

The baseline measure is a four-foot 3-lamp or 4-lamp T8 troffer in an existing building or new construction.

Description of Efficient Condition

The efficient condition is LED fixtures that meet program requirements. Lamp only replacements are not eligible for an incentive. LED's must be on the qualified products list, Design Lights Consortium.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = [(Qty_{BASE} * Watts_{BASE}) – (Qty_{EE} * Watts_{EE})] /1{,}000 * HOU$

Where:

Qty_{BASE} = Quantity of baseline equipment

Qty_{EE} = Quantity of efficient condition

$Watts_{BASE}$ = Wattage of 3- or 4-lamp T8 troffer luminaires (= 115.5 watts)

$Watts_{EE}$ = Wattage of DLC listed 2x4 troffers that consume ≤ 55 watts and has ≥ 4,000 initial lumen output (= 49 watts)

1,000 = Kilowatt conversion

HOU = Hours-of-use, see table below

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = [(Qty_{BASE} * Watts_{BASE}) – (Qty_{EE} * Watts_{EE})]/1,000 * CF$

Where:

CF = Coincidence factor, see table below

Sector	CF[3]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 13 years)[1]

Deemed Savings

Average Annual Deemed Savings for DLC-Listed 2x4 Troffers

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED Troffer, 2x4, Replacing 4-Foot 3-4 Lamp T8 Troffer	3111, 3291, 3348	248	0.0512	316	0.0512	312	0.0446	215	0.0426

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Average Lifecycle Deemed Savings for DLC-Listed 2x4 Troffers

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov
		kWh	kWh	kWh	kWh
LED Troffer, 2x4, Replacing 4-Foot 3-4 Lamp T8 Troffer	3111, 3291, 3348	3,225	4,102	4,061	2,800

Assumptions

Baseline wattages were generated using 3-lamp troffers for 50% of the calculations and 4-lamp troffers for the remaining 50%.

Sources

1. Design Lights Consortium Qualified Parts List.
2. State of Wisconsin Public Service Commission. *Business Programs Deemed Savings Manual V1.0.* Table 3.2 Lighting Hours of Use and Coincidence Factors by Sector. March 22, 2010.
3. State of Wisconsin Public Service Commission. *Business Programs Deemed Savings Manual V1.0.* Table 3.2 Lighting Hours of Use and Coincidence Factors by Sector. March 22, 2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/01/2013	New measure

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LED Fixture, ≤180 Watts, Replacing 4 Lamp T5 or 6 Lamp T8, High Bay, DLC Listed

	Measure Details
Measure Master ID	LED Fixture, ≤180 Watts, Replacing 4 Lamp T5 or 6 Lamp T8, High Bay, DLC Listed, 3393
Measure Unit	Luminaire or Complete Retrofit Kit
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	18[1]
Incremental Cost	$300[2]
Important Comments	

Measure Description

LED high bay fixtures save energy when replacing 4 lamp T5 or 6 lamp T8 high bay products by providing a similar lumen output with lower input wattage. These products can be installed on a 1 for 1 basis to replace 4 lamp T5, or 6 lamp T8 high bay luminaires.

Description of Baseline Condition

The baseline condition is 4-foot 4 lamp T5HO, or 6 lamp T8high/low bay fixtures for existing buildings and new construction buildings. An average of 50% 4-foot 4 lamp T5HO and 50% 6 lamp T8 high/low bay luminaires was used to generate the baseline wattage.

Description of Efficient Condition

The efficient condition is DLC-listed LED high bay "High-Bay Luminaires for Commercial and Industrial Buildings", "High-Bay Aisle Luminaires" or "Retrofit Kits for High-Bay Luminaires for Commercial and Industrial Buildings" that consume ≤ 180 watts.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{LF\ HIGHBAY} - Watts_{LED}) / 1{,}000 * HOU$

Where:

$Watts_{LF\ HIGHBAY}$	=	Annual electricity consumption of 4-foot 4 lamp T5HO or 6 lamp T8 high/low bay luminaires
$Watts_{LED}$	=	Annual electricity consumption of a DLC listed high/low bay luminaire or retrofit kit
1,000	=	Kilowatt conversion
HOU	=	Hours-of-use, see table

Sector	HOU[3]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239
Multifamily	5,950

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{LF\ HIGHBAY} - Watts_{LED}) / 1{,}000 * CF$

Where:

CF	=	Coincidence factor, see table

Sector	CF[4]
Commercial	0.77
Industrial	0.77
Schools & Government	0.64
Agriculture	0.67
Multifamily Common Area	0.77

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 18 years)[1]

Deemed Savings

Average Annual Deemed Savings for DLC-Listed LED Highbay ≤ 180 Watts

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov		Multifamily	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED Fixture, ≤ 180 Watts, Replacing 4 Lamp T5 or 6 Lamp T8, High Bay, DLC Listed	3393	334	0.0689	424	0.0689	420	0.0599	290	0.0572	532	0.0689

Average Lifecycle Deemed Savings for DLC-Listed LED Highbay ≤ 180 Watts (kWh)

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov	Multifamily
LED Fixture, ≤180 Watts, Replacing 4 Lamp T5 or 6 Lamp T8, High Bay, DLC Listed	3393	6,006	7,640	7,564	5,215	9,580

Sources

1. Based on similar measure/technology EUL – SPECTRUM MMID 3093 LED Fixture, <250 Watts, Replacing 400 Watt HID, Highbay.
2. Cost information based on market knowledge of accredited lighting experts, trade allies, and cost information gathered from supplier listings. Data gathered March 1, 2014.
3. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.
4. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
5. ACES Deemed Savings Desk Review November 03, 2010.
6. ACES: Default Deemed Savings Review Final Report 6/24/08. CF is within range of similar programs including Table 4-1 MF housing (in unit) is 65% to 83%. http://www.coned.com/documents/Con%20Edison%20Callable%20Load%20Study_Final%20Report_5-15-08.pdf.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/01/2014	New measure

LED Downlights Replacing CFL Downlight

	Measure Details
Measure Master ID	LED Downlights ≤ 18 Watts Replacing 1 Lamp Pin-Based CFL Downlight, 3394 LED Downlights > 18 Watts Replacing 2 Lamp Pin-Based CFL Downlight, 3395
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	Business = 10[1] Multifamily = 6[1]
Incremental Cost	Varies by measures, see Appendix D
Important Comments	

Measure Description

LED downlights can be used to replace existing 1 and 2 lamp pin based CFL downlights used for the same application without sacrificing performance. LED downlights save energy because they consume less wattage than the 1 and 2 lamp pin based CFL downlights products that they are used to replace.

Description of Baseline Condition

Low Wattage Downlights

Pin based CFL Downlights containing 1 lamp of 26, 32, or 42 watts in existing buildings and new construction or any 1 lamp pin based CFL downlight with a lamp wattage of between 26-45w. An average of 33.3% each for 1 lamp 26 watt pin based CFL downlights, 1 lamp 32 watt pin based CFL downlights and 1 lamp 42 watt pin based CFL downlights was used to generate the baseline usage.

High Wattage Downlights

Pin based CFL Downlights containing 2 lamps of 26, 32 or 42watts each in existing buildings and new construction or any 2 lamp pin based CFL downlight with a lamp wattage of between 26-45w. An average of 33.3% each for 2 lamp 26 watt pin based CFL downlights, 2 lamp 32 watt pin based CFL downlights and 2 lamp 42 watt pin based CFL downlights was used to generate the baseline usage.

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Description of Efficient Condition

Low Wattage Downlights

Efficient low-wattage downlights are ENERGY STAR-rated and/or Focus on Energy QPL listed LED Downlights that consume ≤ 18 watts.

High Wattage Downlights

Efficient high-wattage downlights are ENERGY STAR-rated and/or Focus on Energy QPL listed LED Downlights that consume > 18 watts.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{PB\ CFL} - Watts_{LED}) / 1{,}000 * HOU$

Where:

$Watts_{PB\ CFL}$ = Wattage of 1 or 2 lamp pin- based CFL downlights with 26, 32, or 42 watt lamps

$Watts_{LED}$ = Wattage of LED products

1,000 = Kilowatt conversion factor

HOU = Hours-of-use, see table

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239
Multifamily	5,950

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (W_{PB\ CFL} - W_{LED}) / 1{,}000 * CF$

Where:

CF = Coincidence factor (see table below)

Sector	CF[3]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64
Multifamily	0.77

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Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (business = 10 years, multifamily = 6 years)[1]

Deemed Savings

Average Annual Deemed Savings for LED Downlights Replacing 1 or 2 Lamp Pin-Based CFL

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov		Multifamily	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED downlights that consume ≤ 18 watts replacing 1 lamp pin-based CFL	3394	90	0.0187	115	0.0187	114	0.0162	78	0.0155	144	0.0187
LED downlights that consume > 18 watts replacing 2 lamp pin-based CFL	3395	161	0.0332	204	0.0332	202	0.0289	140	0.0276	256	0.0332

Average Lifecycle Deemed Savings for LED Downlights Replacing 1 or 2 Lamp Pin-Based CFL (kWh)

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov	Multifamily
LED downlights that consume ≤ 18 watts replacing 1 lamp pin-based CFL	3394	904	1,150	1,138	785	865
LED downlights that consume > 18 watts replacing 2 lamp pin-based CFL	3395	1,607	2,044	2,024	1,395	1,538

Sources

1. Based on similar measure/technology EUL – SPECTRUM MMID 2984, LED Fixture, Downlights, Accent Lights and Monopoint, ≤18 Watts, Common Area.
2. All sources used for gathering pricing data are documented in the attached LED Downlights replacing pin based CFL downlights calculation_FES_BIP_LEU_CSF_SBP_MESP_04.01.14.xls.
3. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.

4. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
5. 5949.5 (16.3hours/day * 365days/year) annual operating hours used from Focus on Energy ACES Deemed Savings Desk Review 11/03/10 Multifamily Applications for common areas.
6. ACES Deemed Savings Desk Review, November 03, 2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/01/2014	New measure

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LED Fixture, Downlights, ≤18 Watts, Replacing Incandescent Downlight, Exterior

	Measure Details
Measure Master ID	LED Fixture, Downlights, ≤18 Watts, Replacing Incandescent Downlight, Exterior, 3405
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	193 kWh
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	1,932
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10[1]
Incremental Cost	$66.29[2]
Important Comments	

Measure Description

LED downlights luminaires can be used to replace existing incandescent luminaires used for the same application without sacrificing performance. LED downlights save energy because they consume less wattage than the incandescent luminaries that they are used to replace. There are no demand savings since this measure is used during evening and night lighting hours.

Description of Baseline Condition

The baseline measure is 50 watt to 72 watt incandescent luminaires.

Description of Efficient Condition

The efficient measure is ENERGY STAR-rated LED downlights that consume ≤ 18 watts.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{INC} - Watts_{LED}) / 1{,}000 * HOU * Con_{FACT}$

Where:

$Watts_{INC}$ = Wattage of standard incandescent fixture (= 62)

$Watts_{LED}$ = Wattage of LED product (= 13)

1,000 = Kilowatt conversion

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HOU = Hours-of-use (= 4,380)

Con_{FACT} = Control factor (= 0.90)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (10 years)[1]

Deemed Savings

Average Annual Deemed Savings for Exterior LED Downlights ≤18 Watts

Measure	MMID	Annual Savings	
		kWh	kW
LED Fixture, Downlights, ≤18 Watts, Replacing Incandescent Downlight, Exterior	3405	193	0

Average Lifecycle Deemed Savings for Exterior LED Downlights ≤18 Watts

Measure	MMID	Lifecycle Savings
		kWh
LED Fixture, Downlights, ≤18 Watts, Replacing Incandescent Downlight, Exterior	3405	1,932

Assumptions

A weighted average of 16.66% each for 50 watt, 53 watt, 60 watt, 65 watt, 70 watt, 72 watt incandescent luminaires was used to generate the baseline wattage.

4,380 hours run time of fixtures based on an annual average of 12 hours per day from NOAA data.[3] This also includes the times when photocells turn on prior to exact sunset and turn off after exact sunrise accounting for diminished outdoor lighting as well as time clock scheduled lighting.

Applying a controls factor allows for a more conservative estimate of savings. Based on project experience, less than 10% of the exterior fixtures on the market have additional controls that may operate at conditions other than dusk to dawn.

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Sources

1. Based on similar measure/technology EUL – SPECTRUM MMID 3098 LED Fixture, Downlights, Accent Lights and Monopoint, > 18 Watts, Common Area.
2. All sources used for gathering pricing data are documented in the attached Exterior LED downlights >18w_calculation_FES_BIP_CSF_LEU_SBP_MESP_04.01.14.xls calculation workbook.
3. U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research - NOAA Solar Calculator http://www.esrl.noaa.gov/gmd/grad/solcalc/.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/01/2014	New measure

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Exterior LED Fixtures – Replacement

	Measure Details
Measure Master ID	LED Fixture, Exterior Replacing 150-175 Watt HID, 3099, 3289 Replacing 250 Watt HID, 3102, 3301 Replacing 320 Watt HID, 3105, 3302 Replacing 320-400 Watt HID, 3106, 3290 Replacing 400 Watt HID, 3107, 3303 Replacing 70-100 Watt HID, 3108,3304
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by measure
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by measure
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Exterior LED fixtures are an energy-saving alternative to traditional standard wattage HID light sources that have been used for the same applications. LED light sources can be applied in almost every common application type where HID light sources are currently found. This measure is only for replacement of existing HID fixtures.

Description of Baseline Condition

The baseline condition is existing HID lamps between 70 watts and 400 watts.[2]

Description of Efficient Condition

The efficient condition is LED fixtures that meet program requirements. Replacements must be complete fixtures or retrofit of interior components with a total power reduction of 40% or more. Lamp-only replacements are not eligible for an incentive. LEDs must be on the qualifying list for the Design Lights Consortium.[3]

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Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$	=	Wattage of standard HID fixture
$Watts_{EE}$	=	Wattage of LED fixture
1,000	=	Kilowatt conversion factor
HOU	=	Hours-of-use (= 4,380)

Wattages Used for Deemed Savings Calculations

Measure	$Watts_{BASE}$[5]	$Watts_{EE}$[4]
EXT LED replacing 70-watt to 100-watt HID Average	111.5	31
EXT LED replacing 150-watt to 175-watt HID Average	194.5	59
EXT LED replacing 250-watt HID Average	299	94
EXT LED replacing 320-watt HID	368	160
EXT LED replacing 400-watt HID	463	178

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 12 years)[1]

Deemed Savings

Average Annual Deemed Savings for Exterior LED Fixtures

Measure	MMID	kWh	kW
EXT LED replacing 70-watt to 100-watt HID Average	3108, 3304	344	0
EXT LED replacing 150-watt to 175-watt HID Average	3099, 3289	594	0
EXT LED replacing 250-watt HID Average	3102, 3301	870	0
EXT LED replacing 320-watt HID	3105, 3302	859	0
EXT LED replacing 400-watt HID	3106, 3107, 3290, 3303	1,215	0

Average Lifecycle Deemed Savings for Exterior LED Fixtures

Measure	MMID	kWh
EXT LED replacing 70-watt to 100-watt HID Average	3108, 3304	4,131
EXT LED replacing 150-watt to 175-watt HID Average	3099, 3289	7,127
EXT LED replacing 250-watt HID Average	3102, 3301	10,438
EXT LED replacing 320-watt HID	3105, 3302	10,312
EXT LED replacing 400-watt HID	3106, 3107, 3290, 3303	14,575

Assumptions

Calculations are based on exterior lighting that operates 4,380 hours annually, 12 hours/day (dusk to dawn).

LED lamps can achieve a 40% reduction in power requirements.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, similar measures MMID 2691-2698.
2. Based on market research.
3. Design Lights Consortium Qualified Products List.
4. Focus on Energy Default Wattage Guide 2013, Version 1.0.
5. More Excel calculations referenced on page 125.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/28/2012	New measure

LED Replacing Incandescent ≤ 40 Watts, Exterior

	Measure Details
Measure Master ID	LED Lamp, ENERGY STAR, Replacing Incandescent Lamp ≤40 Watts, Exterior, 3402
Measure Unit	Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	106
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	635
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	6[1]
Incremental Cost	$15[2]
Important Comments	

LED Replacing Incandescent > 40 Watts, Exterior

	Measure Details
Measure Master ID	LED Lamp, ENERGY STAR, Replacing Incandescent Lamp >40 Watts, Exterior, 3403
Measure Unit	Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	202
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	1,213
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	6[1]
Incremental Cost	$15[2]
Important Comments	

Measure Description

ENERGY STAR-rated LED replacement lamps save energy by reducing the total input wattage of the luminaire as compared to the same luminaire operating with standard wattage incandescent lamps. This measure will provide an energy-efficient alternative to using incandescent lamps in several exterior applications.

Description of Baseline Condition

Less than or equal to 40 watts

One baseline condition is for standard incandescent lamps. The baseline wattage is generated using an average of 50% 25-watt incandescents and 50% 40-watt incandescents.

Greater than 40 watts

Another baseline condition is for standard and EISA compliant incandescent lamps of 53, 60, 65, 70, 72, and 80 watts. The baseline wattage is generated using an average of 16.66% each of 53-watt incandescent, 60-watt incandescent and halogen, 65-watt incandescent, 70-watt halogen, 72-watt halogen, and 80-watt halogen lamps.

Description of Efficient Condition

Equipment must be an ENERGY STAR-rated LED lamp. The efficient wattage is generated using an average of 33% each of 11.68 watt, 16.70 watt, and 17.81 watt ENERGY STAR-rated LEDs.

Annual Energy Savings Algorithm[3]

$kWh_{SAVED} = (Watts_{INCANDESCENT} - Watts_{EXT\ LED}) / 1,000 * HOU$

Where:

$Watts_{INCANDESCENT}$ = Wattage of standard 53, 60, 65, 70, 72, and 80 watt incandescent lamps (> 40 watts = 67 watts, ≤ 40 watts = 32.5 watts)

$Watts_{EXT\ LED}$ = Wattage of ENERGY STAR-rated LED lamp with a lumen output rating equivalent to the lumen output of the incandescent being replaced (= 15.4 watts)

1,000 = Kilowatt conversion

HOU = Hours-of-use (= 4,380)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 6 years)[1]

Deemed Savings

Average Annual Deemed Savings for LED Lamp Replacing Incandescent

Measure	MMID	kWh Saved
LED Lamp, ENERGY STAR, Replacing Incandescent Lamp ≤40 Watts, Exterior	3402	106
LED Lamp, ENERGY STAR, Replacing Incandescent Lamp >40 Watts, Exterior	3403	202

Average Lifecycle Deemed Savings for LED Lamp Replacing Incandescent

Measure	MMID	kWh Saved
LED Lamp, ENERGY STAR, Replacing Incandescent Lamp ≤40 Watts, Exterior	3402	635
LED Lamp, ENERGY STAR, Replacing Incandescent Lamp >40 Watts, Exterior	3403	1,213

Assumptions

4,380 hours run time of fixtures based on an annual average of 12 hours per day from NOAA data.[3] This also includes the times when photocells turn on prior to exact sunset and turn off after exact sunrise accounting for diminished outdoor lighting as well as time clock scheduled lighting.

Applying a controls factor allows for a more conservative estimate of savings. Based on project experience, less than 10% of the exterior fixtures on the market have additional controls that may operate at conditions other than dusk to dawn.

Sources

1. Based on similar measure/technology EUL – SPECTRUM MMID 3112 and, 3113 ≤ 40 Watt, ENERGY STAR, Replacing Incandescent, and LED, > 40 Watt, ENERGY STAR, Replacing Incandescent, LED.
2. Cost information based on market knowledge of accredited lighting experts, trade allies, and cost information gathered from supplier listings. Data gathered March 1, 2014.
3. U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research - NOAA Solar Calculator http://www.esrl.noaa.gov/gmd/grad/solcalc/.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/01/2014	New measure

LED Fixtures, High Bay

	Measure Details
Measure Master ID	LED Fixture, High Bay <155 Watts, Replacing 250 Watt HID, 3091, 3285 <250 Watts, Replacing 320-400 Watt HID, 3092, 3286 <250 Watts, Replacing 400 Watt HID, 3093, 3287 <365 Watts, Replacing 400 Watt HID, 3094, 3288 <500 Watts, Replacing 1,000 Watt HID, 3095 <800 Watts, Replacing 1,000 Watt HID, 3096
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by measure and sector
Peak Demand Reduction (kW)	Varies by measure and sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by measure and sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	18[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

High bay LED fixtures are an energy-saving alternative to traditional standard wattage HID light sources used for the same applications. LED light sources can be used in almost every common type of application where HID light sources are currently found.

Description of Baseline Condition

The baseline is standard HID lamps that range from 250 watts to 1,000 watts.

Description of Efficient Condition

To meet program requirements, the LED replacements must be complete fixtures that result in a total power reduction of 40% or more. The LEDs must also be on the qualifying list developed by the Design Lights Consortium. Lamp-only replacements are not eligible for incentive.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = [(Qty_{BASE} * Watts_{BASE}) – (Qty_{EE} * Watts_{EE})]/1,000 * HOU$

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Where:

Qty_{BASE} = Quantity of standard HID fixture

$Watts_{BASE}$ = Baseline consumption of standard HID fixture (see table below)

Qty_{EE} = Quantity of LED fixture

$Watts_{EE}$ = Efficient consumption of LED fixture (see table below)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use, see table below

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Measure	$Watts_{BASE}$	$Watts_{EE}$
LED Fixture, High Bay, < 155 Watts Replacing 250-Watt HID	293	119
LED Fixture, High Bay, < 250 Watts Replacing 400-Watt HID	455	169
LED Fixture, High Bay, < 250 Watts Replacing 320-Watt to 400-Watt HID	356	169
Fixture, High Bay < 365 Watts Replacing 400-Watt HID	455	296
LED Fixture, High Bay < 800 Watts Replacing 1,000-Watt HID	1,079	690
LED Fixture, High Bay< 500 Watts Replacing 1,000-Watt HID	1,079	500

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = [(Qty_{BASE} * Watts_{BASE}) – (Qty_{EE} * Watts_{EE})]/1,000 * CF$

Where:

CF = Coincidence factor, see table below

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 18 years)[1]

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Deemed Savings

Average Annual Deemed Savings for High Bay LED Fixtures

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED Fixture, High Bay, < 155 Watts Replacing 250-Watt HID	3091, 3285	649	0.1340	826	0.1340	817	0.1166	564	0.1114
LED Fixture, High Bay, < 250 Watts Replacing 400-Watt HID	3093, 3286	1,067	0.2202	1,357	0.2202	1,344	0.1916	926	0.1830
LED Fixture, High Bay, < 250 Watts Replacing 320-Watt to 400-Watt HID	3092, 3287	698	0.1440	887	0.1440	879	0.1253	606	0.1197
Fixture, High Bay < 365 Watts Replacing 400-Watt HID	3094, 3288	593	0.1224	754	0.1224	747	0.1065	515	0.1018
LED Fixture, High Bay < 800 Watts Replacing 1,000-Watt HID	3096	1,451	0.2995	1,846	0.2995	1,828	0.2606	1,260	0.2490
LED Fixture, High Bay < 500 Watts Replacing 1,000-Watt HID	3095	2,160	0.4458	2,747	0.4458	2,720	0.3879	1,875	0.3706

Average Lifecycle Deemed Savings for High Bay LED Fixtures (kWh)

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov
LED Fixture, High Bay, < 155 Watts Replacing 250-Watt HID	3091, 3285	11,682	14,861	14,714	10,145
LED Fixture, High Bay, < 250 Watts Replacing 400-Watt HID	3093, 3286	19,202	24,427	24,185	16,674
LED Fixture, High Bay, < 250 Watts Replacing 320-Watt to 400-Watt HID	3092, 3287	12,555	15,972	15,813	10,902
Fixture, High Bay < 365 Watts Replacing 400-Watt HID	3094, 3288	10,675	13,580	13,446	9,270
LED Fixture, High Bay < 800 Watts Replacing 1,000-Watt HID	3096	26,117	33,224	32,895	22,679
LED Fixture, High Bay < 500 Watts Replacing 1,000-Watt HID	3095	38,874	49,452	48,963	33,757

Assumptions

LED lamps are capable of achieving a 40% reduction in power requirements.

Sources

1. Design Lights Consortium *Qualified Parts List, Average* rated life of DLC-listed qualifying equipment.
2. State of Wisconsin Public Service Commission of Wisconsin. *Focus on Energy Evaluation, Business Programs Deemed Savings Manual V1.0*. Table 3.2 Lighting Hours of Use and Coincidence Factors by Sector. March 22, 2010.
3. Focus on Energy Default Wattage Guide 2013. All values are based on metal halide fixtures, except as otherwise noted.
4. Focus on Energy Default Wattage Guide 2013. All values are based on PSMH fixtures.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/28/2012	New measure

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LED, Horizontal Case Lighting

	Measure Details
Measure Master ID	LED, Horizontal Case Lighting, 3114
Measure Unit	Per Linear Foot
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	55 per linear foot
Peak Demand Reduction (kW)	0.0063 per linear foot
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	1,100 per linear foot
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	$86 per installation
Important Comments	

Measure Description

Horizontal LED case lighting will replace existing fluorescent case lighting in both freezers and cooler applications. The measure incentives are based on the feet of lamp replaced.

Description of Baseline Condition

The baseline is assumed to be a mix of fluorescent T8 lamps, T12 lamps, and HOT12 lamps in a multideck refrigerated or freezer case. The deemed value of the existing fluorescent wattage is 10.93 watts per linear foot of lamp. This estimate represents the assumed base case technology of F32 T8 fluorescent lamps with electronic ballasts, F40 T12 fluorescent lamps with energy-saving magnetic ballasts, and F48 HOT12 fluorescent lamps with energy-saving magnetic ballasts. A weighting of 60% for F32 T8 fixtures, 20% for F40 T12 fixtures, and 20% for F48 HOT12 fixtures was used based on industry market research. The deemed wattage value was taken from specifications for a standard refrigeration multideck case.[2]

Description of Efficient Condition

The efficient equipment to be installed are LED fixtures in a multideck refrigerated or freezer case. The deemed value for the LED replacement lamp is 6.29 watts per linear foot of multideck case, based on Design Lights Consortium qualifying products. The deemed wattage value was taken from specifications for a standard refrigeration multideck case with LED lighting.[1]

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Annual Energy-Savings Algorithm

$kWh_{SAVED} = [P_E - P_P + ((P_E * F_{FH} - P_P * F_{LH})/COP_{COOLING})] * HOU$

Where:

P_E	=	Existing fluorescent lighting wattage per linear foot (= 0.01093 kW)
P_P	=	Replacement LED lighting wattage per linear foot (= 0.00629 kW)
F_{FH}	=	Fluorescent lighting to heat factor (= 79%)
F_{LH}	=	LED lighting to heat factor (= 80%)
$COP_{COOLING}$	=	Coefficient of performance of refrigeration system (= 2.22)
HOU	=	Hours-of-use (= 8,760)

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = [P_E - P_P + ((P_E * F_{FH} - P_P * F_{LH})/COP_{COOLING})] * CF$

Where:

CF	=	Coincidence factor (= 1)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 20 years)[1]

Assumptions

The deemed value for the fluorescent lighting to heat factor is 79%, based on an analysis stating that 21% of the power to a fluorescent light is converted to light while the remainder (79%) is infrared radiation or direct heat.[3]

The deemed value for the LED lighting to heat factor is 80%, based on an analysis stating that 15-25% of the power to an LED light is converted to light, while the remainder (75-85%) is converted directly to heat.[4] The deemed value of 80% is the midpoint of the range of the DOE EERE estimate.

The deemed value of the COP for a refrigeration system is 2.5 for coolers and 1.3 for freezers. The COP was weighted 77% to coolers and 23% to freezers for a value of 2.22.[4]

The deemed annual operating hours is 8,760, the number of hours in a year.[4]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, similar measures MMIDs 2456-2457.
2. Arthur D. Little, Inc. Energy Savings Potential for Commercial Refrigeration Equipment – Final Report. 1996. and Navigant Consulting, Inc. Energy Savings Potential and R&D Opportunities for Commercial Refrigeration. 2009.

3. United States Department of Energy Office of Energy Efficiency & Renewable Energy. The calculation assumes that 100% of the thermal energy produced by the lights is removed by the refrigeration system.
4. PA Consulting Group Inc. State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation Business Programs: Deemed Savings Manual v1.0. Updated March 22, 2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/22/2013	New measure

LED, Direct Install

	Measure Details
Measure Master ID	8 Watts, 3273 8 Watts, SBP Package, 3346 12 Watts, 3274 12 Watts, SBP Package, 3347 > 12 Watts > 12 Watts, SBP Package > 16 Watt > 16W, SBP Package
Measure Unit	Single, Screw-In LED
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

An ENERGY STAR qualified LED screw-in bulb is installed by a qualified Trade Ally for the Small Business Program replacing an incandescent screw-in bulb. Assumptions are based on a direct installation, not a time-of-sale purchase. Replacement involves a functioning bulb.

Description of Baseline Condition

The baseline equipment is assumed to be the EISA requirements.[2]

Measure	Baseline Wattage
LED, > 16 Watt, DI	72
LED, > 12 Watt, DI	53
LED, 12 Watt, DI	43
LED, 8 Watt, DI	29

Description of Efficient Condition

This measure applies to standard screw-based LED lamps. Based upon the experiences in 2014 in the Small Business Program, the following are the most common wattages to installed.

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Measure	LED Wattage
LED, > 16 Watt, DI	18
LED, > 12 Watt, DI	12.5
LED, 12 Watt, DI	10.5
LED, 8 Watt, DI	8

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE})/1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Baseline wattage, see table above

$Watts_{EE}$ = Efficient wattage, see table above

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (see table below)

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED}= (Watts_{BASE} – Watts_{EE})/1{,}000 * CF$

Where:

CF = Coincidence factor (see table)

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (=15 years)[1]

Deemed Savings

Annual Savings

Sector	MMID	Commercial		Industrial		Agriculture		Schools & Government	
Measure		kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED, > 16 Watt	3273, 3346	201	0.0416	256	0.0416	254	0.0362	175	0.0346
LED, > 12 Watt	3274	151	0.0312	192	0.0312	190	0.0271	131	0.0259
LED, 12 Watt	3347	121	0.0250	154	0.0250	153	0.0218	105	0.0208
LED, 8 Watt	3346	78	0.0162	100	0.0162	99	0.0141	68	0.0134

Lifecycle Savings

Measure	MMID	Commercial	Industrial	Agricultural	Schools & Government
LED, > 16 Watt	3273, 3346	3,015	3,840	3,810	2,625
LED, > 12 Watt	3274	2,265	2,880	2,850	1,965
LED, 12 Watt	3347	1,815	2,310	2,295	1,575
LED, 8 Watt	3346	1,170	1,500	1,485	1,020

Sources

1. Focus on Energy. *EUL Database Prescriptive Measures_04.18.2013*. April 2013. MMID 2453, LED, 8-12 Watts = 15 years.
2. Focus on Energy. *Approach to Accounting for Changes in Lighting Baseline*. May 2013.
3. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.
4. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.

Revision History

Version Number	Authored by	Date	Description of Change
01	GDS Associates	11/14/2014	Initial submittal

LED Exit Signs

	Measure Details
Measure Master ID	LED Exit Signs, 2768
Measure Unit	Per sign
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government Residential- multifamily
Annual Energy Savings (kWh)	Varies by baseline
Peak Demand Reduction (kW)	Varies by baseline
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by baseline
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	8 MESP, 16 Small Business[4]
Incremental Cost	$91.61
Important Comments	

Measure Description

Exit signs that have earned the ENERGY STAR label use 5 watts or less, compared to standard signs that use up to 40 watts. Savings result from replacing incandescent or fluorescent exit signs with LED exit signs, which use significantly less electricity. The savings estimate assumes that both incandescent and fluorescent exit signs undergo early replacement rather than replacement at failure.

Description of Baseline Condition

The baseline condition is an incandescent or CFL exit sign with one or two bulbs (40 watt or 16 watt, respectively).

Description of Efficient Condition

The efficient condition is an LED exit sign. The fixture must meet ENERGY STAR Version 2 specifications.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * HOU$

Where:

$Watts_{BASE}$ = Watts of baseline measure (= 16 for CFL exit sign and = 40 for incandescent exit sign)[2]

$Watts_{EE}$ = Watts of LED exit sign (= 2.9)[1]

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 8,760)[3]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE})/1{,}000 * CF$

Where:

CF = Coincidence factor (= 1)[3]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 8 years MESP, 16 years small business)[4]

Deemed Savings

Deemed Savings for LED Exit Signs

Type of Savings	MMID	Baseline Measure Type		
		CFL	Incandescent	Default
Annual Energy Savings (kWh)	2768	115	325	220
Peak Demand Reduction (kW)		0.013	0.037	0.025
Lifecycle Energy Savings (kWh) - MESP		918	2,600	1,759
Lifecycle Energy Savings (kWh) – Small Business		1,836	5,200	3,518

Sources

1. ENERGY STAR. "Exit Signs." ENERGY STAR Savings Calculator. Available online: http://www.energystar.gov/index.cfm?c=exit_signs.pr_exit_signs.
2. ENERGY STAR "Save Energy, Money and Prevent Pollution with Light-Emitting Diode Exit Signs." Available online: http://www.energystar.gov/ia/business/small_business/led_exitsigns_techsheet.pdf.
3. Mid Atlantic Technical Reference Manual, Version 3. March 2013.
4. Wisconsin PSC EUL database, 2013. See Appendix C.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	06/07/2012	New measure

LED Fixture, Downlights, Accent Lights and Monopoint ≤ 18 Watts

	Measure Details
Measure Master ID	LED Fixture, Downlights, Accent Lights and Monopoint ≤ 18 Watts, Common Area, 2984 LED Fixture, Downlights, Accent Lights and Monopoint ≤ 18 Watts, In Unit, 3158
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government Residential- multifamily
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by location
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	MMID 2984=$80.13; MMID 3158=$88.38
Important Comments	

Measure Description

LED downlights, accent lights, and monopoint fixtures can replace existing incandescent fixtures without sacrificing performance. LED downlights, accent lights, and monopoint fixtures save energy because they consume less wattage than the incandescent products they replace.

Description of Baseline Condition

The baseline is a 60-watt to 100-watt incandescent fixture.

Description of Efficient Condition

The efficient equipment is a monopoint fixture that consumes ≤ 18 watts, an ENERGY STAR-rated LED downlight that consumes ≤ 18 watts, and an ENERGY STAR-rated LED accent lights that consumes ≤ 18 watts.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) * HOU / 1,000$

Where:

$Watts_{BASE}$ = Power consumption of baseline measure (incandescent fixtures)

$Watts_{EE}$ = Power consumption of efficient measure (LED products)

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1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 5,950 in common area,[2] = 829 in unit)[6]

Location	Lumen Output	Typical Wattage	$Watts_{BASE}$[3]	$Watts_{EFFICIENT}$[4]
In Unit	750-1,049	60	49	13
In Unit	1,050-1,489	75	58	16
Common Area	750-1,049	60	49	13
Common Area	1,050-1,489	75	58	16

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1,000 * CF$

Where:

CF = Coincidence factor (= 0.77 in common area,[5] = 0.11 in unit)[7]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[1]

Deemed Savings

Deemed Savings

Location	MMID	Annual kWh_{SAVED}	kW_{SAVED}	Lifecycle kWh_{SAVED}
In Unit	3158	34	0.009	512
		40	0.005	598
Common Area	2984	214	0.028	3,213
		250	0.032	3,748

Assumptions

The baseline for this measure was therefore a combination of halogen and incandescent efficiencies for 2014, as listed in the tables below. The weighted average is based on estimated sales percentages: 0-309 lumens = 20%; 310-749 lumens = 30%; 750-1,049 lumens = 40%; 1,050-1,489 lumens = 10%.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. ACES Deemed Savings Desk Review. November 3, 2010.
3. United States Environmental Protection Agency. "Next Generation Lighting Programs: Opportunities to Advance Efficient Lighting for a Cleaner Environment." EPA-430-R-11-115, pg. 27. October 2011.http://www.energystar.gov/lightingresources.

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4. Predominant wattage in each category.
5. Focus on Energy *Business Programs Deemed Savings Manual V1.0* March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
6. Cadmus. Field Study Research: Residential Lighting. October 18, 2013. Conducted regarding CFL and incandescent bulbs.
7. Cadmus. Field Study Research: Residential Lighting. October 25, 2013. Conducted regarding CFL and incandescent bulbs.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/26/2012	New measure

LED Fixture, Downlights, ≤ 100 Watts, ≥ 4,000 Lumens, Exterior, Interior

	Measure Details
Measure Master ID	LED Fixture, Downlights ≤ 100 Watts, ≥ 4,000 Lumens, Exterior, 3397 LED Fixture, Downlights ≤ 100 Watts, ≥ 4,000 Lumens, Interior, 3396
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10[1]
Incremental Cost	$60[2]
Important Comments	

LED Fixture, Downlights, ≥ 6,000 Lumens, Exterior, Interior

	Measure Details
Measure Master ID	LED Fixture, Downlights ≥ 6,000 Lumens, Exterior, 3399 LED Fixture, Downlights ≥ 6,000 Lumens, Interior, 3398
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10[1]
Incremental Cost	$60[2]
Important Comments	

Measure Description

LED downlights can be used to replace existing interior and exterior 150-250w HID fixtures used for the same application without sacrificing performance. LED downlights save energy because they consume less wattage than the HID products that they are used to replace.

Description of Baseline Condition

An average of 50% each 150 watt and 175 watt HID fixtures are used to generate the baseline usage.

≥ 4,000 Lumen ≤ 100 Watt LED Downlights

The baseline measure is 150-watt to 175-watt HID fixtures for existing buildings and new construction. 100% 250-watt HID fixtures are used to generate the baseline usage.

≥ 6,000 Lumen LED Downlights

The baseline measure is 176-watt to 250-watt HID fixtures for existing buildings and new construction.

Description of Efficient Condition

Replacement of 150-175 Watt HID

The efficient measure is ENERGY STAR-rated and/or Focus on Energy Qualified Products List-listed LED downlights that produce ≥ 4,000 lumens and consume ≤ 100 watts.

Replacement of 176-250 Watt HID

The efficient measure is ENERGY STAR-rated and/or Focus on Energy Qualified Products List -listed LED downlights that produce ≥ 6,000 lumens.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{HID} - Watts_{LED}) / 1{,}000 * HOU * Con_{FACT}$

Where:

$Watts_{HID}$ = Wattage of standard wattage HID fixtures

$Watts_{LED}$ = Wattage of LED products

1,000 = Kilowatt Conversion

HOU = Hours-of-use (= 4,380 for exterior; see table for interior)

Con_{FACT} = Control factor (= 0.90), exterior only

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239
Multifamily	5,950

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Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{HID} - Watts_{LED}) / 1{,}000 * CF$

Where:

CF = Coincidence factor, interior fixtures only, see table

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64
Multifamily	0.77

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (10 years)[1]

Deemed Savings

Interior LED Downlights That Produce ≥ 4,000 Lumens and Consume ≤ 100 Watts

Average Annual Deemed Savings for LED Downlights ≥ 4,000 Lumens and Consume ≤ 100 Watts

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov		Multifamily	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED Fixture, Downlights ≤ 100 Watts, ≥ 4,000 Lumens, Interior	3396	372	0.0767	473	0.0767	468	0.0668	323	0.0638	593	0.0767

Average Lifecycle Deemed Savings for LED Downlights ≥ 4,000 Lumens and Consume ≤ 100 Watts (kWh)

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov	Multifamily
LED Fixture, Downlights ≤ 100 Watts, ≥ 4,000 Lumens, Interior	3396	3,717	4,729	4,682	3,228	5,930

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Exterior LED Downlights That Produce ≥ 4,000 Lumens and Consume ≤ 100 Watts

Average Annual Deemed Savings for LED Downlights ≥ 4,000 Lumens and Consume ≤ 100 Watts

Measure	MMID	Exterior	
		kWh	kW
LED Fixture, Downlights ≤ 100 Watts, ≥ 4,000 Lumens, Exterior	3397	393	N/A

Average Lifecycle Deemed Savings for LED Downlights ≥ 4,000 Lumens and Consume ≤ 100 Watts (kWh)

Measure	MMID	Exterior
LED Fixture, Downlights ≤ 100 Watts, ≥ 4,000 Lumens, Exterior	3397	3,929

Interior LED Downlights That Produce ≥ 6,000 Lumens

Average Annual Deemed Savings for LED Downlights ≥ 6,000 Lumens

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov		Multifamily	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED Fixture, Downlights ≥ 6,000 Lumens, Interior	3398	518	0.1069	658	0.1069	652	0.0930	449	0.0888	826	0.1069

Average Lifecycle Deemed Savings for LED Downlights ≥ 6,000 Lumens (kWh)

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov	Multifamily
LED Fixture, Downlights ≥ 6,000 Lumens, Interior	3398	5,176	6,585	6519	4,495	8,257

Exterior LED Downlights That Produce ≥ 6,000 Lumens

Average Annual Deemed Savings for LED Downlights ≥ 6,000 Lumens

Measure	MMID	Exterior	
		kWh	kW
LED Fixture, Downlights ≥ 6,000 Lumens, Exterior	3399	547	N/A

Average Lifecycle Deemed Savings for LED Downlights ≥ 6,000 Lumens (kWh)

Measure	MMID	Exterior
LED Fixture, Downlights ≥ 6,000 Lumens, Exterior	3399	5,470

Assumptions

4,380 hours run time of exterior fixtures based on an annual average of 12 hours per day from NOAA data[7]. This also includes the times when photocells turn on prior to exact sunset and turn off after exact sunrise accounting for diminished outdoor lighting as well as time clock scheduled lighting. Applying a controls factor allows for a more conservative estimate of savings. Based on project experience, less than 10% of the exterior fixtures on the market have additional controls that may operate at conditions other than dusk to dawn.

Sources

1. EUL based on similar measure/technology, EUL – SPECTRUM MMID 3098 LED Fixture, Downlights, Accent Lights and Monopoint, > 18 Watts, Common Area
2. Cost information based on market knowledge of accredited lighting experts, trade allies, and cost information gathered from supplier listings. Data gathered March 1, 2014.
3. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.
4. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
5. ACES Deemed Savings Desk Review 11/03/10.
6. ACES: Default Deemed Savings Review Final Report 6/24/08. CF is within range of similar programs including Table 4-1 MF housing (in unit) is 65% to 83%. http://www.coned.com/documents/Con%20Edison%20Callable%20Load%20Study_Final%20Report_5-15-08.pdf.
7. U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research - NOAA Solar Calculator http://www.esrl.noaa.gov/gmd/grad/solcalc/.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/01/2014	New measure

LED 1-Foot by 4-Foot Replacing 2 or 3 Lamp Linear Fluorescent

Measure Master ID	LED 1-Foot by 4-Foot Replacing 2 or 3 Lamp Linear Fluorescent, 3388, 3389
Measure Unit	Per Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	$110[3]
Important Comments	

Measure Description

LED-based fixture replacements or complete LED retrofits save energy over fluorescent based fixtures by increasing the number of lumens per watt and increasing the light quality and distribution. There are varying wattage LED fixtures used to replace 1’x4’ dimension fixtures which normally have two T12 or T8 lamps with ballast installed. While not used in the savings calculations, this measure can be used for replacing specialty 1’x4’ fixtures which have three T12 or T8 lamps. The 1’x4’ LED fixture will replace a 2 lamp or greater T12 or T8 fixture.

LED fixtures will be counted on a per fixture basis. A partial retrofit of the fixture will not be allowed, as of the writing of this description this includes linear LED tubes and LED luminaires which adhere to the interior of the existing fixture housing.

Description of Baseline Condition

T8 Linear Fluorescent Fixtures (EISA compliant)

2 Lamp T8	58 watts

T12 Linear Fluorescent Fixtures

2 Lamp T12	82 watts

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Replaced fixtures are assumed to be 50% T8, 2 Lamp and 50% T12, 2 Lamp prior to 2016. Post 2016, the baseline is assumed to be a 2 lamp T8 fixture. 3 Lamp replacements are allowed, although not included in the calculation because of the expected limited number of applicability in the field.

This measure does not include the replacement of 1 lamp T12 or T8 1-foot by 4-foot fixtures.

Description of Efficient Condition

DLC provides a listing of qualified LED products. The efficient condition uses the listing of luminaires of 1'x4' Luminaires for Ambient Lighting of Interior Commercial Spaces. The new measure condition assumes an average of the DLC listing on December 2, 2013.

1'x4' LED troffer	36 watts

DLC listed equipment in the following categories are not acceptable as replacements.

- Four-Foot Linear Replacement Lamps
- Two-Foot Linear Replacement Lamps

The replacements of the T8 or T12 Fixtures use the DLC listing of 1'x4' Luminaires for Ambient Lighting of Interior Commercial Spaces. The new measure condition assumes an average of the DLC listing on December 2, 2013. The efficient condition wattage and hours of operation are an average of the listing on this date.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{EX} - Watts_{LED}) / 1,000 * HOU$

Where:

$Watts_{EX}$ = Wattage of existing T8 or T12 lamps and ballasts

$Watts_{LED}$ = Wattage of LED 1-foot by 4-foot luminaire

1,000 = Kilowatt conversion

HOU = Hours-of-use, see table

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239
Multifamily	5,950

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{Ex} - Watts_{LED})/1{,}000 * CF$

Where:

CF = Coincidence factor, see table

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64
Multifamily	0.77

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)

Deemed Savings

Average Annual Savings for LED Fixture Replacement/Retrofit of 1-Foot by 4-Foot T8 and T12 Fixtures

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED 1-Foot by 4-Foot replacement/retrofit (2014-2015)	3388 and 3389	126	0.0260	160	0.0260	159	0.0226	110	0.0216
LED 1-Foot by 4-Foot replacement/retrofit (2016 and beyond)		81	0.0168	104	0.0168	102	0.0146	71	0.0140

Average Lifecycle Savings for LED Fixture Replacement/Retrofit of 1-Foot by 4-Foot T8 and T12 Fixtures with 2 or 3 Lamps

Measure	2015	2016 and Beyond
Commercial	1,265	1,220
Industrial	1,609	1,552
Agriculture	1,593	1,537
Schools & Government	1,098	1,059

Assumptions

Replaced fixtures are assumed to be 50% T8, 2 Lamp and 50% T12, 2 Lamp prior to 2016. Post 2016 the baseline is assumed to be a 2 lamp T8 fixture. 3 Lamp replacements are allowed, although not included in the calculation because of the expected limited number of applicability in the field.

This measure does not include the replacement of 1lamp T12 or T8 1'x4' fixtures. This calculation is used to account for the Federal legislation, stemming from EISA, which will dictate that the fluorescent fixture efficiency in lumen per watt. As of July 14, 2012, Federal Standards will require that practically all linear fluorescents meet strict performance requirements essentially requiring all T12 users, when they need to purchase new bulbs, to upgrade to high performance T8 and T5 lamps and electronic ballasts. The effect is that first-year savings for T12 to T8 replacements can be assumed only for the remaining useful life of T12 equipment, at which point customers have no choice but to install equipment meeting the new standard.

Sources

1. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use and Coincidence Factors by Sector.
2. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use and Coincidence Factors by Sector.
3. Cost Assumptions: Cost is expected to be $10 less for materials than the 2'x4' LED replacements base upon preliminary quotes from suppliers. Labor costs are the same as for 2'x4' LED replacements. Labor is estimated at approximately $40 for the troffer replacement and $20 for the troffer retrofit. The Installed Cost was rounded to $150 ($110 materials + $40 labor or $130 material + $20 labor).This price is expected to drop over time.

Revision History

Version Number	Authored by	Date	Description of Change
01	GDS Associates	01/17/2014	Response to evaluator comments

LED 8-Foot, Replacing T12 or T8, 1 or 2 Lamp

	Measure Details
Measure Master ID	LED, 8-Foot Fixture, Replacing T12 or T8, 1L 3425 SBP A La Carte, 3426 SBP Package, 3427 LED, 8-Foot Fixture, Replacing T12 or T8, 2L 3428 SBP A La Carte, 3429 LED, 8-Foot Fixture, Replacing T12HO or T8HO, 1L 3431 SBP A La Carte, 3432 SBP Package, 3433 LED, 8-Foot Fixture, Replacing T12HO or T8HO, 2L 3434 SBP A La Carte, 3435 SBP Package, 3436
Measure Unit	Per Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	16
Incremental Cost	Varies by measure, see Appendix D[3]
Important Comments	

Measure Description

The replacement of an 8-foot T12 or T8 linear fluorescent fixture with an 8-foot LED-based (or equivalent) fixture. Energy savings result from the decrease in fixture watts and increasing lumens per watt improving light quality and distribution. There are varying wattages LED fixtures used to replace 8ft fixtures which normally have one or two 8ft T12 or T8 lamps with ballast installed.

Four different measures will be used depending on the configuration of the existing fixture. These are for 1 and 2 lamp standard output 8ft T8 or T12 fixtures and 1 and 2 Lamp high output T8 or T12 fixtures. A partial retrofit of a fixture does not qualify, as of the writing of this description. The partial retrofits include linear LED tubes and LED luminaires which adhere to the interior of the existing fixture housing. A retrofit that includes two fixtures combined to create the equivalent of an 8 foot long fixture (2- 4 foot fixtures) is acceptable.

Description of Baseline Condition

T8 Linear 8-Foot Fluorescent Fixtures (EISA compliant)

Measure	Wattage
8ft 1 Lamp T8	65 watts
8ft 2 Lamp T8	110 watts
8ft 1 Lamp T8HO	91 watts
8ft 2 Lamp T8HO	145 watts

T12 Linear 8-Foot Fluorescent Fixtures

Measure	Wattage
1 Lamp T12	83 watts
2 Lamp T12	138 watts
1 Lamp T12HO	125 watts
2 Lamp T12HO	227 watts

Replaced standard output 1 and 2 lamp fixtures are assumed to be 80% T12 and 20% T8. Replaced high output 1 and 2 lamp fixtures are assumed to be 95% T12 and 5% T8.

The Illinois TRM assumes that this standard will become fully effective in 2016. Their recommendation is due to a realistic expectation that if a customer relamps an existing T12 fixture the day the standard takes effect, an assumption can be made that they would likely need to upgrade to T8s in less than 5 years' time. The Illinois TRM there recommends that for T12 systems, the baseline becomes a standard T8 in 2016, regardless of the equipment on site due to the phase in of EISA standards. In addition, retrofits to T12 systems installed before 2016 have a baseline adjustment applied in 2016 for the remainder of the measure life.

Description of Efficient Condition

DLC provides a listing of qualified LED products. The efficient condition uses an average from a filtered listing of luminaires for Low-Bay Commercial and Industrial Building applications (V2.0) and similar products from other reputable manufacturers. The new measure condition assumes an average of five models on the DLC listing on 12/10/2013 and 6 models from 2 additional manufacturers that are intending to be listed on DLC. These models were included because of the low number of DLC qualified products at the time of this analysis.

Measure	Wattage
8ft LED Fixture Standard Output	60 watts
8ft LED Fixture Standard Output	84 watts
8ft LED Fixture 1 Lamp High Output	84 watts
8ft LED Fixture 2 Lamp High Output	125 watts

In order to guide the marketplace and ensure the future qualified products meet the intentions of this work paper, the following maximum wattages for the efficient condition are allowable.

Existing Fixture	Maximum Efficient Wattage Specification
8ft LED Fixture Standard Output	70 watts
8ft LED Fixture Standard Output	95 watts
8ft LED Fixture 1 Lamp High Output	95 watts
8ft LED Fixture 2 Lamp High Output	145 watts

Replaced standard output 1 and 2 lamp fixtures are assumed to be 80% T12 and 20% T8. Replaced high output 1 and 2 lamp fixtures are assumed to be 95% T12 and 5% T8.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{EX} – Watts_{LED}) /1,000 * HOU$

Where:

$Watts_{EX}$ = Wattage of existing T8 and T12 lamps and ballasts

$Watts_{LED}$ = Wattage of LED 8-foot luminaire

1,000 = Kilowatt conversion

HOU = Hours-of-use, see table

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{EX}-Watts_{LED}) /1,000 * CF$

Where:

CF = Coincidence factor, see table

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 16 years)

Deemed Savings

Average Annual Deemed Savings for LED Fixture Replacement/Retrofit of 8-Foot T8 and T12 Fixtures

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	Kw	kWh	kW	kWh	kW	kWh	kW
LED, 8-Foot, Replacing T12 or T8, 1L	3425, 3426, 3427	73	0.0150	92	0.0150	91	0.0130	63	0.0124
LED, 8-Foot, Replacing T12 or T8, 2L	3428, 3429, 3430	180	0.0371	229	0.0371	227	0.0323	156	0.0309
LED, 8-Foot, Replacing T12HO or T8HO, 1L	3431, 3432, 3433	146	0.0301	186	0.0301	184	0.0262	127	0.0250
LED, 8-Foot, Replacing T12HO or T8HO, 2L	3434, 3435, 3436	365	0.0754	465	0.0754	460	0.0656	317	0.0627

Average Lifecycle Deemed Savings for LED Fixture Replacement

Measure	2015	2016 and Beyond
LED, 8-Foot, Replacing T12 or T8, 1L (MMID 3425, 3426, 3427)		
Commercial	356	302
Industrial	453	385
Agriculture	448	381
Schools & Government	309	388
LED, 8-Foot, Replacing T12 or T8, 2L (MMID 3428, 3429, 3430)		
Commercial	1,632	1,548
Industrial	2,076	1,969
Agriculture	2,055	1,950
Schools & Government	1,417	1,344

Measure	2015	2016 and Beyond
LED, 8-Foot, Replacing T12HO or T8HO, 1L (MMID 3431, 3432, 3433)		
Commercial	530	410
Industrial	674	521
Agriculture	668	516
Schools & Government	460	356
LED, 8-Foot, Replacing T12HO or T8HO, 2L (MMID 3434, 3435, 3436)		
Commercial	1,494	1,203
Industrial	1,900	1,531
Agriculture	1,881	1,515
Schools & Government	1,297	1,045

Sources

1. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.
2. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
3. For MMIDs 3428-3435: Focus Labor is estimated at approximately $20 to install the fixture. The Installed Cost is estimated as $480 ($460 materials + $20 labor).This price is expected to drop over time.

   Incremental cost is determined to be the difference between the standard replacement of the fixture $110 and the energy efficient replacement of the fixture ($480-$110 = $370).

Revision History

Version Number	Authored by	Date	Description of Change
01	GDS Associates	01/16/2014	
02	GDS Associates	03/21/2014	

LED, Recessed Downlight, ENERGY STAR

	Measure Details
Measure Master ID	LED, Recessed Downlight, Replacing CFL, ENERGY STAR, Common Area, 3464 LED, Recessed Downlight, Replacing CFL, ENERGY STAR, In Unit, 3463 LED, Recessed Downlight, Replacing Incandescent, ENERGY STAR, Common Area, 3462 LED, Recessed Downlight, Replacing Incandescent, ENERGY STAR, In Unit, 3461
Measure Unit	Per Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	Varies by measure
Peak Demand Reduction (kW)	Varies by measure
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by measure
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$46[7]
Important Comments	

Measure Description

This measure is for replacing incandescent or CFL down lights with qualified LED fixtures.

Description of Baseline Condition

The baseline is an incandescent (65 watt) or CFL (16 watt) down light.[3]

Description of Efficient Condition

The efficient condition is replacing a complete luminaire unit. The down light (12 watt)[3] must be ENERGY STAR rated and replace the trim, reflector, lens, heat sink, driver, and light source.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * HOU$

Where:

$Watts_{BASE}$ = Power consumption of baseline measure (= 65 watts if incandescent, = 16 watts if CFL)[3]

$Watts_{EE}$ = Power consumption of efficient LED down light (= 12 watts)[3]

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1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 5,950 for multifamily common areas,[4] = 829 for in-residence lighting)[2]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EFFICIENT})/1,000 * CF$

Where:

CF = Coincidence factor (=0.77 for multifamily common areas,[5] = 0.11 for in-residence lighting)[2]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[1]

Deemed Savings

Baseline Technology	Area Type	MMID	$Watts_{BASE}$	$Watts_{EFFICIENT}$	Annual kWh_{SAVED}	kW_{SAVED}	Lifecycle kWh_{SAVED}
Incandescent	In Unit	3461	65	12	50	0.006	754
CFL	In Unit	3463	16	12	4	0.000	57
Incandescent	Common Area	3462	65	12	315	0.041	4730
CFL	Common Area	3464	16	12	24	0.003	357

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, similar measure MMID 2458.
2. Cadmus Research. Field Study 2013: Residential Lighting. October 18, 2013. (The report was based on using CFL bulbs to replace incandescent bulbs. It's believed that LEDs will initially be treated the same as CFLs, so those values were used.)
3. Mid-Atlantic TRM Version 3, March 2013.
4. Focus on Energy ACES Deemed Savings Desk Review 11/03/10 Multifamily Applications for Common Areas.

5. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
6. Cadmus Research. Field Study 2013: Residential Lighting. October 25, 2013. (The study was conducted for CFL and incandescent bulbs. It's believed that LEDs will initially be treated the same as CFLs, so those values were used.)
7. Assumed to be the same as MMID 2458.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/15/2012	New measure

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LED Replacement of 4-Foot T8 Lamps Using Existing Ballast

	Measure Details
Measure Master ID	LED Replacement of 4-Foot T8 Lamps Using Existing Ballast, 3512
Measure Unit	Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	14[1]
Incremental Cost	$30[5]
Important Comments	

Measure Description

4-foot T8 LEDs are an energy efficient alternative to standard 4-foot 32/28/25 watt T8 fluorescent lamps found commonly throughout commercial, industrial, agriculture, school, government, and multifamily spaces. These products can replace 32/28/25 watt T8 lamps one-for-one and this measure incorporates those that operate off the existing fluorescent ballast.

Description of Baseline Condition

The baseline condition is 4-foot standard 32/28/25 watt T8 lamps on low (0.78), normal (0.88), and high (1.15) ballast factor ballasts. Lamps are weighted 60%, 30%, and 10%, respectively, in the savings calculations. 32 watt lamp ballast factors are weighted 10%, 70%, and 20% with respect to low, normal, and high. 28 watt and 25 watt lamp ballast factors are weighted 5%, 90%, and 5% in the savings calculations.[6]

Description of Efficient Condition

Equipment must be DLC-listed with a measured wattage less than 24 watts based on a normal ballast factor (0.88) and operate off the existing fluorescent ballast. This measure is not intended to be used in refrigerated case lighting applications. Products must carry a safety certification from a NRTL, such as UL or ETL.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{LED}) / 1,000 * HOU$

Where:

$Watts_{BASE}$ = Weighted annual electricity consumption of standard 4-foot 32/28/25 watt T8 fluorescent lamp operating on low/normal/high ballast factor ballasts

$Watts_{LED}$ = Weighted average annual electricity consumption of DLC-listed 4-foot linear LED < 24 watts, noted to operate off existing ballast

1,000 = Kilowatt conversion

HOU = Hours-of-use, see table

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239
Multifamily	5,950

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{FLUORESCENT} - Watts_{LED}) / 1,000 * CF$

Where:

CF = Coincidence factor, see table

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64
Multifamily	0.77

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 14 years)[1]

Deemed Savings

Annual Savings

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov		Multifamily	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED Replacement of 4-Foot T8 Lamps Using Existing Ballast	3512	24	0.0049	30	0.0049	30	0.0043	21	0.0041	37	0.0048

Lifecycle Savings (kWh)

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov	Multifamily
LED Replacement of 4-Foot T8 Lamps Using Existing Ballast	3512	336	420	420	294	518

Sources

1. DesignLights Consortium (DLC) product list from 8/29/2014. Average Rated Life for Four-Foot Linear Replacement Lamps category under 24 measured watts came to ~50,600hrs. (50,600/3,730 = 13.57, rounded to 14yrs.)
2. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.
3. ACES Deemed Savings Desk Review 11/03/10.
4. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
5. See 'Pricing' tab in Excel calculation Four-foot Linear LED replacing four-foot T8 fluor calculation_FES_BIP_CSF_LEU_MESP_9.17.14.
6. Weights are estimated based on general market knowledge and historical application data.

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Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/21/2014	New measure

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LED Replacement of 8-Foot T8 Lamps w/External Driver

	Measure Details
Measure Master ID	LED Replacement of 8-Foot T8 Lamps w/Integral or External Driver, 3511
Measure Unit	Lamp
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Measure Type	Prescriptive
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	14[1]
Incremental Cost	$73[5]
Important Comments	

Measure Description

Dual 4-foot T8 LEDs are an energy efficient alternative to standard 8-foot fluorescent lamps found commonly throughout commercial, industrial, agriculture, and schools and government facilities. These products can replace 96 watt T12 and 75 watt T8 lamps two-for-one and this measure incorporates those that replace the existing fluorescent lamp(s) and ballast(s).

Description of Baseline Condition

8-foot standard 96 watt T12 lamps are required to be replaced by 8 foot T8 lamps. The baseline is considered to be an 8 foot T8 at 75 watts per lamp. These are generally operated on low (0.78), normal (0.88), and high (1.15) ballast factor ballasts within their fixtures. Lamps are weighted 10%, 70%, and 20%, respectively, in the savings calculations.[6]

Description of Efficient Condition

Equipment must be DLC listed with a measured wattage less than 20 watts and use a new external driver, not operate off the existing fluorescent ballast(s). This measure is not intended to be used in refrigerated case lighting applications and those products which intend to bring line voltage to existing sockets. Products must carry a safety certification from a NTRL, such as UL or ETL.

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Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{FLUORESCENT} - Watts_{LED}) / 1{,}000 * HOU$

Where:

$Watts_{FLUORESCENT}$ = Weighted annual electricity consumption of standard 8-foot 75 watt T8 fluorescent lamp operating on low/normal/high ballast factor ballasts

$Watts_{LED}$ = Weighted average annual electricity consumption of two DLC-listed 4-foot linear LEDs < 20 watts, noted w/external driver

1,000 = Kilowatt conversion factor

HOU = Hours-of-use, see table

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{FLUORESCENT} - Watts_{LED}) / 1{,}000 * CF$

Where:

CF = Coincidence factor, see table

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 14 years)[1]

Deemed Savings

Annual Savings	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED Replacement of 8-Foot T8 Lamps w/External Driver	3511	131	0.0270	166	0.0270	165	0.0235	113	0.0224

Lifecycle Savings (kWh)	MMID	Commercial	Industrial	Agriculture	Schools & Gov
LED Replacement of 8-Foot T8 Lamps w/External Driver	3511	1,830	2,328	2,305	1,589

Sources

1. See similar measure MMID 3511.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/15/2012	New measure

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LED Replacement of 8-Foot T8 Lamps Using Existing Ballast

	Measure Details
Measure Master ID	LED Replacement of 8-Foot T8 Lamps Using Existing Ballast, 3512
Measure Unit	Lamp
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Measure Type	Prescriptive
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	14[1]
Incremental Cost	$51[5]
Important Comments	

Measure Description

Dual 4-foot T8 LEDs are an energy efficient alternative to standard 8-foot fluorescent lamps found commonly throughout commercial, industrial, agriculture, and school and government facilities. These products can replace 96 watt T12 and 75 watt T8 lamps two-for-one and this measure incorporates those that replace the existing fluorescent lamp(s) and ballast(s).

Description of Baseline Condition

8-foot standard 96 watt T12 lamps are required to be replaced by 8 foot T8 lamps. The baseline is considered to be an 8 foot T8 at 75 watts per lamp. These are generally operated on low (0.78), normal (0.88), and high (1.15) ballast factor ballasts within their fixtures. Lamps are weighted 60%, 30%, and 10%, respectively, in the savings calculations.[6]

Description of Efficient Condition

Equipment must be DLC listed with a measured wattage less than 20 watts and operate off the existing fluorescent ballast. This measure is not intended to be used in refrigerated case lighting applications. Products must carry a safety certification from a NRTL, such as UL or ETL.

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Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{LED}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$	=	Weighted annual electricity consumption of standard 8-foot 75 watt T8 fluorescent lamp operating on low/normal/high ballast factor ballasts
$Watts_{LED}$	=	Weighted average annual electricity consumption of two DLC listed 4-foot linear LEDs < 20 watts, noted to operate off existing ballast
1,000	=	Kilowatt conversion factor
HOU	=	Hours-of-use, see table

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{LED}) / 1{,}000 * CF$

Where:

CF	=	Coincidence factor, see table

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 14 years)[1]

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Deemed Savings

Annual Savings	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED Replacement of 8-Foot T8 Lamps Using Existing Ballast	3512	132	0.0273	169	0.0273	167	0.0238	115	0.0227

Lifecycle Savings	MMID	Commercial	Industrial	Agriculture	Schools & Gov
LED Replacement of 8-Foot T8 Lamps Using Existing Ballast	3512	1,855	2,359	2,336	1,611

Sources

1. DesignLights Consortium (DLC) product list from 8/29/2014. Average Rated Life for Four-Foot Linear Replacement Lamps category under 24 measured watts came to ~50,600hrs. (50,600/3,730 = 13.57, rounded to 14yrs.)
2. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.
3. ACES Deemed Savings Desk Review 11/03/10
4. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
5. See 'Pricing' tab in Excel calculation Four-foot Linear LED replacing four-foot T8 fluor calculation_FES_BIP_CSF_LEU_MESP_9.17.14
6. Weights are estimated based on general market knowledge and historical application data.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/21/2014	New measures

1 South Pinckney• Suite 340 • Madison WI 53703
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LED Lamp Replacing Incandescent Lamp ≤ 40 Watts

	Measure Details
Measure Master ID	LED Lamp Replacing Incandescent Lamp ≤ 40 Watts, 3112
Measure Unit	Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	6[1]
Incremental Cost	$12.75
Important Comments	

Measure Description

ENERGY STAR-rated LED replacement lamps save energy by reducing the total input wattage of the luminaire as compared to the same luminaire operating with standard wattage incandescent lamps. This measure will provide an energy-efficient alternative to using incandescent lamps in several applications.

Description of Baseline Condition

The baseline condition is standard 25-watt and 40-watt incandescent lamps.

Description of Efficient Condition

Efficient equipment must be an ENERGY STAR-rated LED lamp.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Average consumption of standard 25-watt or 40-watt incandescent lamp (= 32.5 watts)

$Watts_{EE}$ = Consumption of reduced ENERGY STAR-rated lamp of equivalent lumen output to ≤ 40-watt incandescent (= 6 watts)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use, see table below

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Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * CF$

Where:

CF = Coincidence factor, see table below

Sector	CF[3]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 6 years)[1]

Deemed Savings

Average Annual Deemed Savings for LED Lamp Replacing Incandescent Lamp ≤ 40 Watts

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED Lamps ENERGY STAR ≤ 40 Watts	3112	100	0.0204	127	0.0204	126	0.0178	87	0.0169

Average Lifecycle Deemed Savings for LED Lamp Replacing Incandescent Lamp ≤ 40 Watts

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov
		kWh	kWh	kWh	kWh
LED Lamps ENERGY STAR ≤ 40 Watts	3112	601	765	757	522

Assumptions

Assumes an average of 25-watt and 40-watt incandescent lamps in calculation of baseline usage.

Assumes that average ENERGY STAR-rated LED (5.64 watts average) for ≤ 40-watt replacement products.[2]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. State of Wisconsin Public Service Commission. *Business Programs Deemed Savings Manual V1.0.* Table 3.2 Lighting Hours of Use and Coincidence Factors by Sector. March 22, 2010.
3. State of Wisconsin Public Service Commission. *Business Programs Deemed Savings Manual V1.0.* Table 3.2 Lighting Hours of Use and Coincidence Factors by Sector. March 22, 2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/27/2012	New measure

1 South Pinckney• Suite 340 • Madison WI 53703
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LED Lamp Replacing Incandescent Lamp > 40 Watts

	Measure Details
Measure Master ID	LED Lamp Replacing Incandescent Lamp > 40 Watts, 3113
Measure Unit	Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	6[1]
Incremental Cost	$20
Important Comments	

Measure Description

ENERGY STAR-rated LED replacement lamps save energy by reducing the total input wattage of the luminaire as compared to the same luminaire operating with standard wattage incandescent lamps. This measure will provide an energy-efficient alternative to using incandescent lamps in several applications.

Description of Baseline Condition

The baseline condition is standard 53-watt, 60-watt, 65-watt, 70-watt, 72-watt, and 80-watt incandescent lamps.

Description of Efficient Condition

Efficient equipment must be an ENERGY STAR-rated LED lamp.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Average power consumption of standard incandescent lamps (= 66.7 watts)

$Watts_{EE}$ = Power consumption of ENERGY STAR-rated LED lamp with a lumen output rating equivalent to a > 40-watt incandescent (= 14.2 watts)

HOU = Hours-of-use, see table below

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * CF$

Where:

CF = Coincidence factor, see table below

Sector	CF[3]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 6 years)[1]

Deemed Savings

Average Annual Deemed Savings for LED Lamp Replacing Incandescent Lamp > 40 Watts

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW
LED Lamps ENERGY STAR > 40 Watts	3113	196	0.0404	249	0.0404	247	0.0352	170	0.0336

Average Lifecycle Deemed Savings for LED Lamp Replacing Incandescent Lamp > 40 Watts

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov
		kWh	kWh	kWh	kWh
LED Lamps ENERGY STAR > 40 Watts	3113	1,175	1,495	1,480	1020

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Assumptions

An average of 16.67% each of 53-watt incandescent, 60-watt incandescent and halogens, 65-watt incandescent, 70-watt halogens, 80-watt halogens, and 100-watt halogen lamps was used to generate the baseline wattage.[4]

An average of 20% each of 9-watt, 11-watt, 13-watt, 18-watt, and 20-watt ENERGY STAR-rated LED lamps was used to generate the new wattage.[4]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. State of Wisconsin Public Service Commission. *Business Programs Deemed Savings Manual V1.0.* March 22, 2010.
3. Department of Energy, ENERGY STAR Lighting Qualified Parts List.
4. Based on market knowledge.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/26/2012	New measure

LED Tube Retrofit of 4-Foot T12 or T8 Fixtures

	Measure Details
Measure Master ID	T8 LED < 20 Watts, 3L, Replacing 3L or 4L T12/T8
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	14[1]
Incremental Cost	$94[5]
Important Comments	

LED < 20 Watts, 2L, Replacing 3L or 4L T12/T8

	Measure Details
Measure Master ID	T8 LED < 20 Watts, 2L, Replacing 3L or 4L T12/T8
Measure Unit	Fixture
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Measure Type	Prescriptive
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	14[1]
Incremental Cost	$62[6]
Important Comments	

Measure Description

4-foot T8 LEDs are an energy efficient alternative to standard 4-foot 32/28/25 watt T8 fluorescent lamps found commonly throughout commercial, industrial, agriculture, school, and government facilities. These products can replace 32/28/25 watt T8 lamps one-for-one and this measure incorporates those that replace the existing fluorescent lamp(s) and ballast(s).

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Description of Baseline Condition

4-foot standard 32/28/25 watt T8 lamps on low (0.78), normal (0.88), and high (1.15) ballast factor ballasts. Lamps are weighted 60%, 30%, and 10%, respectively, in the savings calculations. 32 watt lamp ballast factors are weighted 10%, 70%, and 20% with respect to low, normal, and high. 28 watt and 25 watt lamp ballast factors are weighted 5%, 90%, and 5% in the savings calculations.[3]

Description of Efficient Condition

Equipment must be DLC listed with a measured wattage less than 20 watts and use a new external driver or operate on a new fluorescent ballast(s). This measure is not intended to be used in refrigerated case lighting applications and those products which intend to bring line voltage to existing sockets. Products must carry a safety certification from a NRTL, such as UL or ETL.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * HOU$

Where:

$Watts_{BASE}$	=	Power consumption of baseline measure based on ballast factor
$Watts_{EE}$	=	Power consumption of efficient equipment based on ballast factor
1,000	=	Kilowatt conversion factor
HOU	=	Hours-of-use, see table

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * CF$

Where:

CF	=	Coincidence factor, see table

Sector	CF[3]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (=14 years)[1]

Deemed Savings

Annual Savings

Measure	Commercial		Industrial		Agricultural		Schools & Gov	
	kWh	kW	kWh	kW	kWh	kW	kWh	kW
T8 LED <20W, 3L, replace 3 or 4L T12/T8	166	0.0342	211	0.0342	209	0.0297	144	0.0284
T8 LED <20W, 2L, replace 3 or 4L T12/T8	230	0.474	292	0.0474	289	0.0413	199	0.0394

Lifecycle Savings

Measure	Commercial	Industrial	Agriculture	Schools & Gov
	kWh	kWh	kWh	kWh
T8 LED <20W, 3L, replace 3 or 4L T12/T8	2,318	2,949	2,920	2,013
T8 LED <20W, 2L, replace 3 or 4L T12/T8	3,216	4,091	4,051	2,793

Sources

1. DesignLights Consortium (DLC) product list from 8/29/2014. Average Rated Life for Four-Foot Linear Replacement Lamps category under 24 measured watts came to ~50,600hrs. (50,600/3,730 = 13.57, rounded to 14yrs).
2. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.
3. Weights are estimated based on general market knowledge and historical application data.
4. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
5. See 'Pricing' tab in Excel calculation *Four-foot Linear LED replacing 4-foot T8 fluor 4to3 calculation_GDS_SBP_12_26_14.*
6. See 'Pricing' tab in Excel calculation *Four-foot Linear LED replacing 4-foot T8 fluor 4to2 calculation_GDS_SBP_12_26_14.*

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Revision History

Version Number	Authored by	Date	Description of Change
01	GDS Associates	12/26/2014	New measures

LED Lamp Replacing Neon Sign

	Measure Details
Measure Master ID	LED, Replacing Neon Sign, 3003, 3353
Measure Unit	Per Fixture (or per sign)
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$55[6]
Important Comments	

Measure Description

This measure is the installation of a new LED open sign to replace old neon sign with high voltage magnetic transformers. All new open signs must meet UL-84 requirements.

Traditionally these signs consist of 5 or 6 millimeter (roughly 1/2 inch) diameter neon tubing with a 3,000 to 15,000 magnetic high-voltage transformer. The tubing length varies depending on the size of the sign, but averages 10 feet. Electrical drive levels vary depending on the brightness, but neon tubing of this diameter typically operates at about 6 watts to 8 watts per linear foot.

The high voltage neon transformers that drive the neon tubing are designed to provide a limited and reasonably constant current of 20 to 30 milliamperes. One of the consequences of this transformer design is an extremely poor normal power factor. Normal power factors range from 45% to 50%, while high power factors range from 85% to 90%.

Improvements in solid-state electronics in the last two decades have led to the availability of electronic neon transformers and LED alternatives to neon tube technology. Electronic neon transformers can supply the needed current limitation and regulation with roughly twice the efficiency of magnetic transformers, while providing a high power factor. LED technology can provide a neon-like appearance at the same or higher brightness levels, with six to eight times the efficiency of neon tubes that use magnetic transformers. LEDs also have the advantage being powered by inherently safe low-voltage drivers in lieu of high voltage neon transformers.

LED drivers can be either electronic switching or linear magnetic, with the supplies for electronic switching being the most efficient. The on-off power switch may be on either the power line or load side of the driver, with the line side location providing significantly lower standby losses when the sign is turned off.

Description of Baseline Condition

The baseline condition is a neon open sign with a normal magnetic ballast neon sign power factor.

Description of Efficient Condition

The efficient equipment is the new LED open sign.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$	=	Wattage of neon sign with magnetic high voltage transformer (= 189)
$Watts_{EE}$	=	Wattage of LED sign with low voltage transformer (= 20 watts)
1,000	=	Kilowatt conversion factor
HOU	=	Hours-of-use, estimated as a fraction of that listed in the Deemed Savings Manual (= 80% to account for when the facility is occupied but not open). See table below.

Sector	HOU[4]
Commercial	80% of 3,730 = 2,984
Industrial	80% of 4,745 = 3,796
Agriculture	80% of 4,698 = 3,758
Schools & Government	80% of 3,239 = 2,591

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * CF$

Where:

CF	=	Coincidence factor (= 1.0 for commercial, industrial, and agriculture; = 0.59 for schools & government)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 15 years)[1]

Deemed Savings

Savings	MMIDs	Commercial	Industrial	Agriculture	Schools & Government
kWh	3003 and 3353	504	642	635	438
kW		0.1690	0.1690	0.1690	0.0997
Lifecycle kWh		7,564	9,623	9,527	6,568

Assumptions

The peak demand coincidence factor varies from the typical weighted average factors because it is assumed that the open sign (if owned by the facility) will be on during peak times. Therefore, the demand coincidence factor is set to 1.0 or 0.59.

The baseline wattage of the fixtures has two components: the real power and the reactive power. Neon open signs have low grade magnetic ballasts that create a very low power factor and increase the apparent power from the grid. The 2004 Core Program LED Open Sign Pilot (in California) findings revealed a power factor of 0.41. In order for the grid to supply the power, the wattage draws of the neon signs must be the wattage draw divided by the power factor. In other words, the wattage draw is only 41% of the power that needs to be supplied from the grid to operate the neon sign.

The baseline wattage is 189 to account for varying real power requirements between 90 and 100 watts.

Sources

1. Open sign manufacturers offer 10-yr warranty. Life most likely 15 yrs. Product does not have rating.
2. Itron. 2004-2005 DEER Update Study Final Report. Table 3-8, pg. 3-12. December 2005.
3. Pacific Gas & Electric. Lighting Rebate Catalog and Application. 2007. Retrieved February 2008. State of Wisconsin Public Service Commission. Business Programs Deemed Savings Manual V1.0. Table 3.2 Lighting Hours of Use in Commercial Applications. March 22, 2010.
4. U.S. Department of Energy. (n.d.). Save Energy, Money, and Prevent Pollution with Light-Emitting Diode Exit Signs. Retrieved February 2008. Available online: http://www.energystar.gov/ia/business/small_business/led_exitsigns_techsheet.pdf.
5. GDS. LED Open Signs. Work Paper PGEPLTG018. August 20, 2009.
6. Focus on Energy Incremental Cost Database 2014.

Revision History

Version Number	Authored by	Date	Description of Change
01	GDS	01/08/2013	New measure
02	GDS	02/18/2013	Updated

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LED Fixture, 2x2, Low and High Output, DLC Listed

	Measure Details
Measure Master ID	LED Fixture, 2x2, Low Output, DLC Listed, 3400 LED Fixture, 2x2, High Output, DLC Listed, 3401
Measure Unit	Luminaire
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	Varies by sector
Peak Demand Reduction (kW)	Varies by sector
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by sector
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	Varies by sector
Incremental Cost	$23.16
Important Comments	

Measure Description

LED 2x2 troffers save energy when replacing 2-4 lamp T8 products and 2-4 lamp FT lamps by providing a similar lumen output with lower input wattage. These products can be installed on a one-for-one basis to replace 2x2 2-4 lamp T8, T12, or FT lamp luminaires.

Description of Baseline Condition

The baseline condition is 2-foot 2, 3, and 4 lamp T8, or FT lamp troffers for existing buildings and new construction buildings.

Low Output 2x2

An average of 2% 2 lamp, 40% 2 lamp U bend, 38% 3 lamp, and 20% 4 lamp troffers was used to generate the baseline wattage.

High Output 2x2

An average of 50% 3 lamp and 50% 4 lamp troffers was used to generate the baseline wattage.

Description of Efficient Condition

Low Output 2x2

The efficient condition is DLC-listed 2x2 “Linear Panel (2x2 troffer),” which consumes ≤ 36 watts and has an output of ≥ 2,000 initial lumens.

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High Output 2x2

The efficient condition is DLC-listed 2x2 "Linear Panel (2x2 troffer)," which consumes ≤ 85 watts and has an output of ≥ 4,000 initial lumens.

Annual Energy-Savings Algorithm

Low Output 2x2

$kWh_{SAVED} = (Watts_{2\text{-}4L\ 2'\ T8} - Watts_{LED\ LOW\ OUTPUT\ 2x2})\ /1{,}000 * HOU$

High Output 2x2

$kWh_{SAVED} = (Watts_{2\text{-}4L\ 4'\ FT} - Watts_{LED\ HIGH\ Output\ 2x2})\ /1{,}000 * HOU$

Where:

$Watts_{LED\ LOW\ OUTPUT\ 2x2}$ = Wattage of a DLC listed 2x2 troffer that consumes ≤ 36 watts and has an initial lumen output ≥ 2,000

$Watts_{LED\ HIGH\ OUTPUT\ 2x2}$ = Annual electricity consumption of a DLC-listed 2x2 troffer that consumes ≤ 85 watts and has an initial lumen output ≥ 4,000

$Watts_{2\text{-}4L\ 4'\ T8\ LOW\ OUTPUT\ 2x2}$ = Annual electricity consumption of 2 or 4 lamp T8 troffer luminaires

$Watts_{2\text{-}4L\ 4'\ FT\ HIGH\ OUTPUT\ 2x2}$ = Annual electricity consumption of 2 to 4 lamp FT troffer luminaires

1,000 = Kilowatt conversion

HOU = Hours-of-use, see table

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239
Multifamily	5,950

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = Watts/1{,}000 * CF$

Where:

CF = Coincidence factor, see table

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64
Multifamily	0.77

Lifecycle Energy-Savings Algorithm

Low Output 2x2

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

High Output 2x2

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 13 years for Commercial, Industrial, Agriculture, Schools & Government and 8 years for multifamily)

Deemed Savings

Average Annual Deemed Savings for DLC Listed 2x2 Troffer

Measure	MMID	Commercial		Industrial		Agriculture		Schools & Gov		Multifamily	
		kWh	kW	kWh	kW	kWh	kW	kWh	kW	kWh	kW
Low Output 2x2 Qualifying DLC Listed HPT Fixtures	3400	94	0.0193	119	0.0193	118	0.0168	81	0.0161	149	0.0193
High Output 2x2 Qualifying DLC Listed HPT Fixtures	3401	345	0.0713	439	0.0713	435	0.0620	300	0.0593	551	0.0713

Average Lifecycle Deemed Savings for DLC Listed 2x2 troffer (kWh)

Measure	MMID	Commercial	Industrial	Agriculture	Schools & Gov	Multifamily
Low Output 2x2 Qualifying DLC Listed HPT Fixtures	3400	1,215	1,546	1,530	1,055	1,195
High Output 2x2 Qualifying DLC Listed HPT Fixtures	3401	4,482	5,701	5,645	3,892	4,408

Sources

1. Based on similar measure/technology EUL – SPECTRUM MMID 3111 LED Troffer,2x4, Replacing 4' 3-4 Lamp T8 Troffer
2. All sources used for gathering pricing data are documented in the attached LED 2x2 calculation_FES_BIP_LEU_CSF_MESP_04.01.14.xls calculation workbook
3. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Lighting Hours of Use in Commercial Applications.
4. Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
5. ACES Deemed Savings Desk Review 11/03/10
6. ACES: Default Deemed Savings Review Final Report 6/24/08. CF is within range of similar programs including Table 4-1 MF housing (in unit) is 65% to 83%. http://www.coned.com/documents/Con%20Edison%20Callable%20Load%20Study_Final%20Report_5-15-08.pdf

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/01/2014	New measure

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High Bay Fluorescent Lighting

	Measure Details
Measure Master ID	High Bay Fluorescent Lighting T8 4L Replacing 250-399 Watt HID, 2884 T8 6L Replacing 400-999 Watt HID, 2885 T8 8L Replacing 400-999 Watt HID, 2886 T8 8L ≤ 500 Watts, Replacing ≥ 1,000 Watt HID, 2887 T8 10L ≤ 500 Watts, Replacing ≥ 1,000 Watt HID, 2888 T8 (2) 6L ≤ 500 Watts, Replacing ≥ 1,000 Watt HID, 2889 T5HO 2L Replacing 250-399 Watt HID, 2890 T5HO 3L Replacing 250-399 Watt HID, 2891 T5HO 4L Replacing 400-999 Watt HID, 2892 T5HO 6L Replacing 400-999 Watt HID, 2893 T5HO 6L ≤ 500 Watts, Replacing ≥ 1,000 Watt HID, 2894 T5HO 8L ≤ 500 Watts, Replacing ≥ 1,000 Watt HID, 2895 T5HO (2) 4L ≤ 500 Watts, Replacing ≥ 1,000 Watt HID, 2896 T5HO (2) 6L ≤ 800 Watts, Replacing ≥ 1,000 Watt HID, 2897
Measure Unit	Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Fluorescent, Linear
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by measure
Peak Demand Reduction (kW)	Varies by measure
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by measure
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	14[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

In high bay lighting applications (ceiling heights generally over 15 feet), HID fixtures have typically been used due to their high lumen output. In recent years, however, improvements in fluorescent lamps and the emergence of new high-intensity fluorescent fixtures have made fluorescent lighting the most cost-effective choice for lighting high indoor spaces. These high-intensity fluorescent systems are more energy efficient than HID solutions and feature lower lumen depreciation rates, better dimming options, virtually instant start-up and re-strike, better color rendition, and reduced glare. Similar high-intensity fluorescent lighting fixtures are also available for low bay applications, generally with equipment available in the same product family as the manufacturers' high bay products.

Description of Baseline Condition

The baseline condition is HID fixtures and lamps.

Description of Efficient Condition

The efficient condition varies by the wattage of the baseline lamp. See table below.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * HOU$

Where:

$Watts_{BASE}$ = Watts of a HID lamp

$Watts_{EE}$ = Watts of HOT5 or HOT8 lamp (see deemed savings table below)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use, see table below

Sector	HOU[2]
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Wattages Used for Deemed Savings Calculations

Measure	$Watts_{BASE}$	$Watts_{EE}$
2L HOT5	293	117
3L HOT5	293	179
4L T8	293	151
4L HOT5	356	234
6L T8	356	224
4L HOT5	455	234
6L HOT5	455	355
6L T8	455	224
8L T8	455	291
6L HOT5	1,079	355
8L HOT5	1,079	585
(2) 4L HOT5	1,079	468
(2) 6L HOT5	1,079	709
8L T8	1,079	291
10L T8	1,079	366
(2) 6L T8	1,079	447

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * CF$

Where:

CF = Coincidence factor, see table below

Sector	CF[2]
Commercial	0.77
Industrial	0.77
Agriculture	0.67
Schools & Government	0.64

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 14 years)[1]

Deemed Savings

Annual Electric Savings (kWh/year/lamp removed)

Existing Wattage	New Fixture Type	MMID	Commercial	Industrial	Agriculture	Schools & Government
250 - 399 watts	2L HOT5	2890, 3330	656	835	827	570
	3L HOT5	2891	425	541	536	369
	4L T8	2884, 3329	532	676	669	462
400 watts - 999 watts	4L HOT5	2892, 3332	824	1,049	1,038	716
	6L HOT5	2893	375	477	472	326
	6L T8	2885, 3331	863	1,098	1,088	750
	8L T8	2886	612	778	770	531
1,000 watts	6L HOT5	2894, 3334	2,701	3,435	3,401	2,345
	8L HOT5	2895	1,841	2,342	2,318	1,598
	(2) 4L HOT5	2896	2,277	2,897	2,868	1,977
	(2) 6L HOT5	2897	1,378	1,753	1,736	1,197
	8L T8	2887, 3333	2,937	3,737	3,700	2,551
	10L T8	2888	2,658	3,381	3,347	2,308
	(2) 6L T8	2889	2,355	2,996	2,967	2,045

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Summer Peak Savings

Existing Wattage	New Fixture Type	MMID	Commercial	Industrial	Agriculture	Schools & Government
250 – 399 watts	2L HOT5	2890, 3330	0.136	0.136	0.118	0.113
	3L HOT5	2891	0.088	0.088	0.076	0.073
	4L T8	2884, 3329	0.11	0.11	0.095	0.091
400 watts - 999 watts	4L HOT5	2892, 3332	0.17	0.17	0.148	0.141
	6L HOT5	2893	0.077	0.077	0.067	0.064
	6L T8	2885, 3331	0.178	0.178	0.155	0.148
	8L T8	2886	0.126	0.126	0.11	0.105
1,000 watts	6L HOT5	2894, 3334	0.557	0.557	0.485	0.463
	8L HOT5	2895	0.38	0.38	0.331	0.316
	(2) 4L HOT5	2896	0.47	0.47	0.409	0.391
	(2) 6L HOT5	2897	0.285	0.285	0.248	0.236
	8L T8	2887, 3333	0.606	0.606	0.528	0.504
	10L T8	2888	0.549	0.549	0.477	0.456
	(2) 6L T8	2889	0.486	0.486	0.423	0.404

Lifecycle Savings (kWh)

Existing Wattage	New Fixture Type	MMID	Commercial	Industrial	Agriculture	Schools & Government
250 - 399 watts	2L HOT5	2890, 3330	9,191	11,692	11,576	7,981
	3L HOT5	2891	5,953	7,573	7,498	5,169
	4L T8	2884, 3329	7,441	9,466	9,373	6,462
400 watts - 999 watts	4L HOT5	2892, 3332	11,541	14,681	14,536	10,021
	6L HOT5	2893	5,248	6,676	6,610	4,557
	6L T8	2885, 3331	12,089	15,379	15,226	10,498
	8L T8	2886	8,564	10,895	10,787	7,437
1,000 watts	6L HOT5	2894, 3334	37,807	48,095	47,619	32,831
	8L HOT5	2895	25,771	32,783	32,458	22,378
	(2) 4L HOT5	2896	31,880	40,556	40,154	27,684
	(2) 6L HOT5	2897	19,295	24,546	24,303	16,755
	8L T8	2887, 3333	41,123	52,314	51,795	35,710
	10L T8	2888	37,207	47,331	46,863	32,309
	(2) 6L T8	2889	32,977	41,951	41,535	28,636

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Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. PA Consulting Group Inc. State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation Business Programs: Deemed Savings Manual v1.0. Updated March 22, 2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/31/2012	New measure

Exterior – Induction, PSMH, CMH, Linear Florescent Fixtures

	Measure Details
Measure Master ID	Induction, PSMH/CMF or Linear Fluorescent, Exterior Replacing 150-watt to 175-watt HID, 3078 Replacing 250-watt HID, 3081 Replacing 320-watt HID, 3084 Replacing 400-watt HID, 3086 Replacing 70- watt to 100-watt HID, 3087
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Other
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by fixture
Peak Demand Reduction (kW)	Varies by fixture
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by fixture
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Induction, PSMH, CMH, and linear fluorescent lighting fixtures save energy by reducing the light fixture wattage compared to standard metal halide fixtures, without sacrificing illumination quality and safety. These lighting technologies are appropriate for exterior applications.

Description of Baseline Condition

The baseline measure is standard HID lamps between 70 watts and 400 watts, located on exterior poles or high canopies.[2]

Description of Efficient Condition

The efficient measure is induction, PSMH, CMH, and linear fluorescent fixtures between 35 watts and 250 watts.[2]

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Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$	=	Wattage of baseline equipment (standard HID fixture)
$Watts_{EE}$	=	Wattage of efficient equipment (induction fixture, PSMH fixture, CMH fixture, or linear fluorescent fixture)
1,000	=	Kilowatt conversion factor
HOU	=	Hours-of-use (= 4,380)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 15 years)[1]

Deemed Savings

Measure	MMID	Annual Savings (kWh)	Peak Demand Savings (kW)	Lifecycle Savings (kWh)
Induction, PSMH/CMH, or Linear Fluorescent, Replacing 70-100 Watt HID, Exterior	3087	247	0	3,712
Induction, PSMH/CMH, or Linear Fluorescent, Replacing 150-Watt to 175-Watt HID, Exterior	3078	329	0	4,938
Induction, PSMH, CMH, or Linear Fluorescent Replacing 250-Watt HID, Exterior	3081	605	0	9,076
Induction, PSMH, CMH, or Linear Fluorescent Replacing 320-Watt HID, Exterior	3084	556	0	8,344
Induction, PSMH, CMH, or Linear Fluorescent Replacing 400-Watt HID, Exterior	3086	972	0	14,585

Assumptions

The induction wattage shown below includes ballast wattage, which was calculated as 10% of the lamp wattage based on the manufacturer specifications.

All exterior replacement calculations use 4,380 hours of annual operation, half the total hours in a year.

70-watt to 100-watt HID exterior replacements are weighted as follows:

- Baseline = 50% 70-watt HID and 50% 100-watt HID (= 111.5 watts)
- Eligible Replacements = 50% linear fluorescent ≤ 60 watts, 25% 35-watt induction, and 25% 55-watt induction (= 55 watts)

150-watt to 175-watt HID exterior replacements are weighted as follows:

- Baseline = 50% 150-watt HID 50% 175-watt HID (= 194.5 watts)
- Eligible Replacements = 33.33% 100-watt induction, 33.33% 100-watt PSMH or CMH, and 33.33% ≤ 120-watt linear fluorescent (= 119 watts)

250-watt HID exterior replacements are weighted as follows:

- Baseline = 100% 250-watt HID (= 299 watts)
- Eligible Replacements = 14.3% 120-watt to 125-watt induction, 14.3% 150-watt induction, 14.3% 165-watt induction, 14.3% 125-watt PSMH or CMH, 14.3% 140-watt PSMH or CMH, 14.3% 150-watt PSMH or CMH, and 14.3% ≤ 155-watts linear fluorescent (= 161 watts)

320-watt HID exterior replacements are weighted as follows:

- Baseline = 100% 320-watt HID (= 368 watts)
- Eligible Replacements = 16.6% 200-watt induction, 16.6% 225-watt induction, 16.6% 250-watt induction, 16.6% 200-watt PSMH or CMH, 16.6% 210-watt PSMH or CMH, and 16.6% 220-watt PSMH or CMH (= 241 watts)

400-watt HID exterior replacements are weighted as follows:

- Baseline = 100% 400-watt HID (= 463 watts)
- Eligible Replacements = 16.6% 200-watt induction, 16.6% 225-watt induction, 16.6% 250-watt induction, 16.6% 200-watt PSMH or CMH, 16.6% 210-watt PSMH or CMH, and 16.6% 220-watt PSMH or CMH (= 241 watts)

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, similar measure MMID 2419.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/28/2012	New measure

Parking Garage Induction PSMH CMH LF Fixtures

	Measure Details
Measure Master ID	Induction, PSMH/CMH, or Linear Fluorescent, Parking Garage Replacing 150-175 Watt HID, 24 Hour, 3079 Replacing 150-175 Watt HID, Dusk to Dawn, 3080 Replacing 250 Watt HID, 24 Hour, 3082 Replacing 250 Watt HID, Dusk to Dawn, 3083 Replacing 70-100 Watt HID, 24 Hour, 3088 Replacing 70-100 Watt HID, Dusk to Dawn, 3089
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Other
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Varies by fixture
Peak Demand Reduction (kW)	Varies by fixture
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by fixture
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Induction, PSMH, CMH, and linear fluorescent lighting fixtures save energy by reducing the light fixture wattage compared to standard metal halide fixtures, without sacrificing illumination quality and safety. These lighting technologies are appropriate for parking garage applications.

Description of Baseline Condition

The baseline is standard HID lamps between 70 watts and 400 watts located in parking garages.

Description of Efficient Condition

The efficient condition is induction, PSMH, CMH, and linear fluorescent fixtures between 35 watts and 250 watts.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1,000 * HOU$

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Where:

$Watts_{BASE}$	=	Wattage of baseline equipment (standard HID fixture)[2]
$Watts_{EE}$	=	Wattage of efficient equipment (induction fixture, PSMH fixture, CMH fixture, or linear fluorescent fixture)[2]
1,000	=	Kilowatt conversion factor
HOU	=	Hours-of-use (varies by hours of operation; = 4,380 for night run only and = 8,760 if on continuously)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 15 years)[1]

Deemed Savings

Average Annual Deemed Savings

Measure	MMID	kWh	kW
Induction, PSMH/CMH, or Linear Fluorescent, Replacing 70-100 Watt HID, Parking Garage, 24 Hour	3088	495	0.057
Induction, PSMH, CMH, or Linear Fluorescent, Replacing 70 Watt to 100 Watt, Parking Garage, Dusk to Dawn	3089	247	0
Induction PSMH, CMH, or Linear Fluorescent, 150 Watt to 175 Watt Parking Garage, 24 Hour	3079	658	0.075
Induction, PSMH/CMH, or Linear Fluorescent, Replacing 150-175 Watt HID, Parking Garage, Dusk to Dawn	3080	329	0
Induction PSMH, CMH, or Linear Fluorescent, 250 Watt, Parking Garage, 24-hour	3082	1.210	0.141
Induction PSMH, CMH, or Linear Fluorescent, 250 Watt, Parking Garage, Dusk to Dawn	3083	605	0

Average Lifecycle Deemed Savings

Measure	MMID	kWh
Induction, PSMH/CMH, or Linear Fluorescent, Replacing 70-100 Watt HID, Parking Garage, 24 Hour	3088	7,424
Induction, PSMH, CMH, or Linear Fluorescent, Replacing 70 Watt to 100 Watt, Parking Garage, Dusk to Dawn	3089	3,712
Induction PSMH, CMH, or Linear Fluorescent, 150 Watt to 175 Watt, Parking Garage, 24 Hour	3079	9,877
Induction, PSMH/CMH, or Linear Fluorescent, Replacing 150 Watt to 175 Watt HID, Parking Garage, Dusk to Dawn	3080	4,938
Induction PSMH, CMH, or Linear Fluorescent, 250 Watt, Parking Garage, 24-hour	3082	18,152
Induction PSMH, CMH, or Linear Fluorescent, 250 Watt, Parking Garage, Dusk to Dawn	3083	9,076

Assumptions

The induction wattages shown below include the ballast wattages, which was calculated as 10% of the lamp wattage based on the manufacturer specifications.

All garage replacement calculations use 8,760 or 4,380 hours of annual operation.

70-watt to 100-watt HID parking garage replacements are weighted as follows:

- Baseline = 50% 70-watt HID and 50% 100-watt HID (= 111.5 watts)
- Eligible Replacements = 25% 35-watt induction, 25% 55-watt induction, and 50% ≤ 60-watt linear fluorescent (= 55 watts)

150-watt to 175-watt HID parking garage replacements are weighted as follows:

- Baseline = 50% 150-watt HID and 50% 175-watt HID (= 194.5 watts)
- Eligible Replacements = 33.33% 100-watt induction, 33.33% 100-watt PSMH or CMH, and 33.33% ≤ 120-watt linear fluorescent (= 119 watts)

250-watt HID parking garage replacements are weighted as follows:

- Baseline = 100% 250-watt HID (= 299 watts)
- Eligible Replacements = 14.3% 120-watt to 125-watt induction, 14.3% 150-watt induction, 14.3% 165-watt induction, 14.3% 125-watt PSMH or CMH, 14.3% 140-watt PSMH or CMH, 14.3% 150-watt PSMH or CMH, and 14.3% ≤ 155-watt linear fluorescent (= 161 watts)

Sources

1. Focus on Energy Evaluation Business Programs: Measure Life Study Final Report: August 25, 2009.
2. Based on Market Research.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/28/2012	New measure

Process

Variable Frequency Drive (Variable Torque and Constant Torque)

	Measure Details
Measure Master ID	VFD, Process Fan, 2647 VFD, Process Pump, 2648 VFD, Constant Torque, 3280
Measure Unit	Motor
Measure Type	Hybrid
Measure Group	Process
Measure Category	Variable Speed Drive
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	Calculated
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Calculated
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Fans, pumps, conveyors, and other motor-driven equipment require controls to vary their operation to produce the desired output (sufficient airflow to cool a building, deliver hot water for heating, or move product down a conveyor). Traditionally, flow rates have been reduced by increasing the head and riding the pump (or fan) curve back to a new flow rate (throttling control). Alternately some systems have bypasses that divert a portion of the flow back to the pump or fan inlet to reduce system flow (bypass control). Other systems simply start and stop the motor to meet the given load (on/off control). An alternate way to provide control of motor systems is to use VFDs, which physically slow the motors driving pumps, fans, and other equipment in order to achieve reduced flow rates at considerable energy savings.

There are three categories of motor applications, but only two (variable torque and constant torque) have the potential for energy savings when adding VFDs. The categories of motor applications are as follows:[4]

Variable Torque Loads – This category consists of centrifugal pumps and fans. For these applications, the motors follow the fan or affinity laws resulting in the input power varying with the cube of the pump or fan rotational speed. This means that small reductions in flow (20% for example) can produce large input power savings (50% at 20% flow reduction).

Constant Torque Loads – This category consists of equipment where the torque requirement is independent of speed. Examples of constant torque applications include cranes, hoists, conveyors, extruders, mixers, and positive displacement pumps. This means that the input power varies linearly with the rotational speed (e.g., a 20% reduction in speed equals a 20% reduction in input power).

Constant Horsepower Loads[5] – For equipment in this category, the torque varies inversely with the speed of the motor. Therefore, the power requirement does not vary, regardless of speed. Examples of constant horsepower loads includes lathes, drilling, and milling equipment. This equipment category does not offer energy savings for installing VFDs and is therefore ineligible for VFD incentives.

Description of Baseline Condition

The baseline condition is a motor for a variable torque or constant torque application operating at full speed and using throttling, bypass, or on/off control to handle variable outputs from the driven device (pump, fan, etc.).

Description of Efficient Condition

The efficient condition is adding a variable frequency drive to the motor to vary the electric frequency (i.e., Hertz) going to the motor, which will allow the speed of the motor to be varied. For variable torque (pump and fan) applications, the variable frequency drive must be automatically controlled by a variable input signal. Constant torque applications have the option to be manually controlled, as these are often used to vary the speed of equipment associated with production in a manufacturing environment.

Annual Energy-Savings Algorithm

Energy savings for this measure are custom calculated using a spreadsheet tool,[6] which is based on an engineering bulletin[7] and savings calculators[8] from two different VFD manufacturers.

For the energy savings analysis, this tool used power curves developed from data obtained by measuring the operating characteristics of various fans and pumps. The curves are representative of typical VFD operation.

Equation used in the software tool:

Power at Design GPM [CFM] = Nameplate Horsepower * Conversion Constant (kW/hp) * Motor Load at Design GPM [CFM] / Nameplate Efficiency

Computed for each capacity level:

Percent of Design kW = A1 + (A2 * Capacity) + (A3 * $(\text{Capacity})^2$) + (A4 * $(\text{Capacity})^3$)

Percent of Design kW for VSD = A1 + (A2 * Capacity) + (A3 * $(\text{Capacity})^2$) + (A4 * $(\text{Capacity})^3$)

Where A1, A2, A3, and A4 are variables unique to each “before VFD” control type that allow a quadratic equation to be created to represent the load profile. The next table shows values for A1, A2, A3, and A4.

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Equation Variables: Before VFD

Control	A1	A2	A3	A4	CF
Pumps					
Outlet Control Valve	55.21240	0.63700	0.00190	0.00000	0.9
Eddy Current Clutch	16.39683	-0.05647	0.01237	-0.00003	0.9
Torque Converter	13.51137	0.34467	0.01269	-0.00007	0.9
Bypass Valve	102.00000	0.00000	0.00000	0.00000	0.9
VFD_Pump	27.44751	-1.00853	0.01762	0.00000	0.9
On/Off	100.00000	0.00000	0.00000	0.00000	0.9
Fans					
Inlet Guide Vane, FC Fans	20.00000	0.06808	0.00128	0.00009	0.9
Inlet Guide Vanes	47.26190	0.67944	0.01554	0.00014	0.9
Inlet Damper Box	50.25833	0.71648	0.01452	0.00013	0.9
Outlet Damper, FC Fans	20.41905	0.10983	0.00745	0.00000	0.9
Discharge Damper	55.92857	-0.56905	0.02462	-0.00014	0.9
Eddy Current Drives	16.39683	-0.05647	0.01237	-0.00003	0.9
VFD_Fan	5.90000	-0.19567	0.00766	0.00004	0.9
Constant Torque VFD					
Constant_Torque_VFD	0.00000	1.00000	0.00000	0.00000	0.78

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = kWh_{SAVED} / HOURS * CF$

Where:

HOURS = Annual hours of operation for the system controlled by the VFD

CF = Coincidence factor, which varies by VFD use

VFD Use	CF	Source
Hot Water Pump	0.0	Heating pumps operate in winter (off peak)
Equip type = Other Pump, Other Fan Baseline flow controls = Fan with Inlet Damper Box, Eddy Current Drives, Torque Converter	0.0	Assume no demand savings
Chilled Water Pump	0.9	DEER model runs are weather normalized for statewide use by population density.
Constant Volume Fan (on/off control)	0.9	
Air foil / inlet guide vanes	0.9	
Forward curved fan with discharge damper	0.9	
Forward curved inlet guide vanes	0.9	
Inlet guide vanes, fan type unknown	0.9	
Cooling tower fan	0.9	
Process pump	0.78	Per Michigan Energy Measures Dataabase[10]

VFD Use	CF	Source
Process fan	0.78	
Constant torque process applications	0.78	Assume same CF as other process equipment
Pool pump	0.78	Assume same CF as process equipment

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Expected useful life (= 15 years)[1]

Assumptions

The following rules and requirements apply to the VFD application:

- VFD must be used in conjunction with a process (non HVAC) pumping application.
- Redundant or back-up units do not qualify.
- Routine replacement of existing VFDs does not qualify.
- VFD speed (for variable torque applications) must be automatically controlled by differential pressure, flow, temperature, or other variable signal.
- VFD speed (for constant torque applications) may be either automatically or manually controlled.
- The system controlled must have significant load diversity that will result in savings through motor speed variation. Conditions requiring the motor to be loaded consistently above 80% or consistently loaded below 30% are not eligible for this incentive, as these operating conditions may not realize sufficient savings from a VFD.
- Copies of invoices that clearly show the drive's size are required.
- Incremental cost assumed to equal measure installed cost. HVAC and process systems either have equipment described under the Baseline Condition section or have a VFD. Baseline condition equipment is required for operation, so VFD is a replacement technology, not an incremental improvement in efficiency (like for a chiller or boiler).

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. "VFD Cost Analysis.xls", developed using RSMeans 2007 Costworks.
3. Telephone conversation with Mike Starck of Precision Drive and Controls on 11/4/2013 (constant torque VFD are typically 1 motor size larger, about an average of 15% additional cost).
4. EERE Advanced Manufacturing Office, Motor Systems Tip Sheet #11, Adjustable Speed Drive Part Load Efficiency.

5. SEDAC Tech Note – Variable Frequency Drives, Smart Energy Design Assistance Center, www.sedac.org, November 2011.
6. Focus on Energy VFD calculation spreadsheet, modified to handle constant torque loads.
7. “Flow Control", a Westinghouse publication, Bulletin B-851, F/86/Rev-CMS 8121.
8. ABB and Toshiba energy saving spreadsheet tools.
   ABB Pump Save (use version 4.4):
   http://www.abb.com/product/seitp322/5fcd62536739a42bc12574b70043c53a.aspx
   ABB Fan Save (use version 4.4):
   http://www.abb.com/product/seitp322/5b6810a0e20d157fc1256f2d00338395.aspx
   Toshiba (set filters to product family=drives and download type=software, look for “Cost Savings Estimator”): http://www.toshiba.com/ind/downloads_main.jsp.
9. Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 2.0, June 7, 2013, page 235.
10. 2013 MEMD Master Database, accessed from http://www.michigan.gov/mpsc/0,4639,7-159-52495_55129---,00.html on 11/21/13. Refer to “VFD 1.5 to 50 hp Process Pumping” and “VFD for Process Fans Under 50 hp” measures.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	11/21/2013	Constant torque (conveyor, mixer, positive displacement pump) VFDs kW and kW savings for select VFDs

Refrigeration

Cooler Evaporator Fan Control

	Measure Details
Measure Master ID	Cooler Evaporator Fan Control, 2269
Measure Unit	Per Fan Motor
Measure Type	Prescriptive
Measure Group	Refrigeration
Measure Category	Controls
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	2,051
Peak Demand Reduction (kW)	0.234
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	30,771
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$275
Important Comments	This measure will be made up of a single motor and a controller that could control multiple fan motors.

Measure Description

Walk-in cooler and freezer refrigeration systems typically operate 24 hours per day, 365 days per year. These systems must run when the compressor is running to provide cooling, and they must run when the compressor is not running to provide air circulation, thus preventing the coil from freezing. The only time these fans do not operate is during the defrost cycle.

Significant energy savings can be realized by installing a more efficient evaporator fan motor and control fan system, which regulates the speed of the evaporator fan motor to meet the need during each phase of the refrigeration cycle. These systems save energy in two ways: (1) the evaporator fans consume less energy, and (2) the system results in less heat being introduced to the refrigerated chamber from the evaporator fan motors, which decreases the overall box load, thereby reducing the compressor/condenser on-duty cycle.

Description of Baseline Condition

The baseline condition is a refrigeration system with a SP or PSC motor without an evaporator fan controller. Existing ECM motors are not eligible for replacement under this measure. It is assumed that these fans run at constant speed for 8,578 hours per year.

Description of Efficient Condition

The efficient condition is a two-speed ECM replacing a SP motor or PSC motor on an evaporator fan unit and a controller to switch the fan to lower speed when the temperature of the unit or refrigerant is determined to need lower air movement. Only upgraded motors connected to the control unit is allowable under this measure.

Controls must meet the requirements of the ECM fan motor control measures.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = kWh_{BASE} - kWh_{EE}$

$kWh_{BASE} = [(kWevap * DCevap) * BF] * HOURS$

$kWh_{EE} = \{[(kWcircH*(1-LS) + kWcircH*LS) * BF\} *HOURS$

Where:

kWh_{BASE}	=	Annual existing base kWh consumed
kWh_{EE}	=	Proposed annual kWh consumed
kWevap	=	Connected load kW of each evaporator fan (see attached spreadsheet)[2]
DCevap	=	Duty cycle of the evaporator fan (= 97%)[3]
kWcircH	=	Connected load kW of the normal speed ECM evaporator fan (see attached spreadsheet)[4]
kWcircL	=	Connected load kW of the low speed ECM evaporator fan (see attached spreadsheet)[4]
BF	=	Bonus factor to account for a reduced cooling load on the compressor, thus refrigeration savings[3, 6]
LS	=	Fraction of time at low speed setting (= 32%)[7]
HOURS	=	Annual operating hours of fans (= 8,578)[1, 8]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = kWh_{SAVED} / (8{,}760) * CF$

Where:

8,760	=	Total annual operating hours of building
CF	=	Coincidence factor (= 1)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 15 years)[1]

Assumptions

A 60% SP motor and 40% PSC motor were assumed for the baseline.

An equal mix of 1/10, 1/15, and 1/20 HP motors were assumed for the motor sizes to be replaced.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C. The database provides a 16 year life for the controller, but the system EUL is controlled by the motor, which has an EUL of 15.
2. This is based on a weighted average of evaporator fan types: 60% SP and 40% PSC. It is assumed that the fan size is equal amounts of 1/10, 1/15 & 1/20 HP for walk in coolers and freezers. It is assumed that there is a 70% load factor, 20% SP motor efficiency, and 40% PSC motor efficiency.
3. Efficiency Maine Commercial Technical Reference Manual, Version 2013.1, January 1, 2013, pg. 67.
4. This is based on a weighted average of evaporator fan types: 100% ECM. It is assumed that the fan size is equal to the HP replaced for walk in coolers and freezers. It is assumed that there is a 70% load factor for full operation and 70% motor efficiency. For low speed operation it assumes a 10% Load Factor and 50% motor efficiency.
5. The assumption is that the application of this measure would occur 50% of the time in a cooler and 50% of the time in a freezer. The associated duty cycle assumed for coolers is 100% and for freezers is 100% and 94%.
6. The assumption is that the application of this measure would occur 50% of the time in a cooler and 50% of the time in a freezer. The assumed bonus factor for coolers is 1.3 and for freezers is 1.5.
7. Regional Technical Forum Evaporator Fan Controls and Evaporator Fan Uniform Energy Savings measures calculations, 2010. Estimated to be a conservative average of a Medium Temperature Low Speed at 42% and a Low Temperature Low Speed at 32%.
8. The assumption is that the application of this measure would occur 50% of the time in a cooler and 50% of the time in a freezer. The assumed number of operating hours for coolers is 8,760 per year and for freezers is 8,273 per year (with for 4 x 20-minute defrost cycles per day).

   The install cost is equal to the controller cost plus the project sum of the motor costs plus installation. It is assumed that the average project will include 1 controller and 4 motors.

   a. Controller: Frigitek, Retail: $350 each
   b. Labor: 2 hours per Controller @ $80/Hr = $160 each
   c. Motors: Retail = $120 per motor

Revision History

Version Number	Authored by	Date	Description of Change
01	GDS	11/14/2014	Initial submittal

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ECM Compressor Fan Motor

	Measure Details
Measure Master ID	ECM Compressor Fan Motor, 2306
Measure Unit	Per Motor
Measure Type	Prescriptive
Measure Group	Refrigeration
Measure Category	Motor
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	396
Peak Demand Reduction (kW)	0.0792
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	5,940
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$80
Important Comments	

Measure Description

Compressor and condenser packaged unit fans typically run 4,500 hours per year to blow air across the compressor and condenser to cool the equipment and refrigerant. The long-time standard in refrigeration equipment is SP fan motors, which are highly inefficient and generate excessive heat. Higher-efficiency ECMs use 75% less energy to run and generate less heat. ECMs or brushless AC fan motors are used in conjunction with air-cooled condensers and/or compressors.

Incentives are available for ECMs replacing SP motors or PSC motors on existing packaged condenser/compressor fans. This measure does not apply to evaporator fan motors.

Description of Baseline Condition

The baseline condition is an SP or PSC packaged compressor/condenser unit fan motor.

Description of Efficient Condition

The efficient condition is an ECM replacing a SP motor or PSC motor on a compressor/condenser unit.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * HOURS$

Where:

$Watts_{BASE}$ = Wattage of the existing SP fan motor (average = 142)[2]

$Watts_{EE}$ = Wattage of the proposed motor (= 54)[2]

1,000 = Kilowatt conversion factor

HOURS = Average annual run hours (= 4,500)[3]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EFFICIENT})/1,000 * CF$

Where:

CF = Coincidence factor (= 0.90)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[1]

Assumptions

A 50% SP motor and 50% PSC motor were assumed for the baseline.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2013.
3. Operating hours based on compressor/condenser run time and Wisconsin weather. This value is between 4,000 – 5,000 hours, so 4,500 hours was used.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	03/20/2012	Original
02	Franklin Energy Services	04/01/2013	Updates by PI

Reach In Refrigerated Case w/ Doors Replacing Open Multi Deck Case

	Measure Details
Measure Master ID	Reach In Refrigerated Case w/ Doors Replacing Open Multi Deck Case, 2509
Measure Unit	Per Linear Foot
Measure Type	Prescriptive
Measure Group	Refrigeration
Measure Category	Refrigerated Case Door
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	847 per linear foot
Peak Demand Reduction (kW)	0.0966 per linear foot
Annual Therm Savings (Therms)	98 per linear foot
Lifecycle Energy Savings (kWh)	12,697 per linear foot
Lifecycle Therm Savings (Therms)	847 per linear foot
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[9]
Incremental Cost	$700[10]
Important Comments	

Measure Description

Existing open multi-deck cases can be replaced with equivalent storage (cubic feet) or linear feet of reach-in cases with doors. For estimating measure savings, the conservative approach uses case replacements with equivalent linear feet, as reach-in cases are designed to hold more cubic feet of product per linear foot (side to side measure) than multi-deck cases.

Description of Baseline Condition

The baseline is assumed to be a 95% to 5% mix of cooler to freezer open multi-deck style cases.

Description of Efficient Condition

Replacement cases must have doors, be tied into a central refrigeration system, and be purchased new. New case upgrades that simply enclose and/or add doors to an existing multi-deck do not qualify for this incentive. New cases must be DOE 2012 Energy Compliant.

Annual Energy-Savings Algorithm

$$kWh_{SAVED} = [((P_{CE} - P_{LE} - P_{ME} - (P_{CE}F_{CR})) - (((P_{CP} * (1 - F_I) - P_{LP} - P_{MP} - P_{CP}F_{CR}(1 - F_I)))] * [((LF * (1/3{,}412) * HOURS) / COP_{REFRIG}) - ((24 * (CDD / (T_S - T_R)) * (12/3{,}412) * COP_{ROOFTOP} * (1/12{,}000))]$$

$$Therms_{SAVED} = [((P_{CE} - P_{LE} - P_{ME} - (P_{CE}F_{CR})) - (((P_{CP} * (1 - F_I) - P_{LP} - P_{MP} - (P_{CP}F_{CR}(1 - F_I)))] * [24 * (HDD / (T_S - T_R)) * (1/eff) * (1/100{,}000)]$$

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Where:

P_{CE}	=	Total case load of multideck case (= 1,500 Btuh per linear foot for coolers, = 1,850 Btuh per linear foot for freezers)
P_{LE}	=	Lighting load of existing case (= 6.7 Btuh per linear foot)
P_{ME}	=	Motor load of existing case (= 7.3 Btuh per linear foot)
F_{CR}	=	Percentage of case load that is associated with conduction and radiation (= 13%)
P_{CP}	=	Total case load of new enclosed case (= 332 Btuh per linear foot for coolers, = 528 Btuh per linear foot for freezers)
F_I	=	Percentage of case load that is associated with infiltration reduction (= 68%)
P_{LP}	=	Lighting load of new case (= 8.2 Btuh per linear foot)
P_{MP}	=	Motor load of new case (= 2.7 Btuh per linear foot for coolers, = 3.5 Btuh per linear foot for freezers)
LF	=	Case load factor, the compressor duty cycle needed to maintain case temperatures, deemed (= 62% for coolers, = 80% for freezers)
HOURS	=	The average annual operating hours of the light fixture and is measured in hours/year, deemed (= 8,760)
COP_{REFRIG}	=	Coefficient of performance of refrigeration system, a measure of the efficiency of the refrigeration system equal to the ratio of net heat removal to total energy input, deemed (= 2.5 for coolers, = 1.3 for freezers)
CDD	=	Cooling degree days, the sum of the number of degrees that the average daily temperature is greater than a base temperature for a given time period, deemed (= 535)
T_S	=	Temperature of store, deemed (= 65°F)
T_R	=	Temperature of refrigerated case that needs to be maintained (= 36.5°F for coolers, = -11°F for freezers)
$COP_{ROOFTOP}$	=	Coefficient of performance of rooftop system, a measure of the efficiency of the rooftop system equal to the ratio of net heat removal to total energy input (= 3.2)
HDD	=	Heating degree days, the sum of the number of degrees that the average daily temperature is less than a base temperature for a given time period, deemed (= 7,699)
eff	=	Heating system efficiency, the average combustion efficiency of the boiler (= 78%)

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Equipment Loads: P_C, P_L and P_M. These variables refer to

P_C = the average energy consumption of the refrigerated case

P_L = the average energy consumption of the lighting in the case

P_M = the average energy consumption of the evaporator motors in the case

Summer Coincident Peak Savings Algorithm

kW_{SAVED} = [((P_{CE} – P_{LE} – P_{ME} – ($P_{CE}F_{CR}$)) – (((P_{CP} * (1 – F_I) – P_{LP} – P_{MP} – $P_{CP}F_{CR}$ (1 – F_I)))] * [(((LF * (1/3,412) * HOURS) / COP_{REFRIG}) – ((24 * (CDD / (T_S – T_R)) * (12/3,412) * $COP_{ROOFTOP}$ * (1/12,000))] * (1/8,760)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE}$ = kWh_{SAVED} * EUL

$Therms_{LIFECYCLE}$ = $Therms_{SAVED}$ * EUL

Where:

EUL = Effective useful life (= 15 years)[9]

Deemed Savings

Unit	MMID	Deemed Savings	
		Annual	Lifecycle
kWh	2509	750	11,247
kW		0.091	N/A
therms		98	1,467

Assumptions

Open Case Load, P_{CE}. The value of the existing open multideck style case is 1,500 Btuh per linear foot of cooler case[1] and 1,850 Btuh per linear foot of freezer case.[2] These values were determined based on information from case manufacturers.

Lighting Load of Open Case, P_{LE}. The value for the fluorescent lamps is 6.7 Btuh per linear foot of multi-deck case based on manufacturer's specification sheets.[2]

Motor Load of Open Case, P_{ME}. The value for the evaporator fan motors is 7.3 Btuh per linear foot of multi-deck case based on manufacturer's specification sheets.[2]

Doored Case Load, P_{CP}. The value of the new case with doors is 332 Btuh per linear foot of cooler case and 528 Btuh per linear foot of freezer case. These values were determined based on information from case manufacturers.[3]

Lighting Load of Doored Case, P_{LP}. The value for the fluorescent lamps is 8.2 Btuh per linear foot of case with doors based on manufacturer's specification sheets.[3]

Motor Load of Open Case, P_{MP}. The value for the evaporator fan motors is 2.7 Btuh per linear foot of cooler and 3.5 Btuh per linear foot for freezers for cases with doors based on manufacturer's specification sheets.[3]

Infiltration Reduction Load Factor, $F_{I.}$ The value for the infiltration reduction load factor is 68%. This value is taken from California Edison Research and Thermal Test Center.[4]

Conduction and Radiation Load Factors, $F_{CR.}$ The value for the conduction and radiation load factor is 13% of the case's total load. This value is taken from ASHRAE RP-1402. This analysis states that 13% of the load is associated with conduction and radiation.[5]

Compressor Load Factor, LF. The deemed value for the compressor duty cycle is 62% for coolers and 80% for freezers.[6]

Coefficient of performance of refrigeration system, COP_{REFRIG}. The deemed value of the coefficient of performance for a refrigeration system is 2.5 for coolers and 1.3 for freezers.[1]

Coefficient of performance of rooftop system, $COP_{ROOFTOP}$. The value of the coefficient of performance for a rooftop system is 3.2.[7]

Refrigerated Case Temperature, T_R. The value for the cooler case temperature is 35.6°F and the value for the freezer case temperature is -11°F. These values were obtains by taking the average of the most commonly used settings for cooler and freezer cases, 35°F to 38°F and -14°F to -8°F, respectively.[7]

Store Temperature, T_S. The deemed value for the store temperature is 65°F.[6]

Cooling Degree Days, CDD. The deemed value for the cooling degree days in the state of Wisconsin is 535.[6]

Annual Operating Hours, HOURS. The deemed value of the annual operating hours is 8,760 hours, the number of hours in a year.[8]

Heating Degree Days, HDD. The deemed value for the heating degree days in the State of Wisconsin is 7,699.[6]

Effective Useful Life, EUL. The effective useful life of the installed measure is taken from the 2008 Deer EUL Summary, 15 years.[9]

Heating System Efficiency, eff. The value for the heating system efficiency is 78%.[7]

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Sources

1. Arthur D. Little, Inc. Energy Savings Potential for Commercial refrigeration Equipment – Final Report. 1996.
2. Manufacturer's specification sheet for open multideck style freezer case. Hussmann Excel F6L. November 2010.
3. Manufacturer's specification sheet for enclosed reach-in cases. Zero Zone RVCC30 and RVZC30. 2012.
4. California Edison Research and Thermal Test Center.
5. ASHRAE RP-1402.
6. State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0 Update Date: March 22, 2010. PA Consulting Group Inc.
7. U.S. Department of Energy- Building Technology Program. Advanced Energy Retrofit Guide: Practical Ways to Improve Energy Performance, Grocery Stores. National Renewable Energy Lab. June 2012.
8. State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0 Update Date: March 22, 2010. PA Consulting Group Inc.
9. 2008 DEER EUL Summary.
10. Project bid data based on Focus on Energy project history.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/2014	New measure
02	Franklin Energy Services	02/24/2014	Update to measure

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Retrofit Open Multi-Deck Cases with Doors

	Measure Details
Measure Master ID	Retrofit Open Multi-Deck Cases with Doors,3409
Measure Unit	Per Linear Foot
Measure Type	Prescriptive
Measure Group	Refrigeration
Measure Category	Refrigerated Case Door
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government
Annual Energy Savings (kWh)	615 per linear foot
Peak Demand Reduction (kW)	0.0702 per linear foot
Annual Therm Savings (Therms)	11 per linear foot
Lifecycle Energy Savings (kWh)	7,378 per linear foot
Lifecycle Therm Savings (Therms)	129 per linear foot
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[8]
Incremental Cost	$126.53
Important Comments	

Measure Description

Existing open multi-deck style cases can be retrofitted with doors. The doors are designed to fit right onto the open multi-deck style cases with minimal case modification. The measure incentives will be based on a per foot case enclosed.

Description of Baseline Condition

The baseline is assumed to be a 95% to 5% mix of cooler to freezer open multi-deck style cases.

Description of Efficient Condition

The efficient equipment to be installed is doors on the cooler or freezer multi-deck style cases.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (P_C F_I - P_L - P_M - (P_C F_{CR} F_I)) * (LF * (1/3{,}412) * HOURS * COP_{REFRIG}) - ((24 * (CDD / (T_S - T_R)) * (12/3{,}412) * COP_{ROOFTOP} * (1/12{,}000))$

$Therms_{SAVED} = P_C F_{CR} F_I * ((24 * (HDD / (T_S - T_R)) * (1/eff) * (1/100{,}000))$

Where:

P_C = Total case load, the average energy consumption of the refrigerated case (= 1,500 Btuh for coolers, = 1,850 Btuh for freezers)

F_I = Percentage of infiltration reduction, the fraction of the case energy associated with infiltration (= 68%)

P_L	=	Lighting load of case, the average energy consumption of the lighting in the case (= 6.7 Btuh)
P_M	=	Motor load of case, the average energy consumption of the evaporator motors in the case (= 5 Btuh)
F_{CR}	=	Percentage of case load energy associated with conduction and radiation (= 13%)
LF	=	Case load factor, the compressor duty cycle needed to maintain case temperatures, deemed (= 62% for coolers, = 80% for freezers)
HOURS	=	The average annual operating hours of the light fixture measured in hours/year, deemed (= 8,760)
COP_{REFRIG}	=	Coefficient of performance of refrigeration system, a measure of the efficiency of the refrigeration system equal to the ratio of net heat removal to the total energy input, deemed (= 2.5 for coolers, = 1.3 for freezers)
CDD	=	Cooling degree days, the sum of the number of degrees that the average daily temperature is greater than a base temperature for a given time period (the State of Wisconsin uses a base temperature of 65°F, which is a standard value used in the HVAC industry), deemed (=535)
T_S	=	Temperature of store, deemed (= 65)
T_R	=	Temperature of case, the refrigerated case temperature that needs to be maintained (= 36.5°F for coolers, = -11°F for freezers)
$COP_{ROOFTOP}$	=	Coefficient of performance of rooftop system, a measure of the efficiency of the rooftop system equal to the ratio of net heat removal to the total energy input (= 3.2)
HDD	=	Heating degree days, the sum of the number of degrees that the average daily temperature is less than a base temperature for a given time period (the State of Wisconsin uses a base temperature of 65°F, which is a standard value used in the HVAC industry), deemed (= 7,699)
eff	=	Heating system efficiency, the average combustion efficiency of the boiler (= 78%)

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (P_C F_I - P_L - P_M - (P_C F_{CR} F_I)) * (LF * (1/3{,}412) * HOURS * (1/COP_{REFRIG})) - ((24 * (CDD / (T_S - T_R)) * (12/3{,}412) * COP_{ROOFTOP} * (1/12{,}000)) * 1/8{,}760$

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 12 years)[8]

Assumptions

Open Case Load, P_C. The value of the existing open multideck style case is 1,500 Btuh per linear foot of cooler case[1] and 1,850 Btuh per linear foot of freezer case.[2] These values were determined based on information from case manufacturers.

Lighting Load of Open Case, P_L. The value for the fluorescent lamps is 6.7 Btuh per linear foot of multi-deck case based on manufacturer's specification sheets.[2]

Motor Load of Open Case, P_M. The value for the evaporator fan motors is 7.3 Btuh per linear foot of multi-deck case based on manufacturer's specification sheets.[2]

Infiltration Reduction Load Factor, $F_{I.}$ The value for the infiltration reduction load factor is 68%. This value is taken from California Edison Research and Thermal Test Center.[3]

Conduction and Radiation Load Factors, $F_{CR.}$ The value for the conduction and radiation load factor is 13% of the case's total load. This value is taken from ASHRAE RP-1402. This analysis states that 13% of the load is associated with conduction and radiation.[4]

Compressor Load Factor, LF. The deemed value for the compressor duty cycle is 62% for coolers and 80% for freezers.[5]

Coefficient of performance of refrigeration system, COP_{REFRIG}. The deemed value of the coefficient of performance for a refrigeration system is 2.5 for coolers and 1.3 for freezers.[1]

Coefficient of performance of rooftop system, $COP_{ROOFTOP}$. The value of the coefficient of performance for a rooftop system is 3.2.[6]

Refrigerated Case Temperature, T_R. The value for the cooler case temperature is 35.6°F and the value for the freezer case temperature is -11°F. These values were obtains by taking the average of the most commonly used settings for cooler and freezer cases, 35°F to 38°F and -14°F to -8°F, respectively.[6]

Store Temperature, T_S .The deemed value for the store temperature is 65°F.[5]

Cooling Degree Days, CDD. The deemed value for the cooling degree days in the State of Wisconsin is 535. [5]

Hours-of-use, HOURS. The deemed value of the annual operating hours is 8,760 hours, the number of hours in a year.[7]

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Heating Degree Days, HDD. The deemed value for the heating degree days in the State of Wisconsin is 7,699.[5]

Heating System Efficiency, eff. The value for the heating system efficiency is 78%.[6]

Sources

1. Arthur D. Little, Inc. Energy Savings Potential for Commercial refrigeration Equipment – Final Report. 1996.
2. Manufacturer's specification sheet for open multideck style freezer case. Hussmann Excel F6L. November 2010.
3. California Edison Research and Thermal Test Center.
4. ASHRAE RP-1402.
5. State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0 Update Date: March 22, 2010. PA Consulting Group Inc.
6. From U.S. Department of Energy- Building Technology Program. Advanced Energy Retrofit Guide: Practical Ways to Improve Energy Performance. Grocery Stores. National Renewable Energy Lab. June 2012.
7. State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0 Update Date: March 22, 2010. PA Consulting Group Inc.
8. 2008 DEER EUL Summary.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/24/2014	New measure

Nonresidential Gas or Electric Backup

	Measure Details
Measure Master ID	Ground Source Heat Pump, 2820, 2821
Measure Unit	Per Heat Pump
Measure Type	Prescriptive
Measure Group	Renewable Energy
Measure Category	Geothermal
Sector(s)	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily
Annual Energy Savings (kWh)	3,476
Peak Demand Reduction (kW)	0.8277
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	62,568
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	18[1]
Incremental Cost	Varies by project
Important Comments	

Measure Description

This advisory covers residential sized geothermal (ground source) heat pump systems in non-residential applications. Geothermal heat pump systems utilize the earth as a source of heating and cooling through the installation of an exterior underground loop working in combination with an interior heat pump unit. The measure provides sites with a centralized heating and cooling system, similar to that of a standard air source heat pump.

Description of Baseline Condition

Air source heat pump with a SEER of 13 and a HSPF of 7.7.[4]

Description of Efficient Condition

A ground source heat pump with a multi-stage (either multi- compressor or multi-stage) compressor, an ECM air handler, a COP of 3.5 and an EER of 15. Additionally, the procedures followed to install the equipment must conform to the ACCA Standard 5 Quality Installation requirements.

Annual Energy-Savings Algorithm

$$kWh_{SAVED} = (FLH_{COOL} * Btu/h_{COOL} * (1/SEER_{BASE} - 1/(EER_{EE} * 1.02)))/1{,}000 + (FLH_{HEAT} * Btu/h_{HEAT} * (1/HSPF_{BASE} - 1/(COP_{EE} * 3.412)))/1{,}000$$

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Where:

FLH_{COOL}	=	Full load hours cooling (= 599 hours)[5]
Btu/h_{COOL}	=	Cooling capacity of equipment (= 40,089 Btu/h)[3]
$SEER_{BASE}$	=	Seasonal energy-efficiency ratio (= 13)[4]
EER_{EE}	=	Energy-efficiency ratio (= 22.43 kBtu/kWh)[3]
GSER	=	Factor to determine SEER based on its EER (= 1.02)
FLH_{HEAT}	=	Full load hours heating (= 1,466 hours)[6]
Btu/h_{HEAT}	=	Heating capacity of equipment (= 30,579 Btu/h)[3]
$HSPF_{BASE}$	=	Heating seasonal performance factor (7.7 kBtu/kWh)[4]
COP_{EE}	=	Coefficient of performance (= 4.18)[3]

Summer Coincident Peak Savings Algorithm

The summer coincident peak is defined as the period from 1:00 p.m. to 4:00 p.m. during weekdays from June through August. Using the supplied Wisconsin calculator, the demand savings were calculated with the following algorithms and methodology:

$kW_{SAVED} = (Btu/h_{COOL} * (1/EER_{BASE} – 1/EER_{EE})) / 1,000 * CF$

Where:

Btu/h_{COOL}	=	Cooling capacity of equipment (= 40,089 Btu/h)[3]
EER_{BASE}	=	Energy-efficiency ratio (= 12.75)[4]
CF	=	Coincidence factor (= 0.61)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 18 years)[1]

Assumptions

This system life expectancy is generally constrained by the heat pump exchanger and compressor equipment. The actual ground loop installation itself often has a much longer life expectancy.

Run-time for non-residential applications differs from residential run-times due to internal heat gains, additional ventilation requirements for non-residential buildings, times of occupancy, and occupancy numbers. The Wisconsin TRM v.22 does not have a non-residential air source heat pump; therefore, heating run-times from the TRM for Pennsylvania 2013 Draft for Commercial HVAC were used and adjusted using EFLH from the U.S. DOE ENERGY STAR Air Source Heat Pump Calculator[5] to account for differences in weather conditions. This resulted in a 42% reduction in hours from ENERGY STAR – or 1,466 hours.

For cooling run-time, the hours from the Commercial High-Efficiency Packaged and Split System Air Conditioning Units in the WI TRM v.22 was used.

$EFLH_{HEATING}$	PE TRM (hours)[4]	ENERGY STAR (hours)[8]
Allentown	1,098	2,492
Erie	1,720	2,901
Harrisburg	1,406	2,371
Philadelphia	1,461	2,328
Pittsburgh	1,411	2,380
Scranton	1,501	2,532
Williamsport	1,483	2,502
Average	**1,440**	**2,501**

$EFLH_{HEATING}$	ENERGY STAR (hours)[8]	WI (hours)
Green Bay	2,641	1,521
La Crosse	2,445	1,408
Madison	2,547	1,467
Milwaukee	2,548	1,467
Average	**2,545**	**1,466**

Building Type	FLH_{HEAT}[6]	FLH_{COOL}[5]
Average Commercial	**1,466**	**599**

The installation of a ground source heat pump is more likely in the northern part of the state due to the lack of available natural gas. A lower coincidence factor than residential (0.68)[5] and non-residential (0.80)[7] air conditioning is used in order to account for reduced occurrence of operation.

Coincidence Factor	Air Conditioner	GSHP
Residential	0.68[5]	0.50[3]
Commercial	0.80[7]	0.61

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Energy Center of Wisconsin, Update of Geothermal Analysis, August 31 2009, Pg. 19-21.
3. WI TRM V 22 – Residential Ground Source Heat Pump, Electric Back-Up.
4. International Energy Conservation Code. Table 503.2.3(1). 2009.
5. WI TRM V 22 – High-Efficiency Packaged and Split System Air Conditioning Units.

6. Technical Reference Manual for Pennsylvania 2013 Draft for Commercial HVAC were used and adjusted using EFLH from the U.S. DOE ENERGY STAR Air Source Heat Pump Calculator to account for differences in weather conditions.
7. WI TRM V 22 – Commercial High-Efficiency Packaged and Split System Air Conditioning Units.
8. WI TRM V 22 – Natural Gas Boiler with DHW (Boiler = 90%+ AFUE).
9. U.S. DOE ENERGY STAR Calculator.

Revision History

Version Number	Authored by	Date	Description of Change
01	CLEAResult	04/23/2014	Original
02	CLEAResult	07/03/2014	Added citations in text, edited Sources order and URLs for consistency and accuracy
03	CLEAResult	07/22/2014	Corrected citations, adjusted coincidence factor which in turn adjusted kW, explained run-time differences in residential and non-residential applications

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Residential Measures

The Residential Portfolio delivers information, incentives, and implementation support to help residential customers access energy-efficient technologies that help them control their electricity and natural gas use. These efficient technologies include, but are not limited to, lighting, heating and cooling systems, home appliances, insulation and air sealing services, and residential renewable energy systems.

The Mass Markets portfolio for 2015 includes 11 programs that Focus on Energy designed to help different types of residential customers access these technologies, using different approaches to outreach and financial support.

All types of residential homeowners can take advantage of the **Residential Lighting and Appliance Program**, in which they can receive in-store discounts for purchasing high-efficiency light bulbs.

Residential customers that live in single-family homes[3] can participate in the following programs that offer incentives for different types of energy-saving measures:

- The **Express Energy Efficiency Program** provides a quick assessment of the home's energy use as well as free direct installation of CFLs, LEDs, low-flow showerheads, and other energy-saving measures.
- The **Appliance Recycling Program** offers a financial incentive for residents to recycle old refrigerators and freezers, as well as free pickup and disposal.
- The **Residential Rewards Program** offers incentives for customers to install energy-efficient furnaces insulation and other heating equipment.
- The **Home Performance with ENERGY STAR® Program** offers comprehensive energy audits and incentives for whole-house energy-savings measures, such as insulation and air sealing.
- The **Enhanced Rewards Program** and **Assisted Home Performance with ENERGY STAR Program** offer enhanced incentives for income-qualified participants.
- The **Renewable Rewards Program** connects customers with experts that help them determine whether their property could effectively support a renewable energy system, and offers financial incentives for customers who proceed to install these systems.

Owners, managers, and residents of multifamily buildings (such as apartments and condominiums) are served through two related programs.

1. The **Multifamily Direct Install Program** offers free installation of CFLs, LEDs, low-flow showerheads, and other energy-savings measures in tenant units, as well as walk-through assessments of the whole building.

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3 Including single-family detached homes, mobile homes, and single-family attached homes with three or fewer units.

7. Those assessments can identify additional incentives that property owners and managers can take advantage of through the **Multifamily Energy Savings Program**, which provides information, financial incentives, and implementation support to install measures in resident units and common areas.

Residential customers who are building a new home can receive assistance through the **New Homes Program**, in which Focus on Energy works with owners, builders, and energy experts to construct homes that are more energy efficient than required by Wisconsin building codes.

Boilers & Burners

Boiler, Hot Water, Near Condensing, ≥ 85% AFUE, >300MBh

	Measure Details
Measure Master ID	Boiler, Hot Water, Near Condensing, ≥ 85% AFUE, >300MBh, 3277
Measure Unit	Per MBh
Measure Type	Prescriptive
Measure Group	Boilers & Burners
Measure Category	Boiler
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	1.42
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	28.31
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	$14.72
Important Comments	

Measure Description

Mid-efficiency boilers use forced draft or induced draft power burners, instead of atmospheric draft, to push or pull gases through the firebox and heat exchanger. Because these boilers have relatively high efficiencies and relatively low flue gas temperatures, they are often constructed with stainless steel or other corrosion-resistant materials to tolerate condensation in the boiler. These boilers are typically used in applications where HESCCM boilers cannot be vented or where they will not have low enough return water temperatures to condense the water vapor in the flue gas. This measure is the installation of a near-condensing, mid-efficiency hot water boiler with a TE ≥ 87% between 300 and 1,000 MBh.

Description of Baseline Condition

Replace on failure hot water boiler with 80% TE[2]

Description of Efficient Condition

The efficient condition for a mid-efficiency boiler is:

- TE ≥ 87% for hot water boilers
- Capable of modulating the firing rate
- Redundant or backup boilers do not qualify

Annual Energy-Savings Algorithm

$Therms_{SAVED} = BC * EFLH * (1 - EFF_{BASELINE} / EFF_{EE}) / 100$

Where:

BC	=	Boiler Input Capacity in MBh (= 1)
EFLH	=	1,759 hours
$EFF_{BASELINE}$	=	TE of the baseline measure (= 80%)
EFF_{EE}	=	TE of the efficient measure (= 87%)
100	=	Conversion factor from MBtu to therms

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 20 years)[1]

Assumptions

Equipment efficiency for the deemed savings is an assumed 87% TE.

The analysis assumes residential furnaces are operated similarly to this type of large, multi-family hot water boiler (i.e. both measures use EFLH based on single unitary residential furnace data).

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, similar measure MMID 2219.
2. Code of Federal Regulations Energy Efficiency Standards, Title 10 Part 431 Section 87.
3. DEER Database.
4. Average boiler size of boilers tuned and cleaned in the ACES program 2008-2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/29/2012	Initial draft
02	Shaw Group	01/08/2013	Updated to new template

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High-Efficiency Space Heating Boiler, < 300 MBh

	Measure Details
Measure Master ID	Hot Water Boiler, 95%+ AFUE, 1983
Measure Unit	Per boiler
Measure Type	Prescriptive
Measure Group	Boilers & Burners
Measure Category	Boiler
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	151
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	3,011
Effective Useful Life (years)	20[1]
Incremental Cost	$3,105
Important Comments	

Measure Description

High-efficiency space heating boilers are applicable to any residential boiler used for space heating. They are not applicable to boilers used for process end uses, DHW, pools, or spas. The qualifying space heating boilers must meet the qualifications listed in the table below.

Type	Input Rating	Required Efficiency
95% Efficient Boiler	≤ 300 MBh	AFUE ≥ 95%

Description of Baseline Condition

The baseline equipment is a hot water boiler with 82% AFUE.

Description of Efficient Condition

Space heating boilers are pressure vessels that transfer heat to water for use primarily in space heating applications. Boilers either heat water using a heat exchanger that works like an instantaneous water heater, or by the addition of a separate tank with an internal heat exchanger that is connected to the boiler. Energy-efficient units often feature high-efficiency and/or low-Nox burners, and typically have features such as forced air burners, relatively large heat exchange surfaces, and/or use heat recovery from stack gases.

Annual Energy-Savings Algorithm

$Therms_{SAVED} = EFLH * (1-EFF_{BASELINE} / EFF_{EE})$

Where:

EFLH = Effective full load hours (= 1,000[3])

$EFF_{BASELINE}$ = AFUE of baseline measure (= 82%)

EFF_{EE} = AFUE of efficient measure (= 95%)

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 20 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Average input capacity of boilers under 300 Mbh in the 2013 SPECTRUM Database.
3. Full load hours for all residential gas measures are estimated from characterization study of Wisconsin homes (Pigg and Nevius, 2000. Online: http://www.ecw.org/sites/d3efault/files/230-1.pdf) with average furnace size from SPECTRUM database. Wisconsin study found 800 therms consumed by 90% AFUE furnaces (i.e. 720 therms output). With average furnace size of 72,000 Btu, (13,000 furnaces from Focus Prescriptive 2012 database) 1,000 full load heating hours are estimated.

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	03/05/2012	Original
02	RSG	11/06/2012	Updated memo
03	RSG	02/20/2013	Reviewed and revised for formatting
04	Cadmus	01/15/2015	Updates by technical reviewer

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Boiler, ≥ 90% AFUE, NG

	Measure Details
Measure Master ID	Boiler, ≥ 90% AFUE, NG, 2747
Measure Unit	Per MBh
Measure Type	Custom
Measure Group	Boilers & Burners
Measure Category	Boiler
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	1.56
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	31.27
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	Varies by project
Important Comments	

Measure Description

High efficiency sealed combustion, condensing, and modulating boilers operate by taking advantage of condensing to lower energy consumption. Condensing boilers are designed to capture the latent heat of condensation in the form of water vapor in the exhaust stream. Capturing this latent heat produces high efficiency levels. For a boiler to operate in condensing mode, its return water temperature should be kept below 120°F. In order to capture as much latent heat as possible, condensing boilers are made from stainless steel or other corrosion resistant materials. Chimney liners must be installed for boilers that are replacing a naturally drafting unit that was vented through the same flue as a water heater. Flue closure protocols must be followed when the chimney that will used by the replacement unit was not in use for the previous equipment.

Description of Baseline Condition

The baseline equipment is an 82% AFUE boiler.[2]

Description of Efficient Condition

The efficient equipment is a 90%+[3] AFUE boiler that is capable of modulating the firing rate, has integrated input/output reset control, and is used for space heating. Industrial process or DHW applications do not qualify. Redundant or backup boilers do not qualify.

Annual Energy-Savings Algorithm

These savings are per Mbh of input boiler capacity.

$Therms_{SAVED} = BC * EFLH * (1-EFF_{BASELINE}/EFF_{EE}) / 100)$

Where:

BC	=	Boiler capacity in MBh (=1)
EFLH	=	Effective full load hours (= 1,759[5])
$EFF_{BASELINE}$	=	AFUE of baseline measure (=82%)
EFF_{EE}	=	AFUE of efficient measure (=90%)
100	=	Conversion factor from MBtu to therms

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 20 years)[1]

Assumptions

Boiler baseline efficiency is based on the EISA requirements of 82%.

Sources

1. Focus on Energy EUL Database 2013. See Appendix C.
2. Annual Fuel Utilization Efficiency, as determined in section 10 CFR 430.23(n)(2). http://www.regulations.gov/#!documentDetail;D=EERE-2006-STD-0102-0009.
3. State of Wisconsin Public Service Commission. *Business Programs: Measure Life Study*. Final Report. Evaluated by PA Consulting Group Inc. August 25, 2009.
4. Average boiler size of boilers tuned and cleaned in the ACES program 2008-2010.
5. Full load hours for all residential gas measures are estimated from characterization study of Wisconsin homes (Pigg and Nevius, 2000).

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/02/2013	Updated baseline efficiency from 80% to 82%

Boiler Control – Outside Air Temperature Reset/Cutout Control – Prescriptive

	Measure Details
Measure Master ID	Boiler Control – Outside Air Temperature Reset/Cutout Control – Prescriptive, 2221
Measure Unit	Per MBh
Measure Type	Prescriptive
Measure Group	Boilers & Burners
Measure Category	Controls
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	1.48
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	7.41
Water Savings (gal/yr)	0
Effective Useful Life (years)	5[1]
Incremental Cost	$612
Important Comments	

Measure Description

Boiler reset controls automatically control the boiler water temperature based on outdoor temperature. This allows the water to run a little cooler during the fall and spring, and a little hotter during the coldest parts of the winter, improving boiler efficiency and indoor comfort by providing a better match between boiler output and space heating needs. Boiler cutout controls prevent a boiler from firing at a predetermined outside temperature setpoint to prevent overheating.

Description of Baseline Condition

The baseline condition is no input/output reset with an 87% TE boiler.

Description of Efficient Condition

Outside air temperature reset or cutout control incentives are for existing space heating boilers only. A new boiler with integrated boiler reset controls is not eligible. New boilers not equipped with these controls are eligible for retrofit. The system must be set so that the minimum temperature is not more than 10 degrees above the manufacturer's recommended minimum return temperature, unless unusual circumstances require a higher setting. The system must have an outdoor air temperature sensor in a shaded location on the north side of the building. For controls on multiple boilers to qualify, a control strategy must stage the lag boiler(s) only after the first boiler stage(s) fail to maintain the boiler water temperature called for by the reset control.

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Annual Energy-Savings Algorithm

$Therms_{SAVED}$ = BC * EFLH / (Eff * 100) * SF

Where:

BC	=	Boiler capacity in MBh (= 1)
EFLH	=	Effective full load hours (= 1,759)[4]
SF	=	Savings factor (= 8%)[3]
Eff	=	Combustion efficiency of the boiler (= 87%)
100	=	Conversion factor from therm to MBtu

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE}$ = $Therms_{SAVED}$ * EUL

Where:

EUL	=	Effective useful life (= 5 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Average boiler size of boilers tuned and cleaned in the ACES program 2008-2010.
3. Michigan Energy Measures Database. Available online: http://www.michigan.gov/mpsc/0,1607,7-159-52495_55129---,00.html.
4. Full load hours for all residential gas measures are estimated from characterization study of Wisconsin homes (Pigg and Nevius, 2000.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/25/2012	Initial draft
02	Shaw Group	01/07/2012	Updated to new template

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Boiler Tune-Up

	Measure Details
Measure Master ID	Boiler Tune-Up, 2744
Measure Unit	Per MBh
Measure Type	Prescriptive
Measure Group	Boilers & Burners
Measure Category	Tune-up / Repair / Commissioning
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	129
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	258
Water Savings (gal/yr)	0
Effective Useful Life (years)	2[1]
Incremental Cost	$119.95
Important Comments	

Measure Description

Tune-ups are required for boilers to maintain optimal combustion efficiency. Boiler tune-ups must be completed according to the boiler tune-up checklist. This measure applies to non-process-related boilers. A boiler tune-up includes reducing excess air and stack temperature; cleaning burners, burner nozzles, combustion chamber, and boiler tubes; sealing the combustion chamber; and recalibrating boiler controls.

The inspector also checks combustion air intake. The proper combustion air-to-fuel ratio directly affects combustion efficiency. Inadequate air supply yields unburned combustibles (fuel, soot, smoke, and carbon monoxide) while excess air causes heat loss from increased flue gas flow, which lowers the boiler efficiency.

Description of Baseline Condition

The baseline measure is 82% boiler efficiency.

Description of Efficient Condition

The minimum burner size for measure eligibility is 110,000 Btu/hr. The incentive is available once in a 24-month period. The service provider must perform before and after combustion efficiency tests and records the results on the boiler tune-up incentive application. The burner must be adjusted to improve combustion efficiency as needed. The incentives are only available for space and water heating equipment.

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Annual Energy-Savings Algorithm

$Therms_{SAVED}$= 0.346 * Boiler Size

Where:

0.346 = Therms savings per input MBh[2]

Boiler Size = Size of the boiler being tuned and cleaned (= 373 MBtu/hr)[3]

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE}$ = $Therms_{SAVED}$ * EUL

Where:

EUL = Effective useful life (= 2 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. State of Wisconsin Public Service Commission. *Business Programs Deemed Savings Manual V1.0*. March 22, 2010. (based on an updated baseline efficiency of 82%).
3. Average boiler size of boilers tuned and cleaned in the ACES program 2008-2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/2013	Initial draft
02	Franklin Energy Services	03/08/13	Updated by PI

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Boiler, 95%+ AFUE, With DHW, NG

	Measure Details
Measure Master ID	Boiler, 95%+ AFUE, With DHW, NG, 3559
Measure Unit	Per 100 MBh
Measure Type	Prescriptive
Measure Group	Boilers & Burners
Measure Category	Boiler
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	272
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	5,440
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	$3,521.72[2]
Important Comments	

Measure Description

Space heating boilers are pressure vessels that transfer heat to water for use in space heating applications. Boilers either heat water using a heat exchanger that works like an instantaneous water heater or by the addition of a separate tank with an internal heat exchanger that is connected to the boiler. A combination boiler contains a separate heat exchanger that heats water for domestic hot water use.

Qualifying combination boilers must be whole-house units used for both space conditioning (boiler) and hot water heating with one appliance and energy source. Only participants who have a natural gas account with a participating natural gas utility are eligible for this rebate.

Description of Baseline Condition

Baseline condition is a boiler with the federal minimum AFUE of 82%[2] and a residential, gas-fueled, storage water heater with an EF of 0.575.[3] New federal efficiency standards that take effect in April 2015 raise the minimum EF for baseline units from 0.575 to 0.600. The criteria date was rounded to January 1, 2016 since the code takes affect mid-year 2015.

Description of Efficient Condition

The efficient condition is a combination boiler unit with AFUE of 95% or greater for the boiler. The combination boiler must have a sealed combustion unit and be capable of modulating the firing rate. Measures that do not qualify for this incentive include boilers with a storage tank, and redundant or backup boilers.

Annual Energy-Savings Algorithm

$Therms_{SAVED} = Therms_{SAVED - BOILER} + Therms_{SAVED - WH}$

$Therms_{SAVED - BOILER} = BC * EFLH (1 - EFF_{BASE} / EFF_{EE}) / 100$

$Therms_{SAVED - WH} = ((GPD * 365 * 8.33 * 1 * \Delta T_w)/100{,}000) * ((1/RE_{BASE}) - (1/E_{C,EE})) + ((UA_{BASE}/RE_{BASE}) - (UA_{EE} / E_{C,EE})) * (\Delta T_S * 8{,}760)/100{,}000$

Where:

BC	=	Boiler capacity (= 110 MBtu/hr)[3]
EFLH	=	Effective full load hours (= 1,000)[4]
EFF_{BASE}	=	Baseline AFUE (= 82%)[5]
EFF_{EE}	=	Efficient AFUE (= 95%)
GPD	=	Gallons of hot water used in home per day (= 51.5)[6]
365	=	Days per year
8.33	=	Density of water (lb/gal)
1	=	Specific heat of water (Btu/lb °F)
ΔT_w	=	Average difference between the cold water inlet temperature (52.3°F) and the hot water delivery temperature (125°F) (= 72.7°F)[7]
100,000	=	Conversion from Btu to therm
RE_{BASE}	=	Recovery efficiency of the baseline water heater (= 76%)[8]
$E_{C,EE}$	=	Combustion efficiency of combination boiler used to provide DHW (= 95%)[9]
UA_{BASE}	=	Overall heat loss coefficient of base tank type water heater (= 14.0 Btu/hr-°F)[10]
UA_{EE}	=	Overall heat loss coefficient of combination boiler (=0 Btu/hr-°F)
ΔT_S	=	Difference between stored hot water temperature (13°F) and the ambient indoor temperature (70°F) (= 57°F)
8,760	=	Hours per year

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 20 years)[1]

Assumptions

Because the efficiency of residential water heater is measured in EF, the true Thermal Efficiency (TE) and Overall Heat Loss Coefficient ($UA_{BASELINE}$) is not available. A TE of 76% and a $UA_{BASELINE}$ of 14 is assumed.

Sources

1. State of Wisconsin Public Service Commission. Business Programs: Measure Life Study. Final Report. Evaluated by PA Consulting Group, Inc. August 25, 2009.
2. NEEP Incremental Cost Study Report - September 23, 2011 finds an incremental measure cost (IMC) of $2,791 for a combination boiler and an IMC of $2,461 for a high efficiency boiler sized at 110 Mbh. The percentage increase is applied to the current boiler IMC to provide a combination IMC of $3,521.72
3. Average input capacity of boilers under 300 Mbh in the 2013 SPECTRUM Database.
4. Full load hours for all residential gas measures are estimated from characterization study of Wisconsin homes (Pigg and Nevius, 2000. Online: http://www.doa.state.wi.us/docview.asp?docid=1812) with average furnace size from SPECTRUM database. Wisconsin study found 800 Therms consumed by 90% AFUE furnaces (i.e. 720 Therms output). With average furnace size of 72,000 Btu (13,000 furnaces from Focus Prescriptive 2012 database), 1,000 full load heating hours are estimated.
5. Title 42 - THE PUBLIC HEALTH AND WELFARE - 42 U.S.C. 6291-6309 (http://www.gpo.gov/fdsys/pkg/USCODE-2010-title42/html/USCODE-2010-title42-chap77-subchapIII-partA-sec6291.htm)
6. Calculated by using the linear relationship of y=16.286x + 13, where x is the average number of people per home and y is the average gallons of hot water used per day. An average value of 2.361 people/home was used for Wisconsin, based on RECS 2009 data. The linear relationship is used in the 2012 Indiana TRM and the 2010 NY TRM.
7. Public Service Commission of Wisconsin. *Request for Proposals*. Issued for Mass Markets Portfolio Residential Energy Efficiency Program Implementation. July 26, 2011.
8. Most common RE for non-heat pump water heaters: http://www.ahridirectory.org/ahridirectory/pages/rwh/defaultSearch.aspx
9. Based on market research: https://www.energystar.gov/index.cfm?c=most_efficient.me_boilers
10. United States Department of Energy. Technical Support Document: Energy Efficiency Standards for Consumer Products, Residential Water Heaters, Including Regulatory Impact Analysis. 2000.

Revision History

Version Number	Authored by	Date	Description of Change
01	CLEAResult	11/03/2014	Original

Building Shell

Air Sealing

	Measure Details
Measure Master ID	Air Sealing, 2745
Measure Unit	Per CFM Leakage
Measure Type	Custom
Measure Group	Building Shell
Measure Category	Air Sealing
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	Varies by heat and cooling system
Peak Demand Reduction (kW)	Varies by heat and cooling system
Annual Therm Savings (Therms)	Varies by heating system
Lifecycle Energy Savings (kWh)	Varies by heat and cooling system
Lifecycle Therm Savings (Therms)	Varies by heating system
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	Varies by project
Important Comments	

Measure Description

Air sealing is the sealing of cracks, gaps, or other penetrations that allow unwanted outside air to enter or exit conditioned spaces. Air sealing reduces the load on heating and cooling equipment, and can increase comfort. Typical areas to seal are attics, basements, crawlspaces, and around doors and windows. Blower door tests may be required to estimate the CFM of leaks before and after air sealing is performed. Savings are determined either by pre- and post-blower door testing or pre- and post-billing analysis.

Description of Baseline Condition

The baseline condition is no air sealing.

Description of Efficient Condition

The efficient condition is air sealing of cracks, gaps, or other penetrations that allow unwanted outside air to enter or exit conditioned spaces.

Annual Energy-Savings Algorithm[2]

$kWh_{SAVED} = kWh_{SAVED\ COOL} + kWh_{SAVED\ HEAT}$

<u>For systems with cooling installed:</u>

$kWh_{SAVED\ COOL} = [\{((CFM50_{PRE} – CFM50_{POST}))/N_{COOL}) * 60 * 24 * CDD * 0.018\} /(1{,}000 * Cool_{EFF})] * LM$

For systems with electric heat:

$kWh_{SAVED\ HEAT} = [((CFM50_{PRE} – CFM50_{POST})/N_{HEAT}) * 60 * 24 * HDD * 0.018] /(3,412 * Heat_{EFF})$

For systems with gas heat:

$Therms_{SAVED} = [((CFM50_{PRE} – CFM50_{POST})/N_{HEAT}) * 60 * 24 * HDD * 0.018] /(100,000 * Heat_{EFF})$

Where:

$CFM50_{PRE}$ = Blower door test result before air sealing is performed

$CFM50_{POST}$ = Blower door test result after air sealing is performed

N_{COOL} = Conversion factor for CFM from 50 Pascal to natural conditions (= 18.5 assuming normal shielding)

CDD = Cooling degree days (= 565, see table below)

0.018 = Specific heat capacity of air (Btu/ Cubic ft – °F)

$Cool_{EFF}$ = Cooling system efficiency, BTW/W - hr (= 10 SEER if manufactured before 2006, = 13 SEER if manufactured in 2006 or later)

LM = Latent multiplier (= 6.6 as an average of Chicago and Minneapolis)[3]

N_{HEAT} = Conversion factor for CFM from 50 Pascal to natural conditions, assuming normal shielding (= 18.5 if 1-story, = 16.5 if 1.5 stories, = 15.0 if 2 stories, = 14.1 if 2.5 stories, and = 13.3 if 3-stories)[4]

60 = Constant to convert minutes to hours

24 = Hours per day

HDD = Heating degree days (= 7,616, see table below)

100,000 = Conversion factor from Btu to therms

1,000 = Conversion factor from kW to W

3,412 = Conversion factor from kW-hr to Btu

Location	HDD[5]	CDD[5]
Milwaukee	7,276	548
Green Bay	7,725	516
Wausau	7,805	654
Madison	7,599	630
La Crosse	7,397	729
Minocqua	8,616	423
Rice Lake	8,552	438
Statewide Weighted	**7,616**	**565**

$Heat_{EFF}$ = Heating system efficiency (fraction of heat output per unit of energy input expressed as a decimal)

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For systems with electric heat $Heat_{EFFf}$ = HSPF/3.412

- Heat pumps manufactured before 2006, $Heat_{EFF}$ = 6.8/3.412 = 1.99
- Heat pumps manufactured in 2006 or later, $Heat_{EFF}$ = 7.7/3.412 = 2.26
- Electric resistance, $Heat_{EFF}$ = 1.0

Installed AFUE for systems with gas heat:

- $Heat_{EFF}$ = 0.92 for condensing systems
- $Heat_{EFF}$ = 0.78 for non-condensing systems

Summer Coincident Peak Savings Algorithm

For systems with central air conditioning

$kW_{SAVED} = (kWh_{SAVED\ COOL}/EFLH_{COOL}) * CF$

Where:

$EFLH_{COOL}$ = 380 hours

Supporting Inputs for Load Hours in Several Wisconsin Cities[6]

Location	$EFLH_{cooling}$
Green Bay	344
La Crosse	323
Madison	395
Milwaukee	457
Wisconsin Average	**380**

CF = Coincidence factor (= 0.66)[7]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 20 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Illinois Energy Efficiency Statewide Advisory Group. *Illinois Statewide Technical Reference Manual*.
3. LM is used to convert the calculated sensible cooling savings to a value representing sensible and latent cooling loads. The values are derived from Harriman et al "Dehumidification and

Cooling Loads From Ventilation Air", ASHRAE Journal, by adding the latent and sensible loads to determine the total, then dividing the total by the sensible load. Values from Chicago and Minneapolis were averaged to develop a representative number for Wisconsin.

4. Lawrence Berkeley National Laboratory. *Building Performance Institute Building Analyst Technical Standards*. Available online: http://www.bpi.org/tools_downloads.aspx?selectedTypeID=1&selectedID=2.
5. Calculated from TMY3 weather files of the seven Wisconsin locations using *ASHRAE Estimation of Degree-Days: Fundamentals*, Chapter 14. Statewide weighted values calculated using 2010 US Census data for Wisconsin.
6. Full load hours were calculated using an average FLH/Cooling Degree Day from values in *Illinois Statewide Technical Reference Manual* and applying to Wisconsin Cooling Degree Days.
7. http://www.dnrec.delaware.gov/energy/information/otherinfo/Documents/EM-and-V-guidance-documents/DELAWARE_TRM_August%202012.pdf.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	02/17/2012	Original
02	Franklin Energy Services	03/21/2013	Comments

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Insulation, Attic, R-11 or R-19 to R-38

	Measure Details
Measure Master ID	Insulation and Air Sealing, Attic, R-11 to R-38, 3570 Insulation, Attic, R-19 to R-38, 3558
Measure Unit	Per Residence
Measure Type	Prescriptive
Measure Group	Building Shell
Measure Category	Insulation
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	Varies by baseline
Peak Demand Reduction (kW)	Varies by baseline
Annual Therm Savings (Therms)	Varies by baseline
Lifecycle Energy Savings (kWh)	Varies by baseline
Lifecycle Therm Savings (Therms)	Varies by baseline
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	$2,647.71[2,3]
Important Comments	

Measure Description

This measure is the installation of attic insulation in an existing single family residence, prefaced by sealing the attic to reduce air infiltration. The associated insulation measure characteristics are from the Focus on Energy single family residential proposal calculator that was provided in 2011,[4] and the air sealing characteristics are based on modeling that was done for a house with the same assumed characteristics; the characteristics assume a natural gas heated home and electrically cooled home, and kWh savings are reduced by 7.5% based on a Cadmus survey that found 92.5% of Wisconsin homes have central cooling.[6]

An additional requirement of this measure is that the existing condition of the space have less than or equal to an insulation effective R-value of R-11 (excluding assembly section) for tier 1, or R-19 for tier 2; and the space should be insulated to a minimum level of R-38. This specific measure detail was not provided in the Focus on Energy calculator, but was determined through additional analysis and calculations in reference to the Illinois TRM attic insulation methodologies.[5] In absence of measure detail, specific program installation guidelines developed by Focus on Energy's Home Performance with ENERGY STAR® Program will be referenced to ensure consistency.

Data from the ECW, the U.S. Census Bureau, and the American Housing Survey were used to calculate best estimates of energy savings for installing attic insulation in single family Wisconsin residences.

Description of Baseline Condition

The baseline is an attic insulated to R-11 or below for tier 1, and up to R-19 for tier 2. Based on projects seen in Illinois adjusted for an expected Wisconsin home, the baseline is assumed to be a CFM50 (cubic feet per minute air leakage, at a pressure of 50 Pascal) of 3,684.

Description of Efficient Condition

The efficient condition is an attic insulated to a minimum of R-38, with air sealing techniques (e.g. caulk) added to any leaks in the attic. The efficient condition for air sealing is assumed to be a CFM50 of 3,377.

Annual Energy-Savings Algorithm (Attic Insulation)

For cooling:

$kWh_{SAVED} = ((1 / R_{BASE} – 1 / R_{EE}) * CDD * 24 * area) / 1,000 / SEER * AC\%$

For heating:

$Therms_{SAVED} = ((1 / R_{BASE} – 1 / R_{EE}) * HDD * 24 * area) / 100,000 / AFUE$

Where:

R_{BASE}	=	Existing R-value of attic (= 11 for tier 1; = 19 for tier 2)
R_{EE}	=	Proposed R-value of attic (= 38)
CDD	=	Cooling degree days (= 565, see table below)
Area	=	Attic area to be insulated (= 1,209 square feet)[6]
SEER	=	Cooling system efficiency (= 12)
AC%	=	Percentage of homes with central cooling systems (=92.5%)[6]
HDD	=	Heating degree days (= 7,616, see table below)
24	=	Hours per day
100,000	=	Conversion from Btu to Therms
AFUE	=	Gas heating system efficiency (= 80%)

Location	HDD[7]	CDD[7]
Milwaukee	7,276	548
Green Bay	7,725	516
Wausau	7,805	654
Madison	7,599	630
La Crosse	7,397	729
Minocqua	8,616	423
Rice Lake	8,552	438
Statewide Weighted	**7,616**	**565**

Annual Energy-Savings Algorithm (Air Sealing)[8]

For cooling:

kWh_{SAVED} = [{((CFM50$_{EXISTING}$ – CFM50$_{NEW}$)/N) * 60 * 24 * CDD * 0.018} /1,000 * SEER] * LM * AC%

For heating:

$Therms_{SAVED}$ = [((CFM50$_{EXISTING}$ – CFM50$_{NEW}$)/N) * 60 * 24 * HDD * 0.018]/(100,000 * AFUE)

Where:

CFM50$_{EXISTINT}$ = Existing air flow rate in cubic feet per minute (= 3,683.6)[9]

CFM50$_{NEW}$ = New air flow rate post-air sealing (= 3,377.0)[7]

N = Conversion factor for CFM from 50 Pascal to natural conditions (18.5 assuming normal shielding)

60 = Constant to convert minutes to hours

0.018 = Specific heat capacity of air (Btu / Cubic ft. – degrees F)

1,000 = Conversion from W to kW

LM = Latent multiplier (= 8.0)[10]

Location	LM
Eau Claire	8.0
Green Bay	7.7
La Crosse	8.0
Madison	6.5
Milwaukee	8.3

Summer Coincident Peak Savings Algorithm[8]

$kW_{SAVED} = (kWh_{SAVED} / EFLH_{COOLING}) * CF$

Where:

$EFLH_{COOLING}$ = Effective full load hours of air conditioning (= 410)[4]

CF = Coincidence factor (=0.68)[4]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 20 years)[1]

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Deemed Savings

Baseline	MMID	Annual kWh	Annual Therms	Peak Coincident kW	Lifecycle kWh	Lifecycle Therms
R-11 (tier 1)	3570	231	219	0.3831	4,620	4,380
R-19 (tier 2)	3558	183	114	0.3035	3,660	2,280

Assumptions

Attic areas are assumed to be 1,209 square feet, which represents the average square footage data across all residential attic insulation projects undertaken in the Residential Rewards Program between 2012 and 2013. Previous figure was 922 (based on weighted average of housing unit areas and number of floors from 2011 American Housing Survey day for Milwaukee). Because this was such a limited geographical range, adjusting the square footage to align with actual program performance seems appropriate. Federal AFUE standard is 78%, but as most new furnaces installed are 90% and higher, we increased the assumption slightly to 80% (as these are likely older homes without many other improvements, only a slight upwards adjustment seemed appropriate). SEER 12 is the assumption used for the ECM measure for Focus Single Family Residential.

The default savings are based on existing heating and cooling equipment efficiencies of 80%AFUE and SEER 12, respectively.

Baseline and efficient R-values are conservative estimates based on the minimum program requirements. Where possible, savings should be calculated based on the square footage of actual existing and final R-values.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C. Attic insulation has an EUL of 25 and air sealing an EUL of 20, so the shorter of the two figures was used to avoid over- counting lifecycle savings.
2. Wisconsin PSC Incremental Cost Database December 2014. Attic Insulation incremental cost found to be $0.99 per square foot.
3. NREL “National Residential Efficiency Measures Database” for Air Leakage and Ceiling/Roof. Air Sealing cost for going from 15ACH50 to 10ACH50 is $1.20 per square foot. http://www.nrel.gov/ap/retrofits/about.cfm
4. Focus on Energy Cost-Effectiveness Calculator, Mass Markets – Residential SF Program, July 2011.
5. Illinois Energy Efficiency Statewide Advisory Group, Illinois Statewide Technical Reference Manual – Section 5.6.4 Wall and Ceiling/Attic Insulation, February 2014,

http://ilsagfiles.org/SAG_Files/Technical_Reference_Manual/Version_3/Final_Draft/Illinois_Statewide_TRM_Effective_060114_Version_3%200_021414_Final_Clean.pdf.

6. Focus on Energy Evaluated Deemed Savings Changes October 21, 2014.
7. Calculated from TMY3 weather files of the seven Wisconsin locations using *ASHRAE Estimation of Degree –Days: Fundamentals*, Chapter 14. Statewide weighted values calculated using 2010 US Census data for Wisconsin.
8. Illinois Energy Efficiency Statewide Advisory Group, Illinois Statewide Technical Reference Manual – Section 5.6.1 Air Sealing, February 2014, http://ilsagfiles.org/SAG_Files/Technical_Reference_Manual/Version_3/Final_Draft/Illinois_Statewide_TRM_Effective_060114_Version_3%200_021414_Final_Clean.pdf.
9. Calculated from EnergyGauge modeling completed using data from a survey of 136 existing homes in Illinois that participated in a CLEAResult home performance program. The model showed CFM50 of 3,683.635 pre-blower door test and 2,588.414 post-test, for a home of 1,209 square feet. To guard against overly aggressive savings estimates, CFM reduction was decreased by 72%, to get a post-test figure of 3,376.973.
10. The Latent Multiplier is used to convert the sensible cooling savings calculated to a value representing sensible and latent cooling loads. The values are derived from Harriman et al "Dehumidification and Cooling Loads from Ventilation Air", ASHRAE Journal, by adding the latent and sensible loads to determine the total, then dividing the total by the sensible load. As a relative midpoint of values for Wisconsin cities, the value of 8.0 was chosen (see table below; https://www.ashrae.org/File%20Library/docLib/eNewsletters/harriman-111997--feature.pdf).

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	11/07/2012	Original
02	RSG	01/17/2013	Added supplemental information
03	RSG	02/19/2013	Updated to address evaluators comments
04	CLEAResult (previously RSG)	10/14/2014	Updated to include air sealing savings and two-tier approach

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Domestic Hot Water

Kitchen Aerators, Single-Family

	Measure Details
Measure Master ID	Faucet Aerator, 1.5 GPM, Kitchen, NG, 2120, 2136, 3474 Faucet Aerator, 1.5 GPM, Kitchen, Electric, 2126, 3473
Measure Unit	Single, Low-Flow, 1.5 GPM Aerator
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Aeration
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	294
Peak Demand Reduction (kW)	0.014
Annual Therm Savings (Therms)	13
Lifecycle Energy Savings (kWh)	3,525
Lifecycle Therm Savings (Therms)	155
Water Savings (gal/yr)	2,897
Effective Useful Life (years)	12[1]
Incremental Cost	$5.00
Important Comments	

Bathroom Aerators, Single-Family

	Measure Details
Measure Master ID	Faucet Aerator, 1.0 GPM, Bathroom, NG, 2121, 2137, 3476 Faucet Aerator, 1.0 GPM, Bathroom, Electric, 2127, 3475
Measure Unit	Single, Low-Flow, 1.0 GPM Aerator
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Aeration
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	70
Peak Demand Reduction (kW)	0.0073
Annual Therm Savings (Therms)	3.1
Lifecycle Energy Savings (kWh)	835
Lifecycle Therm Savings (Therms)	37
Water Savings (gal/yr)	829
Effective Useful Life (years)	12[1]
Incremental Cost	$3.00
Important Comments	

Shower Aerators, Single-Family

	Measure Details
Measure Master ID	Showerhead, Direct Install, 1.5 GPM, NG, 2123, 2139, 3481 Showerhead Direct Install, 1.5 GPM, Electric, 2129, 2145, 3480
Measure Unit	Showerhead
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Showerhead
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	318
Peak Demand Reduction (kW)	0.0167
Annual Therm Savings (Therms)	14
Lifecycle Energy Savings (kWh)	3,821
Lifecycle Therm Savings (Therms)	168
Water Savings (gal/yr)	2,625
Effective Useful Life (years)	12[1]
Incremental Cost	$5.00
Important Comments	

Measure Description

A 1.5 or 1.0 GPM faucet or shower aerator is installed by the Program Implementer or a subcontractor of the Program Implementer in place of a higher flow rate aerator. Assumptions are based on a direct installation, not a time-of-sale purchase.

Description of Baseline Condition

The baseline equipment is assumed to be a higher flow rate aerator.

Description of Efficient Condition

This measure applies to standard 1.5 and 1.0 GPM low-flow aerators.

Annual Energy-Savings Algorithm

$$kWh_{SAVED} = \Delta Gallons * 8.33 * 1 * (T_{POINT\ OF\ USE} - T_{ENTERING}) / RE_{ELECTRIC} / 3{,}412$$

$$Therms_{SAVED} = \Delta Gallons * 8.33 * 1 * (T_{POINT\ OF\ USE} - T_{ENTERING}) / RE_{GAS} / 100{,}000$$

Aerators:

$$\Delta Gallons = (GPM_{EXISTING} - GPM_{NEW}) * PH / FH * LU * 365$$

Showerheads:

$$\Delta Gallons = (GPM_{EXISTING} - GPM_{NEW}) * PH * SPD / FH * SLU * 365$$

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Where:

Shared Parameters

ΔkWh	=	First-year electric savings, kWh
ΔTherms	=	First-year natural gas savings, therms
ΔGallons	=	First-year water savings, gallons
PH	=	Single-family persons/house (= 2.52)[1]
8.33	=	Density of water, lbs/gal
1	=	Specific heat of water, Btu/lb °F
100,000	=	Conversion from Btus to therms
3,412	=	Conversion from Btus to kWhs
365	=	Conversion from days to years
$T_{ENTERING}$	=	Temperature of water entering water heater (= 52.3°F)[2]
$RE_{ELECTRIC}$	=	Recovery efficiency of electric water heater (= 98%)[3]
RE_{GAS}	=	Recovery efficiency of electric water heater (= 76%)[3]

Kitchen Aerator

$GPM_{EXISTING}$	=	Baseline flow rate (= 2.2 GPM)[4]
GPM_{NEW}	=	Efficient flow rate (= 1.5 GPM)
FH	=	Single-family fixtures per home (= 1.0 fixtures/home)[1]
LU	=	Length of use (= 4.5 minutes/person/day)[5]
$T_{POINT\ OF\ USE}$	=	Temperature of water at point of use (= 93°F)[5]

Bathroom Aerator

$GPM_{EXISTING}$	=	Baseline flow rate (= 2.2 GPM)[4]
GPM_{NEW}	=	Efficient flow rate (= 1.0 GPM)
FH	=	Single-family fixtures per home (= 2.13 fixtures/home)[1]
LU	=	Length of use in minutes (= 1.6 minutes/person/day)[5]
$T_{POINT\ OF\ USE}$	=	Temperature of water at point of use (= 86°F)[5]

Showerhead Aerator

$GPM_{EXISTING}$	=	Baseline flow rate (= 2.5 GPM)[4]
GPM_{NEW}	=	Efficient flow rate (= 1.5 GPM)
FH	=	Single-family fixtures/house (= 1.64 fixtures/home)[1]
SLU	=	Shower length of use (= 7.8 minutes/shower)[5]

SPD = Showers per person per day (= 0.6 showers/person/day)[5]

$T_{POINT\ OF\ USE}$ = Temperature of water at point of use (= 101°F)[5]

Summer Coincident Peak Savings Algorithm

Aerators:

$kW_{SAVED} = \Delta kWh * CF / (PH * LU * 365 / 60 / FH)$

$CF = \%Peak_{AERATOR} * LU / 180$

Showerheads:

$kW_{SAVED} = \Delta kWh * CF / (PH * SPD * SLU * 365 / 60 / FH)$

$CF = \%Peak_{SHOWER} * SLU * SPD / 180$

Where:

CF = Coincidence factor (Kitchen = 0.0033, Bathroom = 0.0012, Showerhead = 0.0023)

60 = Conversion from second to minutes

$\%Peak_{AERATOR}$ = Percentage of time faucet aerators used during peak period (= 13%)[6]

$\%Peak_{SHOWER}$ = Percentage of time showers used during peak period (= 9%)[6]

180 = Number of minutes during the peak period

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 12 years)[1]

Sources

1. *Residential Energy Consumption Survey, Micro Survey Data.* Structural and Geographic Characteristics, Wisconsin. 2009. Based on average of single-family units (single-family detached and single-family attached).
2. U.S. Department of Energy. *Domestic Hot Water Scheduler.* Average water main temperature of all locations measured in Wisconsin by scheduler, weighted by city populations.
3. NREL, *Building America Research Benchmark Definition*, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf.
4. Federal minimum at 80 psi.
5. Cadmus. Michigan Water Meter Study. 2012.
6. DeOreo, William B., The End Uses of Hot Water in Single Family Homes From Flow Trace Analysis, Figure 2, p. 10. The peak percentage values of 9% and 13% for showers and aerators

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respectively are determined from the load shape in Figure 2 for the hours between 1 and 4 pm. http://s3.amazonaws.com/zanran_storage/www.aquacraft.com/ContentPages/47768067.pdf.

7. Wisconsin PSC EUL database, 2013. See Appendix C.

Revision History

Version Number	Authored by	Date	Description of Change
01	Conservation Services Group	01/01/2012	New measure
02	Conservation Services Group	03/18/2013	Update to new template and additions
03	Conservation Services Group	04/22/2013	Revisions/corrections

Kitchen, Bath, and Shower Aerators

	Measure Details
Measure Master ID	Faucet Aerator, 1.5 GPM, Kitchen, 3026 and 3025 for Electric and Gas, respectively Faucet Aerator, 1.0 GPM, Kitchen, 3506 and 3507for Electric and Gas, respectively Faucet Aerator, 0.5 GPM, Kitchen 3509 and 3510 for Electric and Gas, respectively Faucet Aerator, 1.5 GPM, Bath, 3028 and 3027 for Electric and Gas, respectively Faucet Aerator, 1.0 GPM, Bath, 2143 and 2137 for Electric and Gas, respectively Faucet Aerator, 0.5 GPM, Bath, 2151 and 3508 for Electric and Gas, respectively Faucet Aerator, 1.5 GPM, Shower, NG, 2139, 3029 Faucet Aerator, 1.5 GPM, Shower, Electric, 2145, 3030
Measure Unit	Aerator, Showerhead
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Aeration
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Therm Savings (Therms)	Varies by location
Lifecycle Energy Savings (kWh)	Varies by location
Lifecycle Therm Savings (Therms)	Varies by location
Water Savings (gal/yr)	Varies by location
Effective Useful Life (years)	Varies by measure
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

This measure is the installation of low-flow kitchen, bath, and/or shower aerators in existing buildings or new construction. It saves either gas or electric consumption depending on the water heating fuel source. It also saves on total water consumption.

Description of Baseline Condition

The baseline equipment is a kitchen aerator at 2.2 GPM, a bath aerator at 2.2 GPM, and a showerhead at 2.5 GPM.

Description of Efficient Condition

The efficient condition is a kitchen aerator at 1.5, 1.0, or 0.5 GPM, bath aerator at 1.5, 1.0, or 0.5 GPM, and showerhead at 1.5 GPM.

Annual Energy-Savings Algorithm

kWh_{SAVED}= ((ΔGallons * 8.33 * 1* ($T_{POINT\ OF\ USE}$ – $T_{ENTERING}$))/ $RE_{electric}$)/3,412

$Therms_{SAVED}$= ((ΔGallons * 8.33 * 1 * ($T_{POINT\ OF\ USE}$ – $T_{ENTERING}$))/ RE_{gas})/100,000

For Aerators:

$Gallons_{SAVED}$ = ($GPM_{EXISTING}$ - GPM_{NEW}) * (PH/FH) * FLU * 365

For Showerheads:

$Gallons_{SAVED}$ = ($GPM_{EXISTING}$ - GPM_{NEW}) * ((PH* SPD)/FH) * SLU * 365

Where:

Shared Parameters

ΔkWh = First-year electric savings, kWh

ΔTherms = First-year natural gas savings, therms

ΔGallons = First-year water savings, gallons

PH = Multifamily persons/house (= 1.93)[1]

8.33 = Density of water, lbs/gal

1 = Specific heat of water, Btu/lb °F

100,000 = Convert Btu to therms, Btu/therm

3,412 = Convert Btu to kWh, Btu/kWh

365 = Convert days to year, days/year

$T_{entering}$ = Temperature of water entering water heater (= 52.3°F)[2]

$RE_{electric}$ = Recovery efficiency of electric water heater (= 98%)[3]

RE_{gas} = Recovery efficiency of natural gas water heater (= 76%)[3]

Kitchen Aerator

$GPM_{existing}$ = Baseline flow rate (= 2.2 GPM)[4]

GPM_{new} = Efficient flow rate (= 1.5, 1.0 or 0.5 GPM)

FH = Multifamily fixtures per home (= 1.0 fixtures/home)[1]

FLU = Length of use (= 4.5 minutes/person/day)[5]

$T_{point\ of\ use}$ = Temperature of water at point of use (= 93°F)[5]

Bathroom Aerator

$GPM_{existing}$ = Baseline flow rate (= 2.2 GPM)[4]

GPM_{new} = Efficient flow rate (= 1.5, 1.0 or 0.5 GPM)

FH = Multifamily fixtures per home (= 1.11 fixtures/home)[1]

FLU = Length of use in minutes (= 1.6 minutes/person/day)[5]

$T_{point\ of\ use}$ = Temperature of water at point of use (= 86°F)[5]

Showerhead Aerator

$GPM_{existing}$ = Baseline flow rate (= 2.5 GPM)[4]

GPM_{new} = Efficient flow rate (= 1.5 GPM)

FH = Multifamily fixtures/house (= 1.0 fixtures/home)[1]

SLU = Shower length of use (= 7.8 minutes/shower)[5]

SPD = Showers per person per day (= 0.6 showers/person/day)[5]

$T_{point\ of\ use}$ = Temperature of water at point of use (= 101°F)[5]

Summer Coincident Peak Savings Algorithm

kW_{SAVED}= kWh_{SAVED} * CF / (PH * LU * 365 days / (60 mins/hr)/ FH)

Where:

$CF_{SHOWERHEAD}$ = Coincidence factor for showerheads (= 0.0039)[6]

$CF_{AERATOR\ BATH}$ = Coincidence factor for bathroom aerators (= 0.0011)[6]

$CF_{AERATOR\ KITCHEN}$ = Coincidence factor for kitchen aerators (= 0.0032)[6]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE}$ = kWh_{SAVED} * EUL

$Therms_{LIFECYCLE}$ = $Therms_{SAVED}$ * EUL

Where:

EUL = Effective useful life (= 10 years)[7]

Deemed Savings

1.5 GPM Deemed Savings

Type of Savings	Kitchen	Bath	Showerhead
Measure ID	3025 (NG) 3026 (Electric)	3027 (NG) 3028 (Electric)	2139, 3029 (NG) 2145, 3030 (Electric)
Annual Energy Savings (kWh)	225	60	400
Peak Demand Reduction (kW)	0.0138	0.0041	0.0170
Annual Therm Savings (Therms)	9.9	2.6	17.6
Lifecycle Energy Savings (kWh)	2250	597	4000
Lifecycle Therm Savings (Therms)	99	26	176
Water Savings (gal/yr)	2,219	711	3,297

1.0 GPM Deemed Savings

Type of Savings	Kitchen	Bath
Measure ID	2156, 3507 (NG) 2155, 3506 (Electric)	2137 (NG) 2143 (Electric)
Annual Energy Savings (kWh)	386	102
Peak Demand Reduction (kW)	0.0237	0.0070
Annual Therm Savings (Therms)	17	4.5
Lifecycle Energy Savings (kWh)	3857	1023
Lifecycle Therm Savings (Therms)	170	45
Water Savings (gal/yr)	3804	1219

0.5 GPM Deemed Savings

Type of Savings	Kitchen	Bath
Measure ID	3510 (NG) 3509 (Electric)	3508 (NG) 2151 (Electric)
Annual Energy Savings (kWh)	546	145
Peak Demand Reduction (kW)	0.0336	0.0099
Annual Therm Savings (Therms)	24	6.4
Lifecycle Energy Savings (kWh)	5464	1449
Lifecycle Therm Savings (Therms)	240	64
Water Savings (gal/yr)	5389	1726

Sources

1. *Residential Energy Consumption Survey, Micro Survey Data.* Structural and Geographic Characteristics, Wisconsin. 2009. Based on average of multifamily units (apartment buildings with 2-4 units and with 5+ units).
2. U.S. Department of Energy. *Domestic Hot Water Scheduler.* Average water main temperature of

all locations measured in Wisconsin by scheduler, weighted by city populations.

3. NREL, *Building America Research Benchmark Definition*, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf.
4. Federal minimum at 80 psi.
5. Cadmus. *Michigan Water Meter Study*. 2012.
6. DeOreo, William B., The End Uses of Hot Water in Single Family Homes From Flow Trace Analysis, Figure 2, p. 10. The peak percentage values of 9% and 13% for showers and aerators respectively are determined from the load shape in Figure 2 for the hours between 1 and 4 pm. http://s3.amazonaws.com/zanran_storage/www.aquacraft.com/ContentPages/47768067.pdf
7. Wisconsin PSC EUL database, 2013. See Appendix C.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	01/02/2012	New measure
02	Franklin Energy Services	10/27/2014	Adding 1.0 and 0.5 GPM options to existing TRM workpaper

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DHW Temperature Turn Down, Electric and Natural Gas

	Measure Details
Measure Master ID	DHW Temperature Turn Down, Direct Install, Natural Gas, 2125, 2141, 3472 Electric, 2131, 2147, 3471
Measure Unit	Single Temperature Turn Down of Natural Gas or Electric Fueled Water Heater
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Controls
Sector(s)	Residential – single family
Annual Energy Savings (kWh)	149
Peak Demand Reduction (kW)	0.0169
Annual Therm Savings (Therms)	13.57
Lifecycle Energy Savings (kWh)	1,786
Lifecycle Therm Savings (Therms)	163
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[1]
Incremental Cost	$0
Important Comments	

Measure Description

The water heater temperature is turn downed to 120°F by the Program Implementer or a subcontractor of the Program Implementer. Assumptions are based on direct installation, not on a time-of-sale purchase.

There are two main effects of hot water storage temperature on energy use. The primary effect is due to standby loss, which increases with hot water temperature. The secondary effect is that hotter stored water affects hot water end-uses. This happens in two ways. For batch appliances, such as most clothes washers, more energy is used for hot and warm wash cycles because a fixed number of gallons is drawn for each load. For mixed end-uses (showers, sinks, bathtubs), when the stored water is hotter, less of it is mixed with cold water to achieve the target use temperature. Since the majority of hot water use is mixed temperature, a modest change in hot water temperature (of 10°F - 20°F) has a relatively small impact on the energy required to heat the delivered hot water.

The reduction in standby loss also affects internal gains. For electric hot water, the reduction in internal gains from a turn-down results in slightly smaller cooling load; assuming that most water heaters in Wisconsin are in basements, and that basements have little or no direct air conditioning, this effect can be ignored. Heating effects are ignored for electric water heaters, assuming a predominance of gas heat; however, it should be accounted at an appropriate efficiency with heat pump or electric resistance heat.

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Description of Baseline Condition

The baseline is to have a hot water temperature above 120°F.

Description of Efficient Condition

The efficient condition is for residential electric water heaters to be set to 120°F.

Annual Energy-Savings Algorithm

Electric Measures

The variables in the equations below that change between the baseline and efficient cases are GPD and $T_{WH.}$

$kWh_{SAVED} = [(HW_{BASE} + SB_{BASE}) – (HW_{EFF} + SB_{EFF})] * 365 * (1/3{,}412)$

$HW = GPD * C_P * (T_{WH} – T_{ENTERING}) * 1/RE * [1 – UA * (T_{WH} – T_{ROOM}/Input)]$

$SB = UA * 24 * (T_{WH} – T_{ROOM})$

$UA = [(1/EF)-(1/RE)]/[67.5 * ((24/Q_{OUT}) – (1/(RE * Input)))]$

Where:

HW_{BASE}	=	Hot water baseline load (= 24,912 Btu/day)
SB_{BASE}	=	Standby baseload (= 4,125 Btu/day)
HW_{EFF}	=	Hot water efficient load (= 24,111 Btu/day)
SB_{EFF}	=	Standby efficient load (= 3,536 Btu/day)
3,412	=	Conversion from Btu to kWh (3,412 Btu/kWh)
GPD	=	Gallons of hot water use per day (= 38.1 with baseline measure, = 42.3 with efficient measure)
C_P	=	Heat capacity of water (= 8.33 Btu/gallon/°F)
T_{WH}	=	Temperature in tank (= 130°F with baseline measure, = 120°F with efficient measure)
$T_{ENTERING}$	=	Cold water mains temperature (= 52.3°F)[2]
RE	=	Water heater recovery efficiency (=0.98)[3]
UA	=	Water heater equivalent heat loss factor (= 2.45 Btu/hr-°F)
Q_{OUT}	=	Energy content of water drawn from water heater during 24 hour test (41,094 Btu/day)[4]
T_{ROOM}	=	Ambient temperature surrounding tank (= 65°F)
Input	=	Firing rate (=15,350 Btu/hr)
EF	=	Energy factor (= 0.904)[4]

Therm Measures

The variables in the equations below that change between the baseline and efficient cases are GPD and $T_{WH.}$

$Therms_{SAVED} = [(HW_{BASE} + SB_{BASE}) – (HW_{EFF} + SB_{EFF})] * 365 * 1/1,000$

$HW = GPD * C_P * (T_{WH} – T_{ENTERING}) * 1/RE * [1 – UA * (T_{WH} – T_{ROOM}/Input)]$

$SB = UA * 24 * (T_{WH} – T_{ROOM})$

$UA = [(1/EF)-(1/RE)] / [67.5 * ((24/Q_{OUT}) – (1/ (RE * Input)))]$

Where:

HW_{BASE}	=	Hot water baseline load (= 31,887 Btu/day)
SB_{BASE}	=	Standby baseload (= 17,752 Btu/day)
HW_{EFF}	=	Hot water efficient load (= 30,900 Btu/day)
SB_{EFF}	=	Standby efficient load (= 15,021 Btu/day)
100,000	=	Conversion from Btu to therms
GPD	=	Gallons of hot water use per day (= 38.1 with baseline measure, = 42.3 with efficient measure)
C_P	=	Heat capacity of water (= 8.33 Btu/gallon/°F)
T_{WH}	=	Temperature in tank (= 130°F with baseline measure, = 120°F with efficient measure)
$T_{ENTERING}$	=	Cold water mains temperature (= 52.3°F)[2]
RE	=	Water heater recovery efficiency (=0.76)[3]
UA	=	Water heater equivalent heat loss factor (= 11.38 Btu/hr-°F)
Q_{OUT}	=	Energy content of water drawn from water heater during 24 hour test (41,094 btu/day)
T_{ROOM}	=	Ambient temperature surrounding tank (= 65°F)
Input	=	Firing rate (=40,000 Btu/hr)[4]
EF	=	Energy factor (= 0.575)[4]

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Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (kWh_{SAVED}/8{,}760) * CF$

Where:

8,760	=	Hours in one year
CF	=	Coincidence factor (= 1)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 12 years)[1]

Assumptions

The gallons per day assumptions were as follows:

- Total hot water use at the tap = 51.5 GPD.[5] The hot water use is broken into two components: unmixed (primarily for clothes washers and dishwashers) and mixed (for showers and sinks). It is assumed that 10 GPD is unmixed and 41.5 GPD is mixed (unmixed is direct draw from the water heater, and does not vary with stored hot water temperature; mixed is delivered at the fixture at 105°F, so the total draw from the water heater varies with stored water temperature).
- The water heater draw is given as:
  - GPD_{Base} = 10 + 41.5 * (105 - 52.3)/(130 - 52.3) = 38.1 GPD
  - GPD_{Eff} = 10 + 41.5 * (105 - 52.3)/(120 - 52.3) = 42.3 GPD
- As the set temperature goes down, the hot water consumption at the tank goes up. As the stored temperature is reduced, more hot and less cold must be mixed to reach the target of 105°F at the showerhead or sink.
- An average value of 2.36 people/home was used for Wisconsin, based on RECS 2009 data. Calculated by using the linear relationship is used in the 2012 Indiana TRM and the 2010 NY TRM. Calculated by using the linear relationship of y = 16.286 x + 13, where x is the average number of people per home (2.36) and y is the average gallons of hot water used per day.

Sources

1. Wisconsin PSC EUL database. See Appendix C.
2. U.S. Department of Energy. *DHW Scheduler*. Used average water main temperature of all Wisconsin locations, weighted by city population.
3. National Renewable Energy Laboratory. *Building America Research Benchmark Definition*. pg. 12. 2009. Available online: http://www.nrel.gov/docs/fy10osti/47246.pdf.
4. U.S. Department of Energy. Federal standard for residential water heaters effective in 2004.

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Revision History

Version Number	Authored by	Date	Description of Change
01	Conservation Services Group	01/01/2012	New measure
02	Conservation Services Group	03/09/2013	Update to new template and add lifecycle savings
03	Conservation Services Group	04/22/2013	Revisions/comments

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Insulation, Direct Install, 6-Foot Pipe, Electric

	Measure Details
Measure Master ID	Insulation, Direct Install, 6-Foot Pipe, Electric, 2128, 3477
Measure Unit	Single, 6-foot pipe insulation for electric water heater, 3 feet on cold pipe and 3 feet on hot pipe
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Insulation
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	162
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	1,944
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[1]
Incremental Cost	$3.96 per foot; $23.76 for all
Important Comments	

Measure Description

This measure is non-insulated water heater pipes being insulated for 6-feet by the Program Implementer or a subcontractor of the Program Implementer

Pipe insulation near the tank saves energy by reducing standby losses from pipes that are hot from conducting heat from the storage tank. This happens by convective currents within the pipe(s), or by eventually drawing and using hot water in the pipe.

In the following calculations, the reduction in electric hot water internal gains from pipe insulation is ignored, assuming that most water heaters in Wisconsin are in basements, and that basements have little or no direct air conditioning. For gas hot water, the regain from reduced pipe heat loss (for the duration of the heating season) is subtracted from the direct savings to arrive at the net gas savings.

Heating effects are ignored for electric water heaters, assuming a predominance of gas heat. For heat pump or electric resistance heat, the heating effects should account for an appropriate efficiency, as with gas heat.

Description of Baseline Condition

The baseline condition is no pipe insulation.

Description of Efficient Condition

The efficient condition is pipe insulation on a residential electric water heater.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (\Delta Btu/yr) / 3,412$

$\Delta Btu/yr = ((1/R_{EXIST} – 1/R_{NEW}) * (L * C) * \Delta T * 8,760 / RE$

Where:

R_{EXIST}	=	Pipe heat loss coefficient of existing uninsulated pipe (= 1 Btu/hr-°F-ft)
R_{NEW}	=	Pipe heat loss coefficient of new insulated pipe (= 1/4 Btu/hr-°F-ft)
L	=	Length of pipe from water heating source covered by pipe wrap (= 6 feet)
C	=	Circumference of pipe, inches of outer diameter * π * 0.083 (= 0.229 feet)
ΔT	=	Average temperature difference from pipe to ambient air (= 60°F)
8,760	=	Conversion for hours per year
RE	=	Water heater recovery efficiency (= 0.98)
3,412	=	Conversion factor from Btu to kWh

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 12 years)[1]

Assumptions

Assumptions are based on a direct installation, not a time-of-sale purchase.

The average difference of 60°F assumes pipe and ambient air temperatures of 125°F and 65°F, respectively.

The pipe inner and outer diameters are assumed to be 3/4-inch and 7/8-inch, respectively.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.

Revision History

Version Number	Authored by	Date	Description of Change
01	Conservation Services Group	01/01/2012	New measure
02	Conservation Services Group	03/19/2013	Update to new template and add lifecycle savings

Insulation, Direct Install, 6-Foot Pipe, NG

	Measure Details
Measure Master ID	Insulation Direct Install, 6-Foot Pipe, NG, 2122, 2138, 3476
Measure Unit	Single, 6-foot pipe insulation for natural gas water heater, 3 feet on cold pipe and 3 feet on hot pipe
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Insulation
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	3.12
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	37.38
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[1]
Incremental Cost	$3.96 per foot; $23.76 for all
Important Comments	

Measure Description

This measure is non-insulated water heater pipes being insulated for 6-feet by the Program Implementer or a subcontractor of the Program Implementer.

Pipe insulation near the tank saves energy by reducing standby losses from pipes that are hot from conducting heat from the storage tank. This happens by convective currents within the pipe(s), or by eventually drawing and using hot water in the pipe.

In the following calculations, the reduction in electric hot water internal gains from pipe insulation is ignored, assuming that most water heaters in Wisconsin are in basements, and that basements have little or no direct air conditioning. For gas hot water, the regain from reduced pipe heat loss (for the duration of the heating season) is subtracted from the direct savings to arrive at the net gas savings.

Heating effects are ignored for electric water heaters, assuming a predominance of gas heat. For heat pump or electric resistance heat, the heating effects should account for an appropriate efficiency, as with gas heat.

Description of Baseline Condition

The baseline condition is no pipe insulation.

Description of Efficient Condition

The efficient condition is pipe insulation on a residential natural gas water heater.

Annual Energy-Savings Algorithm

$Therms_{SAVED} = (\Delta Btu/yr) * (1 - PCT_{HEAT}) * RE / HE / 100,000$

$\Delta Btu/yr = ((1/R_{EXIST} - 1/R_{NEW}) * (L * C) * \Delta T * 8,760 / RE$

Where:

R_{EXIST}	=	Pipe heat loss coefficient of existing uninsulated pipe (= 1 Btu/hr-°F-ft)
R_{NEW}	=	Pipe heat loss coefficient of new insulated pipe (= 1/4 Btu/hr-°F-ft)
L	=	Length of pipe from water heating source covered by pipe wrap (= 6 feet)
C	=	Circumference of pipe, inches of outer diameter * π * 0.083 (= 0.229 feet)
ΔT	=	Average temperature difference from pipe to ambient air (= 60°F)
8,760	=	Conversion for hours per year
RE	=	Water heater recovery efficiency (= 0.76)[2]
PCT_{HEAT}	=	Portion of year the house is mechanically heated (= 0.54)
HE	=	Gas system heating efficiency (= 0.8)
100,000	=	Btu to therm conversion

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 12 years)[1]

Assumptions

Assumptions are based on a direct installation, not a time-of-sale purchase.

The average difference of 60°F assumes pipe and ambient air temperatures of 125°F and 65°F, respectively.

The pipe inner and outer diameters are assumed to be 3/4-inch and 7/8-inch, respectively.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf.

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Revision History

Version Number	Authored by	Date	Description of Change
01	Conservation Services Group	01/01/2012	New measure
02	Conservation Services Group	03/19/2013	Update to new template and add lifecycle savings
03	Conservation Services Group	04/22/2013	Revisions and comments

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Retail Store Markdown, Low-Flow Showerheads

	Measure Details
Measure Master ID	Showerheads, Retail Store Markdown, 3017
Measure Unit	Per Showerhead
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Showerhead
Sector(s)	Residential- single family, Residential- multifamily
Annual Energy Savings (kWh)	96
Peak Demand Reduction (kW)	0.0025
Annual Therm Savings (Therms)	8.6
Lifecycle Energy Savings (kWh)	1,150
Lifecycle Therm Savings (Therms)	103
Water Savings (gal/yr)	2,632
Effective Useful Life (years)	12[1]
Incremental Cost	$5
Important Comments	

Measure Description

This measure is a showerhead with a flow rate of 1.75 GPM or less based on a time-of-sale purchase, for installation in a residential location.

The energy and therm savings were adjusted based on the saturation of fuel types for water heating in Wisconsin (30% electric and 61% gas). Therefore, the values in this TRM do not reflect the full energy or gas savings on a per-unit basis.

Description of Baseline Condition

The baseline equipment is a showerhead with flow rate of 2.5 GPM.

Description of Efficient Condition

The efficient equipment is low-flow showerhead (≤ 1.75 GPM) installed in a residential location. The GPM used for the efficient showerhead in the calculations is a weighted average from the most recent sales data as of October, 2013.

Annual Energy-Savings Algorithm

Water Savings:

$$Gallons_{SAVED} = (GPM_{BASE} - GPM_{EE}) * ((PH * SPD)/FH) * SLU * 365 \text{ days/yr}$$

Electric Water Heater:

$$kWh_{SAVED} = (((\Delta Gallons/yr * 8.33 * 1 * (T_{POINT\ OF\ USE} - T_{ENTERING}))/RE)/3{,}412\ Btu/kWh)*WHS$$

Gas Water Heater

$Therms_{SAVED} = (((\Delta Gallons/yr \ * 8.33 * 1 * (T_{POINT\ OF\ USE} - T_{ENTERING}))/RE)/100{,}000) * WHS$

Where:

GPM_{BASE}	=	Baseline flow rate in gallons per minute (= 2.5 GPM)[2]
GPM_{EE}	=	Efficient flow rate in gallons per minute (= 1.54 GPM)
PH	=	Persons/house (= 2.36)[3]
SPD	=	Showers/day/person (= 0.6)[4]
FH	=	Fixtures/house (= 1.47)[3]
SLU	=	Shower length in minutes (= 7.8)[4]
$T_{POINT\ OF\ USE}$	=	Temperature of water at point of use (= 101°F)[4]
$T_{ENTERING}$	=	Temperature of water entering water heater (= 52.3°F)[5]
RE	=	Average estimated recovery efficiency of electric water heater (= 98%)[6]
WHS	=	Water heater fuel type saturation (= 30% for electric,= 61% for gas)[3]
8.33	=	Density of water, lbs/gal
1	=	Specific heat of water, Btu/lb °F
100,000	=	Convert Btu to therms, 100,000 Btu/therm
3,412	=	Convert Btu to kWh (= 3,412 Btu/kWh)

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = kWh_{SAVED} * CF / (PH * SLU * 365*SPD / (60mins/hr) / FH)$

Where:

CF	=	Coincidence factor (= 0.0039%)[7]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 12 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, similar measure MMID 2123.
2. Federal minimum at 80 psi.

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3. Residential Energy Consumption Survey. 2009 RECS Micro Survey Data. Structural and Geographic Characteristics, Wisconsin.
4. Cadmus. 2012 Michigan Water Meter Study.
5. DoE DHW Scheduler, average water main temp. of all locations measured in WI by scheduler, weighted by city populations.
6. NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf.
7. Calculated as follows: Assume 9% showers take place during peak hours (9% * 7.8 minutes per day /180 (minutes in peak period) = 0.0039

Revision History

Version Number	Authored by	Date	Description of Change
01	Applied Proactive Technologies	02/14/2013	Original
02	Applied Proactive Technologies	04/08/2013	Addressed comments from Cadmus dated 03/15/2013

Domestic Hot Water Plant Replacement

	Measure Details
Measure Master ID	DHW Plant Replacement, 2760
Measure Unit	Number of plants or number of apartments
Measure Type	Hybrid
Measure Group	Domestic Hot Water
Measure Category	MMID 2760 = Other
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	324 (reference savings)
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	4,860 (reference savings)
Water Savings (gal/yr)	0
Effective Useful Life	15[1]
Incremental Cost	$27.07 per MBH
Important Comments	

Measure Description

This measure is upgrading an entire DHW plant in a building with central DHW.

Commercial water heaters with greater than 75,000 Btu/hour have a TE rating, which typically varies from around 80% for standard efficiency gas water heaters to 90% or greater for condensing water heaters.

Description of Baseline Condition

The baseline condition is a DHW plant with TE of 80%.

Description of Efficient Condition

New water heaters must be:

- Commercially sized, HESCCM,
- HESCC stand-alone water heaters, or
- Indirect storage tanks off of a HESCCM boiler(s).

The new commercial water heaters must have a TE of 90% or greater. Fuel switching is not included in this measure. The additional requirements are:

- Building must have a central DHW system.
- Entire DHW system must be replaced: single water heater replacement in a multiple water heater system will not qualify.

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Annual Energy-Savings Algorithm

The Building America Multi-Family Central Water Heating Evaluation Tool[2] was used to determine the deemed savings for this measure. With the exception of the inputs listed below, the tool's default values were used to calculate savings:

$Therms_{SAVED} = Therms_{BASE} - Therms_{EE}$

$Therms_{BASE} = [(GPD * N_{APTS} * C * C_P * \Delta T * 365\ days/year)/(\eta_{BASE} * 100,000\ Btu/therm)] + [(Q_{LOSS-BASE} * N_{WH} * 24\ hours * 365\ days/year)/(100,000\ Btu/therm)]$

$Therms_{EE} = [(GPD * N_{APTS} * C * C_P * \Delta T * 365\ days/year)/(\eta_{EE} * 100,000\ Btu/therm)] + [(Q_{LOSS-EE} * N_{WH} * 24\ hours * 365\ days/year)/(100,000\ Btu/therm)]$

Where:

GPD	=	Gallons per day (= 43.9)[3]
N_{APTS}	=	Total number of dwelling units served by system (= 11.5)[4]
C	=	Conversion from gallons to mass, 8.33 pounds per gallon
C_P	=	1.0 Btu/lb-°F
ΔT	=	$T_{SET} - T_{INLET}$: 125°F hot water setpoint minus 52.3°F inlet water temperature (= 72.7°F difference)[5]
η_{BASE}	=	Baseline TE (= 80%)
η_{EE}	=	Efficient TE (=90%)
$Q_{LOSS-BASE}$	=	Baseline standby heat loss (= 1,233 Btu/hour)[6]
$Q_{LOSS-EE}$	=	Efficient standby heat loss (=929 Btu/hour)[7]
N_{WH}	=	Total number of DWH tanks (= 1)

Average Annual Deemed Savings for Water Heater, Not Otherwise Specified:

$Therms_{SAVED} = 13.3*N_{APTS} + 26.4*N_{WH}$

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 15 years)[1]

Assumptions

The water usage and recirculation loop condition parameters of the Building America Evaluation Tool were set to "medium" and "normal" respectively to represent typical applications and reflect the prescriptive nature of the measure. The total heating capacity and standby losses were scaled from the default value of 600,000 Btuh and 15,000 Btuh to 230,000 Btuh and 5,750 Btuh respectively to reflect the change in number of apartment units from the default of 30 to 11.5.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Evaluation tool is described in Strategy Guideline: Proper Water Heater Selection, August 2012: http://www.nrel.gov/docs/fy12osti/55074.pdf. The evaluation tool may be found here: http://apps1.eere.energy.gov/buildings/publications/docs/building_america/multifamily_central_dhw_evaluationtool_v1-0.xls
3. The gallons per day is calculated by using the linear relationship of y=16.286x + 13, where x is the average number of people per home and y is the average gallons of hot water used per day. An average value of 1.9 people/home was used for Wisconsin, based on RECS 2009 data. The linear relationship is used in the 2012 Indiana TRM and the 2010 NY TRM.
4. The WI multi-family number of units was estimated at 11.5 units per apartment based on the data from the 2009 U.S. Census, table 989. Housing Units by Units in Structure and State; https://www.census.gov/compendia/statab/cats/construction_housing/housing_units_and_characteristics.html.
5. United States Department of Energy. DHW Scheduler. Average water main temp. of all locations measured in Wisconsin by scheduler, weighted by city populations. The water heater set point is assumed to be 125°F. Wisconsin building code 704.06 requires landlords to set water heaters to 125°F: https://docs.legis.wisconsin.gov/statutes/statutes/704/06. Water heater set points typically range between 120°F and 140°F because temperatures below 120 are susceptible to Legionella bacteria (which lead to Legionnaires Disease) and heaters set to temperatures above 140°F can quickly scald users: http://www.nrel.gov/docs/fy12osti/55074.pdf. Most TRMs assume water heater set points of 120°F, 125°F or 130°F, though most of these assumptions are unsourced engineering assumptions.
6. Federal standard for gas storage water heater with 80 gallon storage and 199kBtu/h heat input.
7. Average standby loss of AHRI certified gas storage water heaters with TE > 94%, storage volume between 80 to 100 gallons, and heat input less than 200 kBtu/h.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	09/10/2012	New measure

Condensing Water Heater, NG, 90%+

	Measure Details
Measure Master ID	Condensing Water Heater, NG, 90%+, 1986
Measure Unit	Per Water Heater
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Water Heater
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	-50
Peak Demand Reduction (kW)	-0.0050
Annual Therm Savings (Therms)	54 (pre January 1, 2016), 46 (post January 1, 2016)
Lifecycle Energy Savings (kWh)	-600
Lifecycle Therm Savings (Therms)	648 (pre January 1, 2016), 552 (post January 1, 2016)
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[1]
Incremental Cost	$1,120
Important Comments	

Measure Description

This measure covers high-efficiency, commercial-sized, condensing tank-type water heaters. These heaters are used for whole-house domestic water heating in the residential sector. Commercial-sized water heaters have a minimum input rating of 75,000 Btuh and have a TE rating of 80%. While these appliances have a commercial rating, they are often installed in residential homes.

The rebate is for customers who install condensing water heaters with a TE rating of at least 90% in a residential home.

Description of Baseline Condition

Savings are calculated using the federal code standard minimum 0.575 EF if the unit is purchased before January 1, 2016 and 0.600 if purchased after January 1, 2016. This updated baseline reflects the new federal standard that takes effect April 2015. The criteria date used here is rounded to January 1, 2016, but the code actually takes affect mid-year 2015.[2]

This was calculated as: 0.670 - 0.0019 * 50 = 0.575, per 2001 federal standard that took effect in 2004. The new baseline per federal standard was adopted in 2010 and will take effect in April 2015. This is calculated as 0.675 - 0.0015 * 50 = 0.600. Both calculations assume a 50 gallon tank.

Description of Efficient Condition

The efficient condition is upgrading from the code standard minimum gas storage residential water heater to a higher efficiency 90% TE commercial gas storage-type water heater. Gas storage water heaters are used to supply DHW.

Annual Energy-Savings Algorithm

Because the efficiency of traditional gas storage water heaters is measured using an EF and the efficiency of condensing water heaters is measured using the TE, different algorithms are used to calculate baseline energy and efficient energy use.

$Therms_{SAVED} = Therms_{BASELINE} - Therms_{MEASURE}$

The baseline energy usage is calculated using the following equation:

$Therms_{BASELINE} = [\dot{M} * C_P * (T_{TANK} – T_{INLET})/EF] * (365/100,000)$

Where:

$\dot{M}$	=	Mass of water drawn (= 429 lbs/day)
c_P	=	Specific heat of water (= 1 Btu/lb-°F)
T_{TANK}	=	Water heater thermostat setpoint temperature (= 125°F)[3]
T_{INLET}	=	Inlet water temperature (= 52.3°F)[4]
EF	=	Energy factor (= 0.575 pre January 1, 2016, and = 0.600 post January 1, 2016)
365	=	Days per year
100,000	=	Conversion factor from Btu to Therms

The following shows this equation solved for the pre January 1, 2016 scenario:

$Therms_{BASELINE}$ = [(429 lbs/day * 1 Btu/lb°F * (125°F – 52.3°F))/0.575] * (365 days/yr / 100,000 Btu/therm)

The calculation above is repeated using an EF of 0.600 to solve for the post January 1, 2016 scenario, resulting in 190 therms/year.

Mass flow was calculated as the product of the density of water and the gallons of water used per day: 8.33 lbs/gal * 51.5 GPD = 429 lbs/day. The gallons per day was calculated using the linear relationship of y = 16.286 x + 13, where x is the average number of people per home and y is the average gallons of hot water used per day. The linear relationship is used in the 2012 Indiana TRM and the 2010 NY TRM. An average value of 2.365 people/home was used for Wisconsin, based on RECS 2009 data.

Measure Case Energy Usage

While residential storage water heater efficiency is measured in EF, which includes standby loses, commercial-sized storage water heater efficiency is measured in TE. While the efficiency equation for TE is similar to EF, it only measures the amount of energy used to heat the water consumed, and not the amount of energy needed for standby losses. The total energy usage a water heater consumes can be defined as:

$Therms_{MEASURE} = Q_{USAGE} + Q_{STANDBY}$

Q_{USAGE} can be determined with the equation below:

$Q_{USAGE} = [\dot{M} * C_P * (T_{TANK} – T_{INLET})]/TE$

Using this equation, Q_{USAGE} is solved for below:

Q_{USAGE} = [(429 lbs/day * 1 Btu/lb°F * (125°F – 52.3°F))/0.90] * (365 days/yr / 100,000 Btu/therm)

In addition to the energy needed to reheat the water usage, standby loses must be taken into account. According to the DOE Water Heater Analysis Model:[5]

$Q_{STANDBY} = UA * (T_{TANK} – T_{AMB}) * [24 – ((Q_{USAGE}/(RE*P_{ON}))]$

Where:

TE	=	Thermal efficiency of measure (= 0.90)
UA	=	Standby heat loss coefficient (= 3.319 Btu/hr- °F)
T_{AMB}	=	Ambient temperature (= 65°F)
RE	=	Recovery efficiency (= 0.90, assume TE as a proxy)[6]
P_{ON}	=	Rated input power (= 76,000 Btu/hr, which is conservative)

The standby loses are solved for below:

$Q_{STANDBY}$ = 3.319 Btu/hr-°F * (125°F - 65°F) * [24 – ((133 therms /(0.90 * 76,000 Btu/hr) * (365 days/year /100,000 Btu/therm)]

Combining Q_{USAGE} and $Q_{STANDBY}$:

$Therms_{MEASURE}$ = 126 Therms/year + 17 Therms/year = 144 Therms/year

The measure savings is the difference in energy used by the baseline case and the efficient case:

$Therms_{SAVED}$ = 198 Therms – 144 Therms = 54 Therms/year

Electrical Energy Savings

The condensing water heaters must be power vented to qualify for a program incentive. Power-vented equipment include an electrical fan to exhaust flue gases, which therefore has a negative electrical impact. As shown in the RFP TRC calculator, the estimated electrical impact of power-vented equipment is 50 kWh and 0.005 kW per year.

Summer Coincident Peak Savings Algorithm

The estimated electrical peak impact of power-vented equipment is 0.0050 kW.

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 12 years)[1]

Lifecycle Energy Savings

Deemed Savings	MMID	Measure Lifecycle Energy Savings	Lifecycle Savings
54 Therms (pre January 1, 2016) 46 Therms (post January 1, 2016)	1986	12	649 Therms (pre January 1, 2016) 550 Therms (post January 1, 2016)
-50 kWh		12	-600 kWh

Assumptions

The electric values (kWh and kW) were reviewed from the supplied RFP calculator, which appeared to reasonably align with expected savings.

Additional Information

- State of Wisconsin Public Service Commission. *Request for Proposals.* July 26, 2011. Issued for Mass Markets Portfolio Residential Energy Efficiency Program Implementation. U.S. Department of Energy, E*nergy Efficiency and Renewable Energy. Residential Water Heater Technical Support Document for the January 17, 2001, Final Rule.* Chapter 10: Consumer Sub Group Analysis. Available online: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/10.pdf.U.S.
- Department of Energy, E*nergy Efficiency and Renewable Energy.* Baseline Results and Methodology of the Consumer Sub-group Analysis for Residential Water Heater Efficiency Standard. Submitted to the U.S. Department of Energy Office of Codes and Standards. October 1998. Available online: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/waterheater_lifecycle_1098.pdf.Electronic Code of Federal Regulations, 430.32. Energy and water conservation standards and their effective dates. Available online: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=87e71213c848dd8dd92b27cdbb6ae10e&rgn=div5&view=text&node=10:3.0.1.4.18&idno=10#10:3.0.1.4.18.3.9.2.LARA Public Service Commission, Department of Licensing and Regulatory Affairs. Michigan Energy Measures Database. 2011. Available online: http://michigan.gov/mpsc/0,1607,7-159-52495_55129---,00.html.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. *Electronic Code of Federal Regulations.* Title 10 Energy, Part 431—Energy Efficiency Program For Certain Commercial and Industrial Equipment. Available online: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr;sid=038e9e4d6f73f1b57c7b090187464e0b;rgn=div5;view=text;node=10%3A3.0.1.4.19;idno=10;cc=ecfr#10:3.0.1.4.19.7.

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3. The water heater set point is assumed to be 125°F. Wisconsin building code 704.06 requires landlords to set water heaters to 125°F: https://docs.legis.wisconsin.gov/statutes/statutes/704/06. Water heater set points typically range between 120°F and 140°F because temperatures below 120 are susceptible to Legionella bacteria (which lead to Legionnaires Disease) and heaters set to temperatures above 140°F can quickly scald users: http://www.nrel.gov/docs/fy12osti/55074.pdf. Additionally, a review of TRMs from geographically similar regions (including Connecticut 2012, Mid-Atlantic v3.0, Illinois v2.0, and Indiana v1.0) found assumed hot water set points between 120 and 130 degrees.
4. U.S. Department of Energy. DHW Scheduler. (The average water main temperature is for all locations measured in Wisconsin, weighted by city population.)
5. U.S. Department of Energy, Energy Efficiency and Renewable Energy. *Residential Water Heater Technical Support Document for the January 17, 2001, Final Rule.* Appendix D-2: Water Heater Analysis Model. Last updated October 17, 2013. Available online: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/water_heater_fr.pdf.
6. PG&E Applied Technology Services Performance Testing and Analysis Unit ATS Report #: 491-08.5, PY2008 Emerging Technologies Program, 2008, page 8. Available online: http://www.etcc-ca.com/sites/default/files/OLD/images/stories/reswhtestreport1.pdf.

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	03/05/2012	Original
02	RSG	02/19/2013	Updated content and format

Water Heater, ≥ 0.82 EF, Tankless, Residential, NG

	Measure Details
Measure Master ID	Water Heater, ≥ 0.82 EF, Tankless, Residential, NG, 2652
Measure Unit	Per Water Heater
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Water Heater
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	Varies by date and sector
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	Varies by date and sector
Water Savings (gal/yr)	0
Effective Useful Life (years)	13[1]
Incremental Cost	$605
Important Comments	

Measure Description

This measure is small tankless water heaters that have an EF of 0.82 or greater and are ENERGY STAR-qualified. To be considered small, water heaters must have an input rating less than or equal to 75,000 Btu/hour. In addition, qualifying tankless water heaters must be whole-house units used for domestic water heating, and must be natural gas fueled.

Residential tankless water heaters are defined as equipment having a nominal input between 50,000 and 200,000 Btu/hour and a rated storage volume of 2 gallons or less.

Description of Baseline Condition

The base case EF for residential, gas-fueled, storage water heaters is 0.575.[2] New federal efficiency standards that take effect in April 2015 raise the minimum EF for baseline units from 0.575 to 0.600. The criteria date was rounded to January 1, 2016 since the code takes affect mid-year 2015.

Description of Efficient Condition

Qualifying tankless water heaters must meet the qualifications listed in the table below.

Qualification Requirements for Tankless Water Heaters

Sector	Input Rating	EF
Multifamily	≤ 75,000 Btu/hour	≥ 0.82
Single Family	≥ 50,000 Btu/hour ≤ 200,000 Btu/hour	≥ 0.82

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Annual Energy-Savings Algorithm

$Therms_{SAVED} = (T_{WH} - T_{ENTERING}) * GPD * 8.33 * 1 * 365 * [(1/EF_{BASE}) - (1/EF_{EFF})] * (1/100,000)$

Where:

T_{WH}	=	Water heater temperature setpoint (= 125°F)[3]
$T_{ENTERING}$	=	Temperature of water entering water heater (= 52.3°F)[4]
GPD	=	Gallons of hot water used by the home (MF = 44.4 gal/day; SF = 51.5 gal/day)[5]
8.33	=	Density of water, lbs/gal
1	=	Specific heat of water, Btu/lb-°F
365	=	Days per year
EF_{BASE}	=	Baseline energy factor (=0.575 for units sold before January 1, 2016, = 0.600 for units sold after January 1, 2016)[6]
EF_{EFF}	=	Efficiency energy factor (= 0.820)
100,000	=	Conversion from Btu to therms

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (MF = 13 years; SF = 20 years)[1]

Deemed Savings

Average Annual Deemed Savings for Natural Gas Tankless Water Heaters

Sector	MMIDs	Annual Therms Savings
Residential - Multifamily	1987 and 2652	51 (before January 1, 2016) 44 (after January 1, 2016)

Average Lifecycle Deemed Savings for Natural Gas Tankless Water Heaters

Sector	MMIDs	Lifecycle Therms Savings
Residential - Multifamily	1987 and 2652	663 (before January 1, 2016) 572 (after January 1, 2016)

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. *ENERGY STAR Residential Water Heaters: Final Criteria Analysis.* April 1, 2008. Available online: http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterAnalysis_Final.pdf.

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3. The water heater set point is assumed to be 125°F. Wisconsin building code 704.06 requires landlords to set water heaters to 125°F: https://docs.legis.wisconsin.gov/statutes/statutes/704/06. Water heater set points typically range between 120°F and 140°F because temperatures below 120 are susceptible to Legionella bacteria (which lead to Legionnaires Disease) and heaters set to temperatures above 140°F can quickly scald users: http://www.nrel.gov/docs/fy12osti/55074.pdf. Most TRMs assume water heater set points of 120°F, 125°F or 130°F, though most of these assumptions are unsourced engineering assumptions. (Residential water heater set points found in TRMs include- Connecticut 2012 PSD: 130°F for gas DWH and 125°F for tank wrap, HPWH and temperature reduction. Mid Atlantic TRM V3.0: 130°F for tank wrap and pipe insulation. Illinois V2.0: 125°F for pipe insulation, gas water heater, HPWH and tank wrap and 120°F for temperature reduction. Indiana V1.0: 130°F for pipe insulation.)
4. United States Department of Energy. *DHW Scheduler*. (average water main temperature for all Wisconsin locations as measured by scheduler and weighted by city population).
5. The gallons per day was calculated by using the linear relationship of y=16.286x + 13, where x is the average number of people per home and y is the average gallons of hot water used per day. An average value of 1.93 people/home was used for Wisconsin multifamily and 2.36 for single family, based on RECS 2009 data. The linear relationship is used in the 2012 Indiana TRM and the 2010 NY TRM.
6. Calculated as 0.67 - 0.0019 * 50 = 0.575, per the 2001 federal standard that took effect in 2004. The new federal standard baseline was adopted in 2010 takes effect in April 2015; this was calculated as 0.675 - 0.0015 * 50 = 0.600. Both calculations assume a 50 gallon tank.
7. United States Department of Energy. R*esidential Heating Products Final Rule Technical Support Document.* Tables 8.2.13-14 and 8.2.16. 2010. Available online: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/htgp_finalrule_ch8.pdf.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/25/2012	New measure
02	Franklin Energy Services	03/08/2013	PI update

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Water Heater, Electric, Energy Factor ≥ 0.93

	Measure Details
Measure Master ID	Water Heater, Electric, EF ≥ 0.93, 1989
Measure Unit	Per Water Heater
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Water Heater
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	103
Peak Demand Reduction (kW)	0.0118
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	1,548
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$25.16
Important Comments	

Measure Description

This measure is the installation of qualified electric water heaters, applicable to any tank-type storage water heater with the following criteria:

- Used for DHW
- Whole-house unit
- Electric-fueled
- Not a heat pump water
- Installed before January 1, 2016

Only participants who have an electric account with a participating electric utility are eligible. Furthermore, natural gas cannot be an available fuel source in the participant's area.

Description of Baseline Condition

The baseline EF or electric water heaters is 0.904, as found in a 2008 ENERGY STAR® criteria analysis of water heaters.[2]

New federal efficiency standards that take effect in April 2015 raise the minimum EF baseline to 0.945 for 50 gallon units, which will render this measure obsolete. The criteria date is advanced to January 1, 2016, because this code takes effect mid-year 2015.

Description of Efficient Condition

The qualifying electric water heaters must meet the requirements in the table.

Type	Input Rating	Required Energy Factor
Electric Storage Water Heater	≤ 40,956 Btu/hour	≥ 0.93

Residential electric storage water heaters are defined as having a nominal input of 40,956 Btu/hour or less and a rated storage volume between 20 gallons and 120 gallons.[2]

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (T_{WH} – T_{ENTERING}) * GPD * 8.33 * 1 * 365 * [(1/EF_{BASE}) – (1/EF_{EFF})] * (1/3,412)$

Where:

T_{WH}	=	Water heater temperature setpoint (= 125°F) [3]
$T_{ENTERING}$	=	Temperature of water entering water heater (= 52.3°F)[4]
GPD	=	Gallons of hot water used by the home (= 51.5 gal/day)[5]
8.33	=	Density of water, lbs/gal
1	=	Specific heat of water, Btu/lb °F
365	=	Days per year, days
EF_{BASE}	=	Baseline EF (= 0.904)[6]
EF_{EFF}	=	Efficiency EF (= 0.930)
3,412	=	Convert Btu to kWh (= 3,412 Btu/kWh)

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = kWh_{SAVED} /8,760 * CF$

Where:

8,760	=	Hours in one year
CF	=	Coincidence factor (= 1)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 15 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. ENERGY STAR Residential Water Heaters: Final Criteria Analysis. April 1, 2008. Available online: http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterAnalysis_Final.pdf.

3. The water heater set point is assumed to be 125°F. Wisconsin building code 704.06 requires landlords to set water heaters to 125°F: https://docs.legis.wisconsin.gov/statutes/statutes/704/06. Water heater set points typically range between 120°F and 140°F because temperatures below 120 are susceptible to Legionella bacteria (which lead to Legionnaires Disease) and heaters set to temperatures above 140°F can quickly scald users: http://www.nrel.gov/docs/fy12osti/55074.pdf. Additionally, a review of TRMs from geographically similar regions (including Connecticut 2012, Mid-Atlantic v3.0, Illinois v2.0, and Indiana v1.0) found assumed hot water set points between 120 and 130 degrees.
4. United States Department of Energy. Domestic Hot Water Scheduler, average water main temperature of all locations measured in Wisconsin by scheduler, weighted by city populations.
5. Calculated by using the linear relationship of y=16.286x + 13, where x is the average number of people per home and y is the average gallons of hot water used per day. An average value of 2.36 people/home was used for Wisconsin, based on RECS 2009 data. The linear relationship is used in the 2012 Indiana TRM and the 2010 NY TRM.
6. Calculated as 0.97-0.00132*50 = 0.904, per 2001 federal standard that took effect in 2004. Assumes average tank size of 50 gallons. United States Department of Energy Final Rule, pg 31. http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/htgp_finalrule_fedreg.pdf.

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	01/01/2013	New measure
02	RSG	02/20/2013	Updated for review and formatting
03	Franklin Energy Services	03/08/2013	PI update

Water Heater, Indirect

	Measure Details
Measure Master ID	Water Heater, Indirect, 95% or greater, 1988
Measure Unit	Per Water Heater
Measure Type	Prescriptive
Measure Group	Domestic Hot Water
Measure Category	Water Heater
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	93
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	1,116
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[1]
Incremental Cost	$204.88[2]
Important Comments	

Measure Description

Indirect water heaters are applicable to any indirectly fueled water heater, and must be paired with a high-efficiency boiler. In addition, qualifying indirect water heaters must be whole-house units that are used for domestic water heating.

Unlike other water heaters, indirect water heaters use a boiler as the heat source. The water heater may also have a direct energy source for non-heating seasons when the boiler is shut off and thus not able to meet the water heating demands.[3]

Description of Baseline Condition

The base case is a residential, gas-fueled, storage water heaters with an EF of 0.575.[4] New federal efficiency standards that take effect in April 2015 raise the minimum EF for baseline units from 0.575 to 0.600. The criteria date was rounded to January 1, 2016 since the code takes affect mid-year 2015.

Description of Efficient Condition

Indirect water heaters must be connected to a boiler with an AFUE of 95% or greater.

Annual Energy-Savings Algorithm

$$Therms_{SAVED} = ((GPD * 365 * 8.33 * 1 * \Delta T_w)/100{,}000) * ((1/RE_{BASE}) - (1/E_{C,EE})) + ((UA_{BASE} / RE_{BASE}) - (UA_{EE} / E_{C,EE})) * (\Delta T_s * 8{,}760)/100{,}000$$

Where:

GPD = Average daily hot water consumption (= 51.5 gallons per day)[5]

365 = Days per year

8.33	=	Density of water (lb/gallon)
1	=	Specific heat of water (Btu/lb °F)
ΔT_w	=	Average difference between the cold water inlet temperatures (52.3F) and the hot water delivery temperature (125°F) (= 72.7°F)[6]
100,000	=	Conversion factor (Btu/Therm)
RE_{base}	=	Recovery efficiency of the baseline tank type water heater (= 76%)[7]
$E_{C,EE}$	=	Combustion efficiency of energy-efficient boiler used to heat indirect water heater (= 95%)[8]
UA_{base}	=	Overall heat loss coefficient of base tank type water heater (= 14.0 Btu/hr-°F)[9]
UA_{EE}	=	Overall heat loss coefficient of indirect water heater storage tank (= 6.1 Btu/hr-°F; see table below)[10]
ΔT_s	=	Temperature difference between the stored hot water temperature (125°F) and the ambient indoor temperature (65°F) (= 60°F)
8,760	=	Conversion factor (hours/year)

Typical values for UA_{EE}

Volume (gal)	H (bare tank) inches	Diameter (bare tank) inches	Insulation	UA (Btu/hr-°F)
40	44	17	1 in foam	4.1
			2 in foam	2.1
80	44	24	1 in foam	6.1
			2 in foam	3.1
120	65	24	1 in foam	8.4
			2 in foam	5.4

Summer Coincident Peak Savings Algorithm

Indirect water heaters consume no electrical energy; therefore, they have no impact on demand savings.

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (12 years)[1]

Assumptions

Because the efficiency of residential water heater is measured in EF, the true EF and UA_{BASE} is not available. A thermal efficiency of 76% and a UA_{BASE} of 14 is assumed.

The average difference of 60°F assumes pipe and ambient air temperatures of 125°F and 65°F, respectively.

For UA_{EE}, 80 gallons is slightly above average for a residential installation (typically in the 60-gallon range), and we chose to use 6.1 as the more conservative of the two available estimates at that size.

Sources

1. Wisconsin PSC EUL database 2013.
2. Request for Proposals, issued by Focus on Energy for mass Markets Portfolio Residential Energy Efficiency Program Implementation, July 26, 2011.
3. Public Service Commission of Wisconsin. Focus on Energy Evaluation. *Residential Programs: CY09 Deemed Savings Review.* March 26, 2010.
4. U.S. Department of Energy. Federal standard for residential water heaters effective in 2004.
5. Calculated by using the linear relationship of y=16.286x + 13, where x is the average number of people per home and y is the average gallons of hot water used per day. An average value of 2.361 people/home was used for Wisconsin, based on RECS 2009 data. The linear relationship is used in the 2012 Indiana TRM and the 2010 NY TRM.
6. Public Service Commission of Wisconsin. *Request for Proposals*. Issued for Mass Markets Portfolio Residential Energy Efficiency Program Implementation. July 26, 2011.
7. Most common RE for non-heat pump water heaters: http://www.ahridirectory.org/ahridirectory/pages/rwh/defaultSearch.aspx
8. Assumed the combustion efficiency is a proxy for AFUE, where the program minimum is 95 percent AFUE.
9. United States Department of Energy. Technical Support Document: Energy Efficiency Standards for Consumer Products, Residential Water Heaters, Including Regulatory Impact Analysis. 2000.
10. *New York Technical Reference Manual*. Indirect Water Heaters, pg. 87. 2010.

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	01/01/2012	New measure
02	CLEAResult (previously RSG)	10/30/2014	Updated therms based off 72.7°F for the change in temperature

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HVAC

Gas Furnaces

	Measure Details
Measure Master ID	LP or Oil Furnace with ECM, 90%+ AFUE (Existing), 2023 NG Furnace, 95% AFUE, 3441 NG Furnace with ECM, 95%+ AFUE (Existing), 1981 NG Furnace with ECM, 95+ AFUE (Existing), 3443 NG Furnace with ECM, 97%+ AFUE, 3440 NG Furnace with ECM, 97+ AFUE, Enhanced Rewards, 3442
Measure Unit	Per Furnace
Measure Type	Prescriptive
Measure Group	HVAC
Measure Category	Furnace
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	415 (excluding non-ECM)
Peak Demand Reduction (kW)	0.0792 (excluding non-ECM)
Annual Therm Savings (Therms)	Varies by AFUE and fuel type
Lifecycle Energy Savings (kWh)	9,545 (excluding non-ECM)
Lifecycle Therm Savings (Therms)	Varies by AFUE and fuel type
Water Savings (gal/yr)	0
Effective Useful Life (years)	23[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Conventional gas furnaces produce by-products, such as water vapor and carbon dioxide, which are usually vented out through a chimney along with a considerable amount of heat. This occurs not only when the furnace is in use, but also when it is turned off. Newer designs increase energy efficiency by reducing the amount of heat that escapes and by extracting heat from the flue gas before it is vented. These furnaces use much less energy than conventional furnaces.

Description of Baseline Condition

The current federal furnace standard is a 78% AFUE furnace without an ECM. However, the Residential Rewards Program uses 92% AFUE furnace without an ECM as the baseline due to market trends in Wisconsin,[2] while the Enhanced Rewards Program maintains the 78% AFUE baseline due to income restraints for participating consumers. The measure characteristics were previously based on a 90% AFUE furnace without an ECM for Residential Rewards and a 78% AFUE furnace without an ECM for Enhanced Rewards from 2011 through 2014.

Description of Efficient Condition

The efficient condition varies by measure based on its specific requirements; the measure master name largely explains the efficient condition for each measure. For all measures, the efficient condition pertains to a furnace installed in a residential application and used for space heating only.

Annual Energy-Savings Algorithm

$Therms_{SAVED} = CAP * hours_{HEATING} * (1/\eta_{BASE} - 1/\eta_{EE}) * (1/100)$

$kWh_{SAVED} = kWh_{SAVED\ COOLING} + kWh_{SAVED\ HEATING} + kWh_{SAVED\ CIRC}$

$kWh_{SAVED\ COOLING} = tons * EFLH_{COOLING} * 12\ kBtu/ton * (1/SEER_{BASE} - 1/SEER_{ECM}) * AC\%$

$kWh_{SAVED\ HEATING} = hours_{HEATING} * \Delta kW_{HEAT}$

$kWh_{SAVED\ CIRC} = hours_{CIRC} * \Delta kW_{CIRC}$

Where:

CAP	=	Heating capacity (= 72 MBtu/h)[4]
η_{BASE}	=	78% AFUE for ER and 92% AFUE for RR
η_{EE}	=	95% AFUE or 97% AFUE
$SEER_{BASE}$	=	12[4]
$SEER_{ECM}$	=	13[4]
EER_{BASE}	=	10.5[4]
EER_{ECM}	=	11[4]
CF	=	Coincidence factor (= 68%)[4]
AC%	=	92.5%[4]
$hours_{HEAT}$	=	1,158 hours[4]
ΔkW_{HEAT}	=	0.116 kW[4]
$hours_{CIRC}$	=	1,020 hours[4]
ΔkW_{CIRC}	=	0.207 kW[4]
$EFLH_{COOLING}$	=	410 hours
tons	=	Cooling capacity (=2.425 tons)

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Location	$EFLH_{COOLING}$	Weighting by Participant
Green Bay	344	22%
Lacrosse	323	3%
Madison	395	18%
Milwaukee	457	48%
Wisconsin Average	380	9%
Overall	**410**	

Summer Coincident Peak Savings Algorithm

Peak electrical energy savings for the ECM changed based on the Focus on Energy ECM Study[4] and is deemed as 0.0792 kW/unit.

$kW_{SAVED} = tons * 12\ kBtu/ton * (1/EER_{BASE} - 1/EER_{ECM}) * CF * AC\%$

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 23 years)[1]

Deemed Savings

Type of Savings (Therms)	Measure						
	Enhanced Rewards				Residential Rewards		
	LP/Oil Gas Furnace w/ ECM, 90%+ AFUE, MMID 2023	Natural Gas Furnace, 95%+ AFUE, MMID 3441	Natural Gas Furnace w/ ECM, 95-96.9% AFUE, MMID 3443	Natural Gas Furnace w/ ECM, 97%+ AFUE, MMID 3442	LP/Oil Gas Furnace w/ ECM, 90%+ AFUE, MMID 2023	Natural Gas Furnace w/ ECM, 95-96.9% AFUE, MMID 1981	Natural Gas Furnace w/ ECM, 97%+ AFUE, MMID 3440
Annual	0	191	191	209	0	29	47
Lifecycle	0	4,399	4,399	4,816	0	658	1,074

Type of Savings (kWh)	Measure						
	Enhanced Rewards				Residential Rewards		
	LP/Oil Gas Furnace w/ ECM, 90%+ AFUE, MMID 2023	Natural Gas Furnace, 95%+ AFUE, MMID 3441	Natural Gas Furnace w/ ECM, 95-96.9% AFUE, MMID 3443	Natural Gas Furnace w/ ECM, 97%+ AFUE, MMID 3442	LP/Oil Gas Furnace w/ ECM, 90%+ AFUE, MMID 2023	Natural Gas Furnace w/ ECM, 95-96.9% AFUE, MMID 1981	Natural Gas Furnace w/ ECM, 97%+ AFUE, MMID 3440
Annual	415	0	415	415	415	415	415

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Lifecycle	9,545	0	9,545	9,545	9,545	9,545	9,545

Type of Savings (kW)	Measure						
	Enhanced Rewards				Residential Rewards		
	LP/Oil Gas Furnace w/ ECM, 90%+ AFUE, MMID 2023	Natural Gas Furnace, 95%+ AFUE, MMID 3441	Natural Gas Furnace w/ ECM, 95-96.9% AFUE, MMID 3443	Natural Gas Furnace w/ ECM, 97%+ AFUE, MMID 3442	LP/Oil Gas Furnace w/ ECM, 90%+ AFUE, MMID 2023	Natural Gas Furnace w/ ECM, 95-96.9% AFUE, MMID 1981	Natural Gas Furnace w/ ECM, 97%+ AFUE, MMID 3440
Annual	0.0792	0	0.0792	0.0792	0.0792	0.0792	0.0792

Sources

1. Wisconsin PSC EUL database 2013.
2. Focus on Energy Calendar Year 2013 Baseline Market Study – May 14, 2014. https://focusonenergy.com/sites/default/files/Appendix%20B%20-%20FOC_XC_Deemed_WriteUp_12122013%20(2).pdf
3. Focus on Energy Evaluation. ECM Furnace Impact Assessment Report. Final Report: January 12, 2009. https://focusonenergy.com/sites/default/files/emcfurnaceimpactassessment_evaluationreport.pdf
4. Focus on Energy, Deemed Savings Report October 27, 2014.

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	03/05/2012	Original
02	RSG	11/05/2012	Updated memo
03	RSG	02/20/2013	Review and updates for new formatting
04	CLEAResult (formally RSG)	08/15/2014	New format, changes from 2014 Baseline Study and ECM Study
05	CLEAResult (formally RSG)	09/29/2014	Final results from the 2014 ECM Study
06	CLEAResult (formally RSG)	10/29/2014	Final edits/additions from 2014 Cadmus ECM Study and Deemed Savings Report

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Steam Trap Repair, < 50 psig, General Heating

	Measure Details
Measure Master ID	Steam Trap Repair, < 10 psig, Radiator, 2772
Measure Unit	Per Steam Trap
Measure Type	Prescriptive
Measure Group	HVAC
Measure Category	Steam Trap
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	Varies by measure
Lifecycle Energy Savings (kWh)	0
Lifecycle Therm Savings (Therms)	Varies by measure
Water Savings (gal/yr)	0
Effective Useful Life (years)	5[1]
Incremental Cost	$219.40
Important Comments	

Measure Description

These measures are the repair of a radiator steam trap that is < 10 psig and the repair of general heating steam trap that is < 50 psig.

Steam systems distribute heat from boilers to satisfy space heating requirements. Steam distribution systems contain steam traps, which are automatic valves that remove condensate, air, and other non-condensable gases, while preventing or minimizing steam loss. Steam traps that fail may allow excess steam to escape, thus increasing the amount of steam that must be generated to meet end-use requirements.

All traps are susceptible to wear and dirt contamination and require periodic inspection and maintenance to ensure correct operation. Faulty steam traps (with blocked, leaking, or blow-through) can be diagnosed with ultrasonic, temperature, or conductivity monitoring techniques. Regular steam trap maintenance and faulty steam trap replacement are steps that minimize steam loss. There are four major types of steam traps: 1) thermostatic (including float and thermostatic), 2) mechanical, 3) thermodynamic, and 4) fixed orifice (fixed orifice traps do not qualify for incentives).

Individual steam traps must be failed open to qualify. When mass replacing steam traps, 30% of traps replaced will qualify. Systems on a city steam do not qualify for incentives. Traps can be repaired or replaced.

Description of Baseline Condition

The baseline condition is that a steam trap failed open.

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Description of Efficient Condition

The efficient condition is that the steam trap is operating per design with the same specifications as the baseline.

Annual Energy-Savings Algorithm

The steam leakage rate is calculated using the Napier equation:

$Therms_{SAVED} = [24.24 * (P_1 – P_2) * D^2 * h_{fg} * HOURS * \beta] / (100,000 * \eta)$

Where:

P_1	=	Steam pressure (psig)
P_2	=	Condensate tank pressure (psig)
D	=	Size of steam trap orifice (inches)
h_{fg}	=	Heat of evaporation of water to steam at P_1 (Btu/lb)
HOURS	=	Average annual run hours (hours/year)
β	=	Adjustment factor to account for actual vs. theoretical steam loss (%)
100,000	=	Btu/therm conversion factor
η	=	Combustion efficiency of boiler (%)

Lifecycle Energy-Savings Algorithm

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 5 years)[1]

Assumptions

The following assumptions are true for both types of steam traps (< 50 psig and < 10 psig operating pressure, general heating):

- Average diameter of steam trap orifice (D) = default of 1/4-inch
- HOURS = 5,392 hours/year (based on a WI temp bin analysis – see Appendix B)
- P_2 = 0 psig
- η[1] = 80%
- β[1] = 50%

For steam traps < 50 psig operating pressure, general heating:

- P_1 = 30 psig
- h_{fg} = 929 Btu/lb

For steam traps < 10 psig operating pressure, radiators:

- P_1 = 5 psig
- h_{fg} = 961 Btu/lb

The HOUs for the steam systems were calculated using bin analysis of weather data across Wisconsin and a 55°F balance point on the heating system.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/25/2012	Original draft
02	Franklin Energy Services	03/08/2013	PI update

A/C Split System, ≤ 65 MBh, SEER 14/15/16+

	Measure Details
Measure Master ID	A/C Split System, ≤ 65 MBh SEER 15, 2192 SEER 16+, 2193 SEER 14, 2194
Measure Unit	Per Split System Installed
Measure Type	Prescriptive
Measure Group	HVAC
Measure Category	Rooftop Unit / Split System AC
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	Varies by SEER level
Peak Demand Reduction (kW)	Varies by SEER level
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by SEER level
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[7]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

A split-system air conditioner has a compressor and condenser located outside of the building, and has an evaporator mounted inside the building in an air handler or blower. The system is connected by pipes that cycle refrigerant between the two heat exchangers. Energy savings result from installing a more efficient unit than the market standard. Additional savings are incurred because the unit must be installed with proper RCA. Proper adjustment of the RCA results in more efficient operation. Installation by a qualified contractor and regular servicing are required to maintain proper RCA.

Description of Baseline Condition

A SEER value of 13 is assumed for the baseline unit.[8]

Description of Efficient Condition

The efficient condition is an air conditioning split system ≤ 65 MBh with SEER 14 or greater. Both the condenser and evaporator coils must be replaced. The refrigerant line diameters must meet manufacturer specifications.

The condenser model and serial number, evaporator model and serial number, and AHRI reference number are required for all installations.

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System efficiency is based solely on the evaporator and condenser coils; the SEER may not be increased by factoring in the efficiency of a variable speed forced air heating system fan, except where a two-stage air conditioner is installed.

All efficiency ratings will be verified using the AHRI database.[2]

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (CAP / 1,000) * (1 / SEER_{BASE} – 1 / SEER_{EE}) * EFLH_c$

Where:

CAP = Rated cooling capacity of the energy-efficient unit (= 29,100 in BtuHcool)[4]

1,000 = Kilowatt conversion factor

$SEER_{BASE}$ = Seasonal efficiency rating of the baseline unit (= 13)

$SEER_{EE}$ = Seasonal efficiency rating of the energy-efficiency unit (= 14, 15, or 16)

$EFLH_c$ = Equivalent full load hours for the cooling season (Wisconsin Average= 380)[6]

Supporting Inputs for Load Hours in Several Wisconsin Cities[2]

Location	$EFLH_{cooling}$
Green Bay	344
La Crosse	323
Madison	395
Milwaukee	457
Wisconsin Average	**380**

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (CAP / 1,000) * (1 / EER_{BASE} – 1 / EER_{EE}) * CF$

Where:

CF = Coincidence factor (= 0.66)[5]

EER_{EE} = 11.7 for 14 SEER, 12.2 for 15 SEER, and 12.7 for 16 SEER

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 18 years)[7]

Deemed Savings

SEER	MMID	Annual kWh Savings	kW Savings	Lifecycle kWh Savings
14	2194	60.7	0.104	1,093
15	2192	113.3	0.172	2,040
16+	2193	159.4	0.234	2,869

Assumptions

For the typical cooling capacity (size) of the unit, 2.425 tons was used.[3] This is equivalent to 29,100 Btu/hour (12,000 Btu/hour is equivalent to 1 ton).

Additional savings incurred from proper adjustment of the RCA is highly variable, and was unaccounted for in the savings algorithm.

Sources

1. Appliance Standards Awareness Project. “Central Air Conditioners and Heat Pumps.” Available online: http://www.appliance-standards.org/product/central-air-conditioners-and-heat-pumps.
2. Air-Conditioning, Heating, and Refrigeration Institute. “Directory of Certified Product Performance.” Last updated 2013. Available online: www.ahridirectory.org.
3. Focus on Energy Evaluation, Residential Programs: CY09 Deemed Savings Review. March 26, 2010.
4. Morgan Marketing Partners. *Michigan Energy Measures Database*. Details online: http://www.michigan.gov/mpsc/0,1607,7-159-52495_55129---,00.html.
5. http://www.dnrec.delaware.gov/energy/information/otherinfo/Documents/EM-and-V-guidance-documents/DELAWARE_TRM_August%202012.pdf.
6. Several Cadmus metering studies show EFLH in the ENERGY STAR calculator are over-estimated by 30% for cooling. The cooling EFLH values used are adjusted by population-weighted CDD TMY-3 values.
7. Wisconsin PSC EUL database, 2013. See Appendix C.
8. Federal minimum efficiency standard.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	10/25/2012	Initial draft
02	Franklin Energy Services	03/08/2013	Edits by PI

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Joint Furnace & Central AC with ECM Motor

	Measure Details
Measure Master ID	Furnace and A/C, ECM, 95%+ AFUE, ≥ 16 SEER, 2990 Furnace and A/C, ECM, 95% + AFUE, ≥ 16 SEER, Enhanced Rewards, 3569
Measure Unit	Per System
Measure Type	Prescriptive
Measure Group	HVAC
Measure Category	Other
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	518
Peak Demand Reduction (kW)	0.277
Annual Therm Savings (Therms)	Varies
Lifecycle Energy Savings (kWh)	11,904
Lifecycle Therm Savings (Therms)	Varies
Water Savings (gal/yr)	0
Effective Useful Life (years)	23[1]
Incremental Cost	$1,451.66 for Residential Rewards[2] $2,238.73 for Enhanced Rewards[2]
Important Comments	

Measure Description

This is the joint measures of a high-efficiency furnace with an electronically commutated motor (ECM) and a central air conditioner.

Description of Baseline Condition[2]

The baseline condition is a 92%[3] annual fuel utilization efficiency (AFUE) natural gas furnace without ECM and a 13 seasonal energy efficiency ratio (SEER) central air conditioner for Residential Rewards and a 78% AFUE natural gas furnace without ECM and a 13 SEER central air conditioner for Enhanced Rewards.

Description of Efficient Condition

The efficient condition is a 95% AFUE natural gas furnace with ECM and a 16 SEER central AC.

Annual Energy-Savings Algorithm

$Therms_{SAVED} = CAP * HOURS_{HEAT} * (1/ AFUE_{BASE} - 1/AFUE_{EE}) * (1/100)$

$kWh_{SAVED} = kWh_{SAVED\ COOLING} + kWh_{SAVED\ HEATING} + kWh_{SAVED\ CIRC}$

$kWh_{SAVED\ COOLING} = tons * EFLH_{COOLING} * 12\ kBtu/ton * (1/SEER_{BASE} - 1/SEER_{EE})$

$kWh_{SAVED\ HEATING} = HOURS_{HEAT} * kW_{SAVED\ HEAT}$

$kWh_{SAVED\ CIRC} = HOURS_{CIRC} * kW_{SAVED\ CIRC}$

Where:

CAP	=	Heating capacity (= 72 MBtu/h)[3]
$HOURS_{HEAT}$	=	Hours of heating operation (= 1,158 hours)[3]
$AFUE_{BASE}$	=	Efficiency rating of standard efficiency furnace, deemed (= 78% AFUE for ER, = 92% AFUE for RR)
$AFUE_{EE}$	=	Efficiency rating of efficient furnace, deemed (= 95% AFUE or 97% AFUE)
$kWh_{SAVED\ COOLING}$	=	kWh saved from AC with ECM (=173: see algorithm)
$kWh_{SAVED\ HEATING}$	=	kWh saved in heating mode, deemed (= 134)[3]
$kWh_{SAVED\ CIRC}$	=	kWh saved in heating mode, deemed (= 211)[3]
tons	=	Cooling capacity (= 2.425 tons)[3]
$EFLH_{COOLING}$	=	Effective full load cooling hours (= 410)[3]
$SEER_{BASE}$	=	Federal minimum seasonal energy efficiency ratio (= 13)
$SEER_{EE}$	=	Efficient measure seasonal energy efficiency ratio (= 16)
$kW_{SAVED\ HEAT}$	=	Average power saved in heating mode (= 0.116 kW)[3]
$HOURS_{CIRC}$	=	Circulation hours of operation (= 1,020 hours)[3]
$kW_{SAVED\ CIRC}$	=	Average power saved in circulation mode (= 0.207 kW)[3]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = tons * 12\ kBtu/ton * (1/EER_{BASE} – 1/EER_{ECM}) * CF$

Where:

CF	=	Coincidence factor (= 68%)[3]
EER_{BASE}	=	Baseline energy efficiency ratio (= 11.0)[5]
EER_{ECM}	=	Efficient measure energy efficiency ratio (= 13)[5]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (=23 years)[1]

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Deemed Savings

Program	MMID	Annual Electric Energy Savings (kWh/yr)	Peak Demand Savings (kW)	Lifecycle Electric Energy Savings (kWh)	Annual Gas Savings (therms/yr)	Lifecycle Gas Savings (therms)
Enhanced Rewards	3569	518	0.277	11,904	191	4,399
Residential Rewards	2990	518	0.277	11,904	29	658

Assumptions

- The current federal furnace standard is a 78 percent annual fuel utilization efficiency (AFUE) furnace without an electronically commutated motor (ECM). However, the Residential Rewards Program uses 92 percent AFUE furnace without an ECM as the baseline due to market trends in Wisconsin, while the Enhanced Rewards Program maintains the 78 percent AFUE baseline due to income restraints for participating consumers.

- Electrical energy savings for the ECM were established in a State of Wisconsin Department of Administration Division of Energy Impact Assessment Report, and later revised in a 2009 Impact Assessment Report to be 733 kWh/furnace[7]. Upon receiving feedback from Cadmus, the ECM electric savings were adjusted downward to 500 kWh/furnace in 2012. The ECM savings were revised in 2014 to 415 kWh/furnace for the 2015 program year.

- Review of AHRI ratings found that 76% of 16 SEER combinations have an EER rating of 13 or higher. This seems consistent with Federal Tax credits given to 13 EER / 16 SEER equipment in 2006, 2007, 2009 – 2013.

- Per Cadmus - Review of AHRI combination ratings found EER rating is approximately 2 less than SEER[6]. This is very close to the DOE guideline of EER = -0.02 x SEER^2 + 1.12 x SEER (http://www.nrel.gov/docs/fy11osti/49246.pdf), obtained using an equation first proposed in *Wassmer, M. (2003). A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. Masters Thesis, University of Colorado at Boulder*.

Supporting inputs for load hours in several Wisconsin cities are shown in the table below.

Location	$EFLH_{COOLING}$	Weighting by Participant
Green Bay	344	22%
La Crosse	323	3%
Madison	395	18%
Milwaukee	457	48%
Wisconsin Average	380	9%
Overall	**410**	

Sources

1. Wisconsin PSC EUL database 2013. All NG furnaces in database have a measure life of 23 years.
2. Incremental costs based on Fall 2014 review of Residential Prescriptive trade allies. IMCs are different for the two programs because the measures use different baselines.
3. Focus on Energy Calendar Year 2013 Baseline Market Study – May 14, 2014 https://focusonenergy.com/sites/default/files/Appendix%20B%20-%20FOC_XC_Deemed_WriteUp_12122013%20(2).pdf
4. Average furnace size of 13,000 furnaces in the 2012 SPECTRUM Focus Prescriptive Database
5. Focus on Energy Evaluation, Residential Programs: CY09 Deemed Savings Review. March 26, 2010 https://focusonenergy.com/sites/default/files/cy09residentialdeemedsavingsreview_evaluationreport.pdf
6. Focus on Energy Evaluated Deemed Savings Changes. November 14, 2014. https://focusonenergy.com/sites/default/files/FoE_Deemed_WriteUp%20CY14%20Final.pdf
7. Focus on Energy Evaluation. ECM Furnace Impact Assessment Report. Final Report: January 12, 2009

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	11/06/2012	Original
02	RSG	01/17/2013	Added supplement information
03	RSG	02/19/2013	Updated based on evaluation comments
04	CLEAResult (formally RSG)	08/15/2014	Updated with new format and results from the 2014 – published Baseline Study and ECM Study
05	CLEAResult (formally RSG)	10/31/2014	Final results from the 2014 ECM Study and Deemed Savings Report
06	CLEAResult (formally RSG)	01/12/2015	Updated EER based on AHRI database information

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Laundry

ENERGY STAR Multifamily Common Area Clothes Washers

	Measure Details
Measure Master ID	ENERGY STAR Clothes Washer Common Area Electric Water Heater, 2756 Common Area Gas Water Heater, 2757
Measure Unit	Per Clothes Washer
Measure Type	Prescriptive
Measure Group	Laundry
Measure Category	Clothes Washer
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	Varies by measure
Peak Demand Reduction (kW)	Varies by measure
Annual Therm Savings (Therms)	Varies by measure
Lifecycle Energy Savings (kWh)	Varies by measure
Lifecycle Therm Savings (Therms)	Varies by measure
Water Savings (gal/yr)	13,978
Effective Useful Life (years)	14[1]
Incremental Cost	$325.40
Important Comments	

Measure Description

ENERGY STAR is a standard for energy-efficient consumer appliances. This standard increases savings for clothes washers in multifamily buildings are derived from factors such as hot water fuel, dryer type, and location (in-unit or common area).

This measure describes clothes washers in common areas. For washers installed in individual units of a multifamily building, see the residential single-family clothes washer measure.

Description of Baseline Condition

The baseline condition is a non-ENERGY STAR commercial clothes washer.

Description of Efficient Condition

The efficient condition is an ENERGY STAR commercial clothes washer.

Annual Energy-Savings Algorithm

Clothes washer with electric DHW:

$kWh_{SAVED} = [\Delta kWh(EG) * \%EG + \Delta kWh(EE) * \%EE + \Delta kWh(EnD) * \%EnD] * Cycles/year$

$Therms_{SAVED} = [\Delta Therm(EG) * \%EG] * Cycles/year$

Clothes washer with gas DHW:

kWh_{SAVED} = [ΔkWh(GE) * %GE + ΔkWh(GG) * %GG + ΔkWh(GnD) * %GnD] * Cycles/year

$Therms_{SAVED}$ = [ΔTherm(GG) * %GG + ΔTherm(GE) * %GE + ΔTherm(GnD) * %GnD] * Cycles/year

Where:

Mix of dryers for clothes washers with electric DHW[2]

EG = Electric DHW/gas dryer (= 8.0%)

EE = Electric DHW/electric dryer (= 92.0%)

EnD = Electric DHW/no dryer (= 0.0%)

Cycles/year = Wash cycles/year (= 1,241)[2]

Mix of dryers for clothes washers with gas DHW[2]

GG = Gas DHW/gas dryer (= 26.5%)

GE = Gas DHW/electric dryer (= 74.5%)

Gnd = Gas DHW/no dryer (=0.0%)

Cycles/year = Wash cycles/year (= 1,241)[2]

Electric and gas savings for mixes of dryer and DHW types[1]

ΔkWh(GE) = Electric savings per cycle in kWh (= 1.45)

ΔkWh(EG) = Electric savings per cycle in kWh (= 0.25)

ΔkWh(EE) = Electric savings per cycle in kWh (= 1.70)

ΔkWh(EnD) = Electric savings per cycle in kWh (=1.70)

ΔTherm(GG) = Gas savings per cycle in therms (= 0.066)

ΔTherm(GE) = Gas savings per cycle in therms (= 0.011)

ΔTherm(EG) = Gas savings per cycle in therms (= 0.055)

ΔTherm(GnD) = Gas Savings per cycle in therms (= 0.011)

Summer Coincident Peak Savings Algorithm

kW_{SAVED} = kWh_{SAVED}/(Cycles/year * Hours/cycle) * CF

Where:

Hours/cycle = 1 (estimated)

CF = Coincidence factor (= 0.045)[3]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE}$ = kWh_{SAVED} * EUL

$Therms_{LIFECYCLE}$ = $Therms_{SAVED}$ * EUL

Where:

EUL = Effective useful life (= 14 years)[1]

Deemed Savings

	CAE (MMID 2756)	CAG (MMID 2757)
Annual Deemed Electricity Savings (kWh)	1,971	1,331
Deemed Summer Peak Electricity Demand Savings (kW)	0.071	0.048
Lifecycle Deemed Electricity Energy Savings (kWh)	27,594	18,634
Annual Deemed Natural Gas Energy Savings (therms)	5.3	31.9
Lifecycle Deemed Natural Gas Energy Savings (Therms)	74.2	446.6
Annual Demand Water Savings (gallons)	13,978	13,978
Lifecycle Deemed Water Savings (gallons)	195,692	195,692

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. CPUC Res Retro HIM Evaluation Report - Weighted by quantity of each efficiency level from MESP Spectrum.
3. RECs Database - Wisconsin Multifamily unit counts.
4. Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 2.0. June 7, 2013, p. 349.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	02/17/2012	Original

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Lighting

Occupancy Sensors – Prescriptive

	Measure Details
Measure Master ID	Occupancy Sensor, Ceiling Mount ≤ 500 Watts, 2471 ≥ 1,001 Watts, 2472 501-Watts to 1,000 Watts, 2473 Occupancy Sensor, Wall Mount ≤ 200 Watts, 2483 > 200 Watts, 2484 Occupancy Sensor, Fixture Mount ≤ 60 Watts, 3561 > 60 Watts, 3560
Measure Unit	Sensor
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Controls
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	Varies by connected wattage
Peak Demand Reduction (kW)	Varies by connected wattage
Annual Thermal Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by connected wattage
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	8[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Occupancy sensors reduce energy consumption by reducing the operating hours for lighting equipment in low occupancy areas such as halls, storage rooms, and restrooms. Occupancy sensors automatically turn lights off a preset time after people leave a space, and turn lights on automatically when movement is detected. Occupancy sensors feature a delay adjustment that determines the time that lights are on after no occupancy is detected, as well as a sensitivity adjustment that determines the magnitude of the signal required to trigger the occupied status.

The two primary technologies used for occupancy sensors are PIR and ultrasonic. PIR sensors determine occupancy by detecting the difference in heat between a body and the background. Ultrasonic sensors detect people using volumetric detectors and broadcast sounds above the range of human hearing, then measure the time it takes the waves to return.

Description of Baseline Condition

The baseline condition is no occupancy sensor, but lighting fixtures being controlled by manual wall switches.

Description of Efficient Condition

The efficient condition is a hard-wired wall- or ceiling-mounted occupancy sensor, where lighting fixtures are controlled by the sensors based on detected occupancy.

Annual Energy-Savings Algorithm

kWh_{SAVED} = Watts / 1,000 * SF * HOU

Where:

Watts	=	Controlled lighting wattage (see values in table below)
1,000	=	Kilowatt conversion factor
SF	=	Savings factor (= 41%)[3]
HOU	=	Hours-of-use (= 5,950)

Summer Coincident Peak Savings Algorithm

The deemed summer peak savings is set to zero. Although occupancy sensors may reduce load during the peak period, most savings will occur during non-peak hours.

kW_{SAVED} = Watts /1,000 * CF

Where:

CF	=	Coincidence factor (= 0)

Deemed Annual and Lifecycle Electricity Savings

Measure Name	MMID	Average Connected Wattage	Annual kWh Savings	Lifecycle kWh Savings
Occupancy Sensor, Ceiling Mount, ≤ 500 Watts	2471	350[5]	854	6,831
Occupancy Sensor, Ceiling Mount, ≥ 1,001 Watts	2472	1,200[5]	2,927	23,419
Occupancy Sensor, Ceiling Mount, 501-1,000 Watts	2473	750[5]	1,830	14,637
Occupancy Sensor, Wall Mount, ≤ 200 Watts	2483	150[5]	366	2,927
Occupancy Sensor, Wall Mount, > 200 Watts	2484	350[5]	854	6,831
Occupancy Sensor, Fixture Mount, ≤ 60 Watts	3561	35[6]	86	686
Occupancy Sensor, Fixture Mount, > 60 Watts	3560	89[6]	217	1,737

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Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 8 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. PA Consulting Group Inc., Public Service Commission of Wisconsin, *Focus on Energy Evaluation, Business Programs: Incremental Cost Study.* Final Report, October 28, 2009.
3. See 'Cost' tab in Excel file Non-High Bay Controls_FES_MESP_10_29_14.xlsx.
4. PA Consulting Group Inc. and Public Service Commission of Wisconsin. *Focus on Energy.*
   11. *Evaluation, Business Programs: Deemed Savings Manual V1.0*. Final Report, Page 4-193 and Table 4-161. March 22, 2010.
5. PA Consulting Group Inc. and Public Service Commission of Wisconsin. *Focus on Energy.*
   12. *Evaluation, Business Programs: Deemed Savings Manual V1.0*. Final Report, Page 4-194 and Table 4-163. March 22, 2010.
6. Average wattage taken from common pin-based CFL fixtures and 4ft linear fluorescent fixtures ≤ 60w and > 60w. List can be found in Excel file *Non-High Bay Controls_FES_MESP_10_29_14.xlsx.*
7. ACES Deemed Savings Desk Review 11/03/10.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/16/2012	New measure
02	Franklin Energy Services	10/29/2014	Updated to include fixture mounted

CFL, Direct Install, 9, 14, 19, or 23 Watts

	Measure Details
Measure Master ID	CFL, Direct Install 9 Watts, 2116 and 2132 14 Watts, 2117 and 2133 19 Watts, 2118 and 2134 23 Watts, 2119 and 2135
Measure Unit	Single, Spiral, Screw-in CFL
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Fluorescent, Compact (CFL)
Sector(s)	Residential-single family Residential- multifamily
Annual Energy Savings (kWh)	Varies by wattage
Peak Demand Reduction (kW)	Varies by wattage
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by wattage
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	6[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

A 9-watt, 14-watt, 19-watt, and 23-watt ENERGY STAR-qualified screw-in CFL is installed by the Program Implementer or a subcontractor of the Program Implementer in place of an incandescent screw-in bulb. Assumptions are based on a direct installation, not a time-of sale-purchase.

Description of Baseline Condition

The baseline equipment is an incandescent or halogen light bulb.

Description of Efficient Condition

The efficient equipment is a standard screw-based CFL lamp installed by the Program Implementer or a subcontractor.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Baseline wattage, see table

$Watts_{EE}$ = Efficient wattage, see table

1,000 = Kilowatt conversion factor

HOU = Hours-of-use, based on 2.27 hrs/day (single family = 829; multifamily = 734)[2]

$Watts_{BASE}$	MMIDs	$Watts_{EFFICIENT}$
72	2119 and 2135	23
53	2118 and 2134	19
43	2117 and 2133	14
29	2116 and 2132	9

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * CF$

Where:

CF = Coincident factor (single family = 0.075; multifamily = 0.055)[3]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 6 years)[1]

Deemed Savings

Single family Savings

$Watts_{EFFICIENT}$	MMID	Annual kWh_{SAVED}	kW_{SAVED}	Lifecycle kWh_{SAVED}
23	2119 and 2135	41	0.0037	244
19	2118 and 2134	28	0.0026	169
14	2117 and 2133	24	0.0022	144
9	2116 and 2132	17	0.0015	99

Multifamily Savings

$Watts_{EFFICIENT}$	MMID	Annual kWh_{SAVED}	kW_{SAVED}	Lifecycle kWh_{SAVED}
23	2119 and 2135	36	0.0030	216
19	2118 and 2134	26	0.0020	156
14	2117 and 2133	21	0.0020	128
9	2116 and 2132	15	0.0010	88

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Cadmus Research. Field Study 2013: Residential Lighting. October 18, 2013.

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3. Cadmus Research. Field Study 2013: Residential Lighting. October 25, 2013.

Revision History

Version Number	Authored by	Date	Description of Change
01	Conservation Services Group	01/01/2012	New measure
02	Conservation Services Group	03/19/2013	Added lifecycle savings
03	Conservation Services Group	04/22/2013	Revisions/corrections
04	CB&I	05/31/2013	Revision to EUL

CFL, Direct Install, 20 Watt

	Measure Details
Measure Master ID	CFL, Direct Install, 20 Watt, 3487
Measure Unit	Single, Spiral, Screw-in CFL 20 Watt
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Fluorescent, Compact (CFL)
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	27
Peak Demand Reduction (kW)	0.0025
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	164
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	6[1]
Incremental ($/unit)	$5.00
Important Comments	

Measure Description

A 20 watt ENERGY STAR-qualified screw-in CFL is (respectively) installed by the Program Implementer or a subcontractor of the Program Implementer in place of an incandescent screw-in bulb. The incremental cost of the CFL compared to the incandescent light bulb is full installed cost. Savings are based on a direct installation, not a time of sale purchase.

Description of Baseline Condition

The baseline equipment is an incandescent 53 watt or 75 watt equivalent light bulb. Savings are evaluated using a baseline wattage of 53 watts for both scenarios.

Description of Efficient Condition

This measure applies to standard screw-based 20 watt CFL lamps.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1,000 * HOU$

Where:

$Watts_{BASE}$ = Baseline wattage (= 53 watts)

$Watts_{EE}$ = Efficient wattage (= 20 watts)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 829 hours/year)[2]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * CF$

Where:

CF = Coincidence factor (= 0.075)[2]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 6 years)[1]

Sources

1. Focus on Energy Prescriptive EUL Database, 2013. See EUL for similar CFL measures in database.
2. Cadmus. Focus on Energy Evaluated Deemed Savings Changes. November 6, 2013.

Revision History

Version Number	Authored by	Date	Description of Change
01	Conservation Services Group	09/10/2014	New Measure – new lighting values

CFL, Direct Install, 13 Watt

	Measure Details
Measure Master ID	CFL, Direct Install, 13 Watt, 2732, 3413
Measure Unit	Single, Spiral, Screw-in CFL 13 Watt
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Fluorescent, Compact (CFL)
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	25
Peak Demand Reduction (kW)	0.0023
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	149
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	6[1]
Incremental Cost	$0.37
Important Comments	

Measure Description

A 13 watt ENERGY STAR-qualified screw-in CFL is (respectively) installed by the Program Implementer or a subcontractor of the Program Implementer in place of an incandescent screw-in bulb. The incremental cost of the CFL compared to the incandescent light bulb is full installed cost. Savings are based on a direct installation, not a time of sale purchase.

Description of Baseline Condition

The baseline equipment is an incandescent 43 watt or 60 watt light bulb. Savings are evaluated using a baseline wattage of 43 watts in both scenarios.

Description of Efficient Condition

This measure applies to standard screw-based 13 watt CFL lamps.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Baseline wattage (= 60 watts)

$Watts_{EE}$ = Efficient wattage (= 13 watts)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 829)[2]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1,000 * CF$

Where:

CF = Coincidence factor (= 0.075)[2]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 6 years)[1]

Sources

1. Focus on Energy Prescriptive EUL Database, 2013
2. Cadmus. Focus on Energy Evaluated Deemed Savings Changes. November 6, 2013.

Revision History

Version Number	Authored by	Date	Description of Change
01	Conservation Services Group	01/03/2014	New measure
02	Conservation Services Group	03/19/2014	Revisions/corrections
03	Conservation Services Group	03/19/2014	Revisions/corrections

CFL Reflector Lamps – Prescriptive

	Measure Details
Measure Master ID	CFL, Reflector Flood Lamps, ≤32 Watts, 2246
Measure Unit	Unit
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Fluorescent, Compact (CFL)
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	45
Peak Demand Reduction (kW)	0.004
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	225
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	5[1]
Incremental Cost	$3.00
Important Comments	

Measure Description

CFLs are designed to replace an incandescent lamp and fit into most existing in-unit light fixtures used for incandescent lamps (E26 base). This measure includes flood-type screw-based CFL lamps. CFLs use less power and have a longer rated life than their incandescent equivalents.

Description of Baseline Condition

The baseline equipment is an incandescent light bulb.

Description of Efficient Condition

The efficient condition is CFL lamps replacing incandescent lamps. The replacement lamp must be screw based, up to 30 watts, and with an integrated reflector.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Watts of baseline measure (Incandescent lamp)

$Watts_{EE}$ = Watts of efficient measure (CFL lamp)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 829)[2]

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Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE})/1{,}000 * CF$

Where:

CF = Coincidence factor (= 0.075)[3]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 5 years)[1]

Assumptions

The savings for this measure were evaluated using a combination of the ENERGY STAR QPL for CFL bulbs and information from the U.S. DOE EERE data book.[4] Baseline and efficient wattage values were determined for a set of lumens bins prescribed by the U.S. DOE in the EERE data book. The overall energy-savings value and an overall demand-reduction value are weighted values determined based on the relative number of qualified products from the ENERGY STAR QPL. A summary of the analysis is shown below.

Lumens Range [L]	$Watts_{BASE}$	$Watts_{EE}$	Energy Savings (kWh)	Demand Reduction (kW)	Weight
420-560	45	12	27	0.002	5%
561-837	65	15	42	0.004	59%
838-1,203	75	21	45	0.004	8%
1,204-1,681	90	23	55	0.005	28%

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Cadmus Research. Field Study 2013: Residential Lighting. October 18, 2013.
3. Cadmus Research. Field Study 2013: Residential Lighting. October 25, 2013.
4. ENERGY STAR. Qualified Product List. October 25, 2013. Available online: https://data.energystar.gov/Government/ENERGY-STAR-Certified-Light-Bulbs/8qjd-zcsy.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	04/16/2012	New measure

CFL, Reflector, 15 Watt, Retail Store Markdown

	Measure Details
Measure Master ID	CFL, Reflector, 15 Watt, Retail Store Markdown, 3552
Measure Unit	Single, Screw-in CFL Reflector Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Fluorescent, Compact (CFL)
Sector(s)	Upstream
Annual Energy Savings (kWh)	51
Peak Demand Reduction (kW)	0.0059
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	404
Lifecycle Therm Savings (Therms)	0
Effective Useful Life (years)	8[1]
Incremental Cost	$4[2]
Important Comments	

Measure Description

This measure is an ENERGY STAR-certified CFL reflector that is purchased through a retail outlet to replace an incandescent bulb. Savings are based on a time-of-sale purchase, for installation in a residential location.

Description of Baseline Condition

The baseline is an incandescent 65-watt reflector. Reflectors are exempt from EISA legislation.[4]

Description of Efficient Condition

The efficient equipment is a standard screw-based 15-watt ENERGY STAR-certified CFL reflector.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * HOU$

Where:

$Watts_{BASE}$ = Power consumption of baseline measure (= 65 watts)

$Watts_{EE}$ = Power consumption of efficient measure (= 15 watts)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 1,011)[2]

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Summer Coincident Peak Savings Algorithm

kW_{SAVED}= ($Watts_{BASE}$ – $Watts_{EE}$) / 1,000 * CF

Where:

CF = Coincidence factor (= 0.1189)[3]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE}$ = kWh_{SAVED} * EUL

Where:

EUL = Effective useful life (= 8 years)[1]

Deemed Savings

CFL Type	MMID	$Watts_{BASE}$	$Watts_{EFFICIENT}$	Annual kWh_{SAVED}	kW_{SAVED}	Lifecycle kWh_{SAVED}
Reflector	3552	65	15	51	0.0059	404

Assumptions

A 65-watt baseline is used based on 2014 Focus on Energy Residential Lighting CFL reflector sales, where 65-watt replacements represented 96% of reflector sales. The table below shows total 2014 reflector sales by baseline wattage.

Baseline Wattage	Total Reflector Units Sold in 2014	Percentage of Total Reflector Sales
50	6,433	1%
65	71,5395	96%
75	2,137	0%
100	19,503	3%
Total	**743,468**	**N/A**

Hours of use is a weighted average of single family residential, multifamily and commercial use. The weighting for these variables are[5]:

- Single Family Weighting, 74.7%
- Multifamily Weighting, 25.3%
- Single Family HOU, 2.27 hours per day
- Multifamily HOU, 2.01 hours per day
- Residential Weighting 93%
- Commercial Weighting 7%
  - Residential HOU Average, 2.20
  - Commercial HOU Average, 10.2
- Single Family Coincidence Factor 7.5%

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- Multifamily Coincidence Factor 5.5%
  - Residential, Averaged, Coincidence Factor 6.99%
  - Commercial Coincidence Factor 77%

Sources

1. Focus on Energy Prescriptive EUL Database, 2013. EUL based on similar measure; CFL, reflector replacing incandescent.
2. Focus on Energy Incremental Cost Database, 2014. Cost assumed the same as measure 2246, CFL, Reflector Lamp.
3. Cadmus. Focus on Energy Evaluated Deemed Savings Changes. November 14, 2014.
4. EISA 2007 legislation. https://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/eisa_2007.pdf
5. Focus on Energy. Deemed Savings Report. November 7, 2014.

Revision History

Version Number	Authored by	Date	Description of Change
01	CLEAResult [previously APT]	12/22/2014	Added incremental cost and source
02	CLEAResult [previously APT]	12/30/2014	Added EISA exemption and source; added baseline wattage assumption and source

CFL, Standard Bulb, Retail Store Markdown

	Measure Details
Measure Master ID	CFL, Standard Bulb 310-749 Lumens, Retail Store Markdown, 3548 750-1,049 Lumens, Retail Store Markdown, 3549 1,050-1,489 Lumens, Retail Store Markdown, 3550 1,490-2,600 Lumens, Retail Store Markdown, 3551
Measure Unit	Single, Spiral, Screw-in CFL
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Fluorescent, Compact (CFL)
Sector(s)	Upstream
Annual Energy Savings (kWh)	Varies by wattage
Peak Demand Reduction (kW)	Varies by wattage
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by wattage
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	8[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

An ENERGY STAR-certified standard screw-in CFL is purchased through a retail outlet in place of an incandescent or halogen screw-in bulb. Assumptions are based on a time-of-sale purchase, for installation in a residential location.

Description of Baseline Condition

The baseline equipment is an incandescent light bulb (standard or EISA compliant halogen). The baseline wattage is determined using the lumens equivalence method in conjunction with the lumen output of the efficient bulb.

Description of Efficient Condition

The efficient measure is a standard ENERGY STAR-certified CFL.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1,000 * HOU$

Where:

$Watts_{BASE}$ = Baseline wattage (see table below for values)

$Watts_{EE}$ = Efficient wattage (see table below for values)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 1,011)[2]

$Watts_{BASE}$	$Watts_{EE}$
29	9
43	13
53	18
72	23

Summer Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE}) / 1,000 * CF$

Where:

CF = Coincidence factor (= 0.1189)[2]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 8 years)[1]

Deemed Savings

MMID	Annual kWh_{SAVED}	kW_{SAVED}	Lifecycle kWh_{SAVED}
3548	20	0.0024	162
3549	30	0.0036	243
3550	35	0.0042	283
3551	50	0.0058	396

Assumptions

Incremental costs by lumen bin:

- CFL Standard Bulb 310-749 Lumens $2.12, Cost assumed the same as measure 2116, CFL 9 Watt
- CFL Standard Bulb 750-1049 Lumens $1.28, Cost assumed the same as measure 2117, CFL 14 Watt
- CFL Standard Bulb 1050-1489 Lumens $1.28, Cost assumed the same as measure 2117, CFL 19 Watt
- CFL Standard Bulb 1490-2600 Lumens $1.94, Cost assumed the same as measure 2118, CFL 23 Watt

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Sources

1. Focus on Energy Prescriptive EUL Database, 2013, Measure ID 2959, CFL Retail Store Markdown.
2. Cadmus. Focus on Energy Evaluated Deemed Savings Changes. November 14, 2014.

Revision History

Version Number	Authored by	Date	Description of Change
01	CLEAResult [previously APT]	12/22/2014	Added incremental costs
02	CLEAResult [previously APT]	12/30/2014	Moved incremental cost details to Assumptions section

LED, Direct Install, 9.5 Watt

	Measure Details
Measure Master ID	LED, Direct Install, 9.5 Watt, 3279
Measure Unit	Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	42
Peak Demand Reduction (kW)	0.0031
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	629
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1] (in unit only)
Incremental Cost	$7.07
Important Comments	

Measure Description

ENERGY STAR-rated LED replacement lamps save energy by reducing the total input wattage of the luminaire as compared to the same luminaire operating with standard wattage incandescent lamps. This measure will provide an energy efficient alternative to using incandescent lamps in several applications.

Description of Baseline Condition

EISA compliant standard 53 watt incandescent, 60 watt incandescent and halogen, 65 watt incandescent, 70 watt halogen, 72 watt halogen, 80 watt halogen lamps can be used as the baseline. An average of 16.67% each of 53 watt incandescent, 60 watt incandescent and halogen, 65 watt incandescent, 70 watt halogen, 72 watt halogen, 80 watt halogen lamps used to generate the baseline usage. Existing lamps above 80 watts will be replaced by CFL lamps and are not part of this measure.

Description of Efficient Condition

An ENERGY STAR-rated LED lamp at 9.5 watts.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = [(Watts_{INCAN} – Watts_{LED})/1,000] * HOU$

Where:

$Watts_{INCAN}$ = Electricity consumption of standard 53, 60, 65, 70, 72, and 80 watt incandescent lamps

$Watts_{LED}$ = Electricity consumption of ENERGY STAR-rated LED lamp with a lumen output rating (= 9.5w)

1,000 = Kilowatt conversion

HOU = Hours-of-use (= 734)[2]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = [(Watts_{INCAN} – Watts_{LED})/1,000] * CF$

Where:

CF = Coincidence factor (= 0.055)[3]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[1]

Deemed Savings

Average Annual Deemed Savings for LED Replacing Incandescent Lamp

Measure	MMID	Existing Building
LED, Direct Install, 9.5 Watt	3279	42 kWh / 0.0031 kW

Average Lifecycle Deemed Savings for LED Replacing Incandescent Lamp

Measure	MMID	Existing Building
LED, Direct Install, 9.5 Watt	3279	629 kWh

Sources

1. Focus on Energy Prescriptive EUL Database, 2013.
2. ACES Deemed Savings Desk Review 11/03/10.
3. ACES: Default Deemed Savings Review Final Report 6/24/08. CF is within range of similar programs including Table 4-1 MF housing (in unit) is 65% to 83%. http://www.coned.com/documents/Con%20Edison%20Callable%20Load%20Study_Final%20Report_5-15-08.pdf

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	11/01/2013	New measure

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LED, Omnidirectional, Retail Store Markdown

	Measure Details
Measure Master ID	LED, Omnidirectional, Retail Store Markdown 310-749 Lumens, 3553 750-1,049 Lumens, 3554 1,050-1,489 Lumens, 3556 1,490-2,600 Lumens, 3557
Measure Unit	Single, Screw-in, or Pin-Based LED Lamp
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Upstream
Annual Energy Savings (kWh)	Varies by light output
Peak Demand Reduction (kW)	Varies by light output
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by light output
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[2]
Incremental Cost	$12.50[4]
Important Comments	

Measure Description

This measure is an ENERGY STAR-certified omnidirectional LED bulb that is purchased through a retail outlet to replace an incandescent or halogen bulb. The assumptions were based on a time-of-sale purchase, for installation in a residential location.

Description of Baseline Condition

The baseline equipment is a general service incandescent light bulb (standard or EISA compliant halogen). The wattage of the baseline bulb is determined by the lumens equivalence method.

Description of Efficient Condition

The efficient equipment is an ENERGY STAR-certified omnidirectional LED bulb. The actual wattage of the installed bulb will be used to evaluate savings.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * HOU$

Where:

$Watts_{BASE}$ = Power consumption of baseline measure, see table

$Watts_{EE}$ = Power consumption of efficient measure, see table

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 1,011)[1]

Lumen Bin	Mean Wattage of Omnidirectional LED Bulbs[3]	EISA Compliant Baseline Wattages[5]
310-749	6.94	29
750-1,049	10.57	43
1,050-1,489	12.93	53
1,490-2,600	17.27	72

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE})/1{,}000 * CF$

Where:

CF = Coincidence factor (= 0.1189)[1]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[2]

Deemed Savings

The deemed savings are calculated using the mean wattage of the omnidirectional bulbs in the approved ENERGY STAR Qualified Product List, available December 5, 2014. The mean wattage values are shown below.

Lumens Bin	MMID	Annual Energy Savings (kWh)	Coincident Peak Demand Savings (kW)
310-749	3553	22	0.0026
750-1,049	3554	33	0.0039
1,050-1,489	3555	41	0.0048
1,490-2,600	3556	55	0.0065

Lumens Bin	MMID	Lifecycle Energy Savings (kWh)
310-749	3553	335
750-1,049	3554	492
1,050-1,489	3555	608
1,490-2,600	3556	830

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Sources

1. Cadmus Research. Focus on Energy Evaluated Deemed Savings Changes. November 14, 2014.
2. Focus on Energy. EUL Database Prescriptive Measures_04.18.2013. April 2013. EUL assumed to be the same as Measure ID 2458, LED, Recessed Downlight, ENERGY STAR.
3. ENERGY STAR Qualified Products List. December 5, 2014. Mean wattage of omnidirectional LEDs falling within the specified lumens bin.
4. Focus on Energy Incremental Cost Database, 2014. Cost assumed the same as measure 3385, LED, Non PI Direct Install, 13.5 Watt.
5. Cadmus Research based on EISA 2007 backstop legislation. https://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/eisa_2007.pdf

Revision History

Version Number	Authored by	Date	Description of Change
01	CLEAResult [previously APT]	12/09/2014	Updated lifecycle kWh
02	CLEAResult [previously APT]	12/22/2014	Added incremental cost and source
03	CLEAResult [previously APT]	12/30/2014	Added EISA compliant baselines and source

LED Fixture, Replacing HID, Exterior

	Measure Details
Measure Master ID	LED Fixture, Replacing 70-100 Watt HID Exterior, 3108 LED Fixture, Replacing 150-175 Watt HID, Exterior, 3099 LED Fixture, Replacing 250 Watt HID, Exterior, 3102 LED Fixture, Replacing 320 Watt HID, Exterior, 3105 LED Fixture, Replacing 400 Watt HID, Exterior, 3107
Measure Unit	Per Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	Varies by baseline
Peak Demand Reduction (kW)	0
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by baseline
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	11[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Exterior LED fixtures are an energy-saving alternative to traditional standard wattage HID light sources that have been used for the same applications. LED light sources can be applied in almost every common application type where HID light sources are currently found.

Description of Baseline Condition

The baseline condition is standard HID lamps between 70 watts and 400 watts.[2]

Description of Efficient Condition

The efficient condition is LED fixtures that meet program requirements. Replacements must be complete fixtures with a total power reduction of 40% or more. Lamp-only replacements are not eligible for an incentive. LEDs must be on the qualifying list for the Design Lights Consortium.[3]

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE})/1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Wattage of standard HID fixture (= varies by measure)

$Watts_{EE}$ = Wattage of LED fixture (= varies by measure)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 4,380)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 12 years)[1]

Deemed Savings

Average Annual Deemed Savings for Exterior LED Fixtures

Measure	MMID	kWh
LED Fixture, Replacing 70-100-watt HID Exterior	3108	317
LED Fixture, Replacing 150- 175-watt HID, Exterior	3099	534
LED Fixture, Replacing 250 Watt HID, Exterior	3102	808
LED Fixture, Replacing 320 Watt HID, Exterior	3105	820
LED Fixture, Replacing 400 Watt HID, Exterior	3107	1,123

Average Lifecycle Deemed Savings for Exterior LED Fixtures

Measure	MMID	kWh
LED Fixture, Replacing 70- 100-watt HID, Exterior	3108	3,804
LED Fixture, Replacing 150-watt t 175-watt HID, Exterior	3099	6,408
LED Fixture, Replacing 250-watt , Exterior	3102	9,696
LED Fixture, Replacing 320-watt HID, Exterior	3105	9,840
LED Fixture, Replacing 400-watt HID, Exterior	3107	13,476

Assumptions

Calculations are based on exterior lighting that operates 4,380 hours annually, dusk to dawn. LED lamps can achieve a 40% reduction in power requirements.

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Based on market research.
3. Design Lights Consortium Qualified Parts List.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/28/2012	New measure

Exterior/Parking LED Fixtures

	Measure Details
Measure Master ID	LED Fixture, Replacing 150-175 Watt HID, Parking Garage 24 Hour, 3100 Dusk to Dawn, 3101 LED Fixture, Replacing 250 Watt HID, Parking Garage 24 Hour, 3103 Dusk to Dawn, 3104 LED Fixture, Replacing 70-100 Watt HID, Parking Garage 24 Hour, 3109 Dusk to Dawn, 3110 LED Fixture, Replacing 320 Watt HID, Parking Garage, 3056
Measure Unit	Fixture
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Residential- multifamily
Annual Energy Savings (kWh)	Varies by measure
Peak Demand Reduction (kW)	Varies by measure
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by measure
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12[1]
Incremental Cost	Varies by measure, see Appendix D
Important Comments	

Measure Description

Parking garage and exterior LED fixtures are an energy-saving alternative to traditional standard wattage HID light sources used for the same applications. LED light sources can be applied in almost every common application type where HID light sources are currently found.

Description of Baseline Condition

The baseline is standard HID lamps between 70 watts and 400 watts.

Description of Efficient Condition

Replacements must be complete fixtures with a total power reduction of 40% or more. Lamp-only replacements are not eligible for incentive. LEDs must be on the Design Lights Consortium qualifying list.[2]

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) * HOU / 1,000$

Where:

$Watts_{BASE}$ = Annual electricity consumption of baseline measure (standard HID fixture)

$Watts_{EE}$ = Annual electricity consumption of efficient measure (LED fixture)[2]

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 4,380 for exterior lights, = 4,380 or 8,760 for garage lights)

Baseline HID Lamps	$Watts_{BASE}$
70-watt to 100-watt HID replacement	70-watt HID: 94 watts 100-watt HID: 129 watts
150-watt HID replacement	150-watt HID: 179 watts
175-watt HID replacement	175-watt HID: 210 watts
250-watt HID replacement	250-watt HID: 299 watts
320-watt HID replacement	320-watt HID: 368 watts

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE}-Watts_{EE})/1,000 * CF$

Where:

CF = Coincidence factor (= 0 for exterior lights, = 0 for garage lights or 1 for garage lights)

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 12 years)[1]

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Deemed Savings

Average Annual Deemed Savings for Exterior LED Fixtures

Annual Savings Measure	MMID	kWh
Exterior LED replacing 70-watt to 100-watt HID	3109 (24 Hour); 3110 (Dusk to Dawn)	195
Exterior LED replacing 150-watt to 175-watt HID	3100 (24 Hour); 3101 (Dusk to Dawn)	341
Exterior LED replacing 250-watt HID	3103 (24 Hour); 3104 (Dusk to Dawn)	524
Exterior LED replacing 320-watt HID	3056	645

Average Lifecycle Deemed Savings for Exterior LED Fixtures

Lifecycle Savings Measure	MMID	kWh
Exterior LED replacing 70-watt to 100-watt HID	3109 (24 Hour); 3110 (Dusk to Dawn)	2,344
Exterior LED replacing 150-watt to 175-watt HID	3100 (24 Hour); 3101 (Dusk to Dawn)	4,089
Exterior LED replacing 250-watt HID	3103 (24 Hour); 3104 (Dusk to Dawn)	6,286
Exterior LED replacing 320-watt HID	3056	7,737

Average Annual Deemed Savings for Parking LED Fixtures

Measure (hours)	MMID	kWh	kW
Parking LED replacing 70-watt to 100-watt (8,760)	3109	391	0.045
Parking LED replacing 70-watt to 100-watt (4,380)	3110	195	0
Parking LED replacing 150-watt to 175-watt (8,760)	3100	682	0.078
Parking LED replacing 150-watt to 175-watt (4,380)	3101	341	0
Parking LED replacing 250-watt (8,760)	3103	1,048	0.120
Parking LED replacing 250-watt (4,380)	3104	524	0

Average Lifecycle Deemed Savings for Parking LED Fixtures

Measure (hours)	MMID	kWh
Parking LED replacing 70-watt to 100-watt (8,760)	3109	4,688
Parking LED replacing 70-watt to 100-watt (4,380)	3110	2,344
Parking LED replacing 150-watt to 175-watt (8,760)	3100	8,178
Parking LED replacing 150-watt to 175-watt (4,380)	3101	4,089
Parking LED replacing 250-watt (8,760)	3103	12,572
Parking LED replacing 250-watt (4,380)	3104	6,286

Assumptions

4,380 and 8,760 hours of annual operation were used for parking garage calculations

4,380 hours of annual operation were used for exterior lighting calculations, with dusk to dawn operation. A load factor of 1.0 was used for both parking garage and exterior lighting calculations.

It was assumed that LED lamps are capable of achieving a 40% reduction in power requirements.[2]

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Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C, similar measures MMIDs 2697-2698.
2. Design Lights Consortium Qualified Parts List; http://www.designlights.org/.

Revision History

Version Number	Authored by	Date	Description of Change
01	Franklin Energy Services	12/28/2012	New measure

LED, Direct Install, 10 Watt

	Measure Details
Measure Master ID	LED, Direct Install, 10 Watt, 3488
Measure Unit	Single, Spiral, Screw-in LED 10 Watt
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Residential– single family
Annual Energy Savings (kWh)	27
Peak Demand Reduction (kW)	0.0025
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	410
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[2]
Incremental Cost	$12.50
Important Comments	

Measure Description

A 10 watt ENERGY STAR-qualified screw-in LED is (respectively) installed by the Program Implementer or a subcontractor of the Program Implementer in place of an incandescent screw-in bulb. The incremental cost of the LED compared to the incandescent light bulb is full installed cost. Assumptions are based on a direct installation, not a time of sale purchase. Replacement involves a functioning bulb.

Description of Baseline Condition

The baseline equipment is assumed to be an incandescent 43 watt or 60 watt light bulb. The baseline wattage used to calculate savings is 43 watts for both cases.

Description of Efficient Condition

This measure applies to standard screw-based 10 watt LED lamps.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE})/1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Baseline wattage (= 43 watts)

$Watts_{EE}$ = Efficient wattage (= 10 watts)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 829)[1]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE})/1{,}000 * CF$

Where:

CF = Coincidence factor (= 0.075)[1]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)

Sources

1. Cadmus Research. Focus on Energy Evaluated Deemed Savings Changes. November 6, 2013.
2. Focus on Energy. EUL Database Prescriptive Measures_04.18.2013. April 2013.

Revision History

Version Number	Authored by	Date	Description of Change
01	Conservation Services Group	09/10/2014	New measure – new lighting values
02	Conservation Services Group	10/06/2014	Revisions/corrections

LED, Direct Install, 13.5 Watt

	Measure Details
Measure Master ID	LED, Direct Install, 13.5 Watt, 3385, 3479 With Co-pay, 13.5 Watt, 3439
Measure Unit	Single, Spiral, Screw-in LED 13.5 Watt
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	39
Peak Demand Reduction (kW)	0.0035
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	578
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$12.50
Important Comments	

Measure Description

A 13.5watt ENERGY STAR-qualified screw-in LED is (respectively) installed by the Program Implementer or a subcontractor of the Program Implementer in place of an incandescent screw-in bulb. The incremental cost of the LED compared to the incandescent light bulb is full installed cost. Savings are based on a direct installation, not a time of sale purchase.

Description of Baseline Condition

The baseline equipment is an incandescent 43 watt or 60 watt light bulb. Energy savings are evaluated using a baseline wattage of 43 watts.

Description of Efficient Condition

This measure applies to standard screw-based 13.5 watt LED lamps.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} - Watts_{EE})/1{,}000 * HOU$

Where:

$Watts_{BASE}$ = Baseline wattage (= 60 watts)

$Watts_{EE}$ = Efficient wattage (= 13.5 watts)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 829)[2]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE})/1,000 * CF$

Where:

CF = Coincidence factor (= 0.0750)[2]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)

Sources

1. Focus on Energy Prescriptive EUL Database, 2013
2. Cadmus. Focus on Energy Evaluated Deemed Savings Changes. November 6, 2013.

Revision History

Version Number	Authored by	Date	Description of Change
01	Conservation Services Group	01/03/2014	New measure
02	Conservation Services Group	06/17/2014	Added co-pay measure

LED, Reflector, 12 Watt, Retail Store Markdown

	Measure Details
Measure Master ID	LED, Reflector, 12 Watt, Retail Store Markdown, 3557
Measure Unit	Single, Screw-in LED Reflector or Recessed Downlight
Measure Type	Prescriptive
Measure Group	Lighting
Measure Category	Light Emitting Diode (LED)
Sector(s)	Upstream
Annual Energy Savings (kWh)	54
Peak Demand Reduction (kW)	0.0063
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	804
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15[1]
Incremental Cost	$8.08[2]
Important Comments	

Measure Description

This measure is an ENERGY STAR-certified LED reflector or LED recessed downlight that is purchased through a retail outlet to replace an incandescent bulb. The savings are based on a time-of-sale purchase, for installation in a residential location.

Description of Baseline Condition

The baseline is an incandescent 65 watt reflector or downlight. Reflectors are exempt from EISA legislation.[4]

Description of Efficient Condition

The efficient equipment is a standard screw-based 12-watt ENERGY STAR-certified LED reflector or downlight.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (Watts_{BASE} – Watts_{EE}) / 1,000 * HOU$

Where:

$Watts_{BASE}$ = Power consumption of baseline measure (= 65 watts)

$Watts_{EE}$ = Power consumption of efficient measure (= 12 watts)

1,000 = Kilowatt conversion factor

HOU = Hours-of-use (= 1,011)[2]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (Watts_{BASE} - Watts_{EE})/1{,}000 * CF$

Where:

CF = Coincidence factor (= 0.1189)[3]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 15 years)[1]

Deemed Savings

LED Type	MMID	Annual kWh_{SAVED}	kW_{SAVED}	Lifecycle kWh_{SAVED}
Reflector or Downlight	3557	54	0.0063	804

Assumptions

A 65-watt baseline is used based on 2014 Focus on Energy Residential Lighting CFL reflector sales, where 65-watt replacements represented 96% of reflector sales. The table below shows total 2014 reflector sales by baseline wattage.

Baseline Wattage	Total Reflector Units Sold in 2014	Percentage of Total Reflector Sales
50	6,433	1%
65	71,5395	96%
75	2,137	0%
100	19,503	3%
Total	**743,468**	**100%**

Sources

1. Focus on Energy Prescriptive EUL Database, 2013. Assumed to be the same as Measure ID 2453.
2. Focus on Energy Incremental Cost Database, 2014. Cost assumed to be the same as Measure ID 3347.
3. Cadmus. Focus on Energy Evaluated Deemed Savings Changes. November 14, 2014.
4. EISA 2007 legislation. https://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/eisa_2007.pdf

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Revision History

Version Number	Authored by	Date	Description of Change
01	CLEAResult [previously APT]	12/22/2014	Added incremental cost and source
02	CLEAResult [previously APT]	12/30/2014	Added EISA exemption and source; added baseline wattage assumption and source

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Motors and Drives

ECM, Furnace or Air Handler

	Measure Details
Measure Master ID	ECM, Furnace, New or Replacement, 2989
Measure Unit	Per Motor
Measure Type	Prescriptive
Measure Group	Motors and Drives
Measure Category	Motor
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	415
Peak Demand Reduction (kW)	0.0792
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	9,545
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	23[1]
Incremental Cost	$172
Important Comments	Electrical energy savings for the ECM were established in a State of Wisconsin Department of Administration Division of Energy Impact Assessment Report, and later revised in a 2009 Impact Assessment Report, to be 733 kWh[2] Upon receiving feedback from Cadmus, the ECM electric savings were adjusted downward to 500 kWh in 2012. The ECM savings were revised in 2014 to 415 kWh and 0.0792 kW.

Measure Description

Conventional gas furnaces and air handlers contain a PSC blower motor to deliver the treated air to the home. This motor can be replaced with a brushless DC motor, commonly called an ECM, for electrical savings.

Description of Baseline Condition

The baseline is a furnace or air handler with a PSC motor.

Description of Efficient Condition

The efficient condition is an ECM motor replacing a PSC motor in a furnace or air handler.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = \Delta kWh_{COOL} + \Delta kWh_{HEAT} + \Delta kWh_{CIRC}$

$kWh_{COOL} = Tons * EFLH_{COOLING} * 12\ kBTU/ton * (1/SEER_{BASE} - 1/SEER_{ECM}) * \%\ AC$

$kWh_{HEAT} = HOURS_{HEAT} * \Delta kW_{HEAT}$

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$kWh_{CIRC} = HOURS_{CIRC} * \Delta kW_{CIRC}$

Where:

Tons	=	Air conditioner capacity in tons (= 2.425)[3]
$EFLH_{COOLING}$	=	Effective full load cooling hours (see table)[3]
$SEER_{BASE}$	=	Baseline SEER (= 12)[3]
$SEER_{ECM}$	=	Efficient condition SEER (= 13)[3]
% AC	=	Percentage of furnaces with AC (= 92.5 %)[3]
$HOURS_{HEAT}$	=	Hours of heating operation (= 1,158 hours)[3]
ΔkW_{HEAT}	=	Energy savings in heating (= 0.116 kW)[3]
$HOURS_{CIRC}$	=	Hours of fan-only operation (= 1,020)[3]
ΔkW_{CIRC}	=	Energy savings in fan-only (= 0.207 kW)[3]

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = Tons * 12kBtu/ton * (1/EER_{BASE} - 1/EER_{ECM}) * CF * \%AC$

Where:

Tons	=	Air conditioner capacity in tons (= 2.425)[3]
EER_{BASE}	=	Baseline EER (= 10.5)[3]
EER_{ECM}	=	Efficient condition EER (= 11)[3]
CF	=	Coincidence factor (= 68%)[3]
%AC	=	Percentage of furnaces with AC (= 92.5%)[3]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 23 years)[1]

Location	$EFLH_{COOLING}$	Weighting by Participant
Green Bay	344	22%
Lacrosse	323	3%
Madison	395	18%
Milwaukee	457	48%
Wisconsin Average	380	9%
Overall	**410**	

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Focus on Energy Evaluation. ECM Furnace Impact Assessment Report. Final Report: January 12, 2009. https://focusonenergy.com/sites/default/files/emcfurnaceimpactassessment_evaluationreport.pdf
3. Focus on Energy, Deemed Savings Report. November 14, 2014.

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	02/19/2013	Original
02	CLEAResult (formerly RSG)	08/15/2014	New format and results from the 2014 ECM study - draft
03	CLEAResult (formerly RSG)	10/31/2014	Final results from the 2014 ECM study, new format, inputs from Deemed Savings Report

Air Source Heat Pump, ≥ 16 SEER

	Measure Details
Measure Master ID	Air Source Heat Pump, ≥ 16 SEER, 2992
Measure Unit	Unit
Measure Type	Prescriptive
Measure Group	HVAC
Measure Category	Other
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	933
Peak Demand Reduction (kW)	0.2823
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	16,794
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	18[1]
Incremental Cost	$1,274.10[2]
Important Comments	

Measure Description

A residential-sized air source heat pump has an input capacity of ≤ 65,000 Btu/hr. The deemed measure algorithms and associated savings for the air source heat pump have been derived from the use of the Illinois Statewide Technical Reference Manual – Section 5.3.1 Air Source Heat Pumps.[2]

Description of Baseline Condition

The baseline measure is a federal standard baseline air source heat pump with a SEER rating of 13 and a HSPF of 7.7.

Description of Efficient Condition

The efficient measure is a residential sized air source heat pump with a SEER rating of 16 and an HSPF of 8.4.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = ((EFLH_{COOLING} * CAP * (1/SEER_{BASE} – 1/SEER_{EE}))/ 1,000) + ((EFLH_{HEATING} * CAP * (1 / HPSF_{BASE} – 1 / HSPF_{EE})) / 1,000)$

Where:

$EFLH_{COOLING}$ = Effective full load cooling hours (= 321)

CAP = Capacity (= 37,000 Btu/hour)

$SEER_{BASE}$ = Baseline seasonal energy efficiency ratio (= 13)

$SEER_{EE}$ = Efficient measure seasonal energy efficiency ratio (= 16)

1,000 = Kilowatt conversion factor

$EFLH_{HEATING}$ = Effective Full load heating (= 1,909)[3]

$HSPF_{BASE}$ = Baseline heating seasonal performance factor (= 7.7)

$HSPF_{EE}$ = Efficient measure heating seasonal performance factor (= 8.4)

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (CAP * (1/ EER_{BASE} – 1 / EER_{EE})) / 1,000 * CF$

Where:

EER_{BASE} = Baseline energy efficiency ratio (= 11.2)[2]

EER_{EE} = Efficient energy efficiency ratio (= 12.8)[2]

1,000 = Kilowatt conversion factor

CF = Coincidence factor (= 0.68)[4]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (=18 years)[1]

Assumptions

Measure characteristics assume an all-electric heated and cooled home.

The capacity of residential heat pumps is assumed to be 3.1 tons for equipment installed in the Wisconsin market, based on analysis of 75 Air Source Heat Pumps installed between 2013 and 2015 for the Focus on Energy Residential Prescriptive program. At 12,000 Btu/hour per ton, the assumed average capacity is therefore 37,200 Btu/hr.

Supporting inputs for heating load hours in several Wisconsin cities are shown in the table below.

Location	$EFLH_{heating}$[3]
Green Bay	1,852
La Crosse	1,966
Madison	1,934
Milwaukee	1,883
Wisconsin Average	**1,909**

Incremental cost is based on the Illinois TRM reported IMC of $411/ton, multiplied by an installed capacity of 3.1 tons.

Cooling hours are based on the cooling hours for an air conditioner in the Deemed Savings Report[4] adjusted for the larger capacity system (410 hours at 2.425 tons is equivalent to 284 hours at 3.5 tons).

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Illinois Energy Efficiency Statewide Advisory Group. *Illinois Statewide Technical Reference Manual*. February 2014.
3. http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_3/Final_Draft/Illinois_Statewide_TRM_Effective_060114_Version_3%200_021414_Final_Clean.pdf
4. Several Cadmus metering studies show EFLH in the ENERGY STAR calculator are over-estimated by 25%. The heating EFLH are adjusted by population-weighted HDD and TMY-3 values. Focus on Energy. *Technical Reference Manual*. August 15, 2014
5. Focus on Energy, Deemed Savings Report. November 14, 2014.

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	11/06/2012	Original
02	RSG	01/16/2012	Added supplemental information
03	RSG	02/19/2013	Addressed evaluator comments
04	RSG	03/07/2013	Revised for comments
05	CLEAResult (previously RSG)	10/30/2014	Updated based on Cadmus comments

Refrigeration

Refrigerator and Freezer Recycling

	Measure Details
Measure Master ID	Refrigerator Recycling, 2955 Freezer Recycling, 2956
Measure Unit	Per Unit
Measure Type	Prescriptive
Measure Group	Refrigeration
Measure Category	Other
Sector(s)	Residential- single Family
Annual Energy Savings (kWh)	Varies by appliance
Peak Demand Reduction (kW)	Varies by appliance
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	Varies by appliance
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	8[1]
Incremental Cost	$85
Important Comments	

Measure Description

This measure involves removing an operable refrigerator or freezer from service prior to its natural end of life. The average age of a harvested unit is anticipated to be 20+ years. Savings are based on the estimated energy consumption during the remaining life of the unit, per unit characteristics at the time of removal.

Description of Baseline Condition

The baseline is an existing, inefficient unit in working order not being removed from service.

Description of Efficient Condition

The efficient condition is to remove an existing inefficient unit from circulation and send it for recycling.

Annual Energy-Savings Algorithm

The annual energy savings is a deemed value based on EM&V analyses conducted by Cadmus,[2] with adjustments for envisioned 2012-2014 Wisconsin conditions as noted below.

Note that the DP&L study was used for the following reasons:

1. It is relatively recent,
2. It was created for Midwest implementation, and
3. It includes part-use factors and *in situ* effects.

Metric	Refrigerators	Freezers
Unadjusted gross annual kWh savings/unit[3]	1,190	1,283
Allowance for the passage of time between the 2010 DP&L Plan Year and the current 2012-2014 period	x 0.9 factor	x 0.9 factor
Adjusted gross annual kWh savings/unit	1,071	1,155

Summer Coincident Peak Savings Algorithm

kW_{SAVED} = [(kWh savings/unit)/HOURS] * P

Where:

HOURS = Annual operating hours (= 8,760)

P = Peak intensity factor, captures the increase in compressor cycling time in summer peak conditions relative to average annual conditions (= 1.01 for refrigerators, = 1.08 for freezers)[3]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE}$ = kWh_{SAVED}* EUL

Where:

EUL = Effective useful life of replaced refrigerator (= 8 years)[1]

For this technology, eight years is technically the remaining useful life of the equipment; however, for consistency it is represented as the EUL.

Deemed Savings

	Refrigerator (MMID 2955)	Freezer (MMID 2956)
Annual Energy Savings (kWh)	1,071	1,155
Peak Demand Reduction (kW)	0.123	0.142
Lifecycle Energy Savings (kWh)	8,568	9,240

Assumptions

The per-unit deemed energy and demand savings values quantify the early retirement of inefficient refrigerators and freezers. These values should be reviewed and updated every two or three years to quantify expected gradual improvements in the average unit efficiency (i.e., as reflected in lower kWh/unit).

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Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. The Cadmus Group, Inc. EM&V Report for Dayton Power & Light. March 15, 2011.
3. Memo to Michigan Evaluation Working Group from Cadmus RE: Appliance Recycling Measure Savings Study, August 20, 2012.

Revision History

Version Number	Authored by	Date	Description of Change
01	JACO	08/22/2012	Original

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Ground Source Heat Pump, Residential, NG and Electric Backup

	Measure Details
Measure Master ID	Ground Source Heat Pump, Residential, NG and Electric Backup, 2820, 2821
Measure Unit	Per Heat Pump
Measure Type	Prescriptive
Measure Group	Renewable Energy
Measure Category	Geothermal
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	3,999
Peak Demand Reduction (kW)	0.9286
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	71,982
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	18[1]
Incremental Cost	Varies by project
Important Comments	

Measure Description

This measure covers residential-sized geothermal (ground source) heat pump systems in residential applications. Geothermal heat pump systems utilize the earth as a source of heating and cooling through the installation of an exterior underground loop working in combination with an interior heat pump unit. The measure provides sites with a centralized heating and cooling system, similar to that of a standard air source heat pump.

Description of Baseline Condition

The baseline is a 13 SEER air source heat pump. For estimating Therm savings, the calculated results are converted to Btus.

Description of Efficient Condition

A qualifying product must meet a minimum of 15 EER in a closed-loop application. Program will accept applications for open or closed loop systems. Additionally, the procedures followed to install the equipment must conform to the ACCA Standard 5 Quality Installation requirements.

Annual Energy-Savings Algorithm

$$kWh_{SAVED} = (FLH_{COOL} * Btu/h_{COOL} * (1/SEER_{BASE} – 1/(EER_{EE} * 1.02)))/1{,}000 + (FLH_{HEAT} * Btu/h_{HEAT} * (1/HSPF_{BASE} – 1/(COP_{EE} * 3.412)))/1{,}000$$

Where:

FLH_{COOL}	=	Full load hours cooling (= 410 hours)[2]
Btu/h_{COOL}	=	Cooling capacity of equipment (= 40,089 Btu/h)[3]
$SEER_{BASE}$	=	Seasonal energy efficiency ratio (= 13)[4]
EER_{EE}	=	Energy efficiency ratio (= 22.43 kBtu/kWh)[3]
GSER	=	Factor to determine SEER based on its EER (= 1.02)[5]
FLH_{HEAT}	=	Full load hours heating (= 1,890 hours)[2]
Btu/h_{HEAT}	=	Heating capacity of the equipment (= 30,579 Btu/h)[3]
$HSPF_{BASE}$	=	Heating seasonal performance factor (7.7 kBtu/kWh)[4]
COP_{EE}	=	Coefficient of performance (= 4.18)[3]

Summer Coincident Peak Savings Algorithm

The summer coincident peak is defined as the period from 1:00 p.m. to 4:00 p.m. during weekdays from June through August. Using the supplied Wisconsin calculator, the demand savings were calculated with the following algorithms and methodology:

$kW_{SAVED} = (Btu/h_{COOL} * (1/EER_{BASE} – 1/EER_{EE})) / 1{,}000 * CF$

Where:

CF	=	Coincidence factor (= 0.5)[6]
EER_{BASE}	=	Energy efficiency ratio (= 11)[4]

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL	=	Effective useful life (= 18 years)[1]

Assumptions

This system life expectancy is generally constrained by the heat pump exchanger and compressor equipment. The actual ground loop installation itself often has a much longer life expectancy.

Supporting inputs for load hour sin several Wisconsin cities are shown in the table below.[2]

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Location	$EFLH_{cooling}$	$EFLH_{heating}$
Green Bay	344	1,852
La Crosse	323	1,966
Madison	395	1,934
Milwaukee	457	1,883
Wisconsin Average	380	1,909
Weighted Average	**410**	**1,890**

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Several Cadmus metering studies show EFLH in the ENERGY STAR calculator are over-estimated by 30% for cooling. EFLH heating hours for heat pumps are over-estimated by – 25%. The heating and cooling EFLH values used are adjusted by population-weighted CDD and HDD TMY-3 values.
3. Tracking data model look-ups of AHRI certifications.
4. Federal standard.
5. Proposed update to 2011 Pennsylvania TRM.
6. Energy Center of Wisconsin, Update of Geothermal Analysis, August 31, 2009, Pg. 19-21, http://www.ecw.org/ecwresults/249-1.pdf.

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	06/18/2012	Original
02	CLEAResult (previously RSG)	10/06/2014	Changes to format and inputs to match TRM
03	CLEAResult	10/23/2014	Edited EFLH hours based off final Cadmus ECM study
04	CLEAResult	10/30/2014	kWh/kW adjustments; added IMC

Solar Photovoltaic

	Measure Details
Measure Master ID	Solar Photovoltaic, 2819
Measure Unit	Per kWDC Installed
Measure Type	Hybrid
Measure Group	Renewable Energy
Measure Category	Photovoltaics
Sector(s)	Residential- single family
Annual Energy Savings (kWh)	1,121
Peak Demand Reduction (kW)	0.450
Annual Therm Savings (Therms)	0
Lifecycle Energy Savings (kWh)	22,420
Lifecycle Therm Savings (Therms)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	Varies by project
Important Comments	

Measure Description

PV systems generate DC electric current through the photovoltaic effect when exposed to light. The DC power in one or more series of PV modules, called strings, is converted to AC power by an inverter. Inverters can either be classified as string inverters, which are centrally located and combine the output of multiple modules or strings of modules, or can be classified as microinverters, which are installed at the module and convert each module's DC output to AC individually.

AC modules are growing in popularity. They provide AC output without the need for external inverters. Once the output of the PV system is converted into AC current compatible with the local utility grid, the system is interconnected to the residence wiring system.

The total system output is affected by the tilt and azimuth of the modules, module temperature, inverter efficiency, and shading factors. Ideal systems are designed to face south, have minimal shading, have a tilt close to the local latitude, and be installed in a safe area. The most common application is fixed-mounted panels on a south facing rooftop, but other configurations can include ground mounted or pole mounted arrays, and can be in fixed, manual, or automatic sun tracking configurations.

The average installed capacity of residential PV systems in Wisconsin is 4.4 kWDC.

Description of Baseline Condition

The baseline for this measure is having no PV system installed at the home.

Description of Efficient Condition

PV arrays are designed to be installed within 45 degrees of due south, where there is 10% or less shading, they can have a tilt between 10-50 degrees of the local latitude, and they can be installed in a safe area. A central inverter is typically installed in a basement or garage. In some cases, microinverters are used for one or two PV modules, which convert DC to AC power.

Annual Energy-Savings Algorithm

The energy savings for residential PV systems can be calculated using PVWatts, a free online tool developed by NREL. This tool uses TMY2 solar radiation data, combined with user-entered capacity, array type, tilt, azimuth, and derate factor, to calculate hourly AC energy output and annual energy output. The table below summarizes the expected savings per kWDC installed by location. Note that these general calculations do not reflect the actual conditions at any site, but are a general representation of typical PV systems installed in Wisconsin.

System Derate Factor = DerateFactor * (1 - ShadeFactor) * (1 - SnowFactor)

Where:

DerateFactor = Accounts for amount of power lost in DC to AC conversion (= 0.80)

ShadeFactor = Percentage of time system is shaded (= 10 per program rules)

SnowFactor = Percentage of time system in covered in snow (= 2 for 34° tilt)

Reference City	Reference ZIP Code	AC kWh/kWDC Installed Capacity
Milwaukee	53220	1,128
Madison	53706	1,130
Green Bay	54302	1,106
Average		**1,121**

Summer Coincident Peak Savings Algorithm

kW_{SAVED} = Peak Period kWh Product / Peak Period Hours

Reference City	Reference ZIP Code	Peak Hours AC kWh (June, July, August)	kW
Milwaukee	53220	87	0.447
Madison	53706	92	0.469
Green Bay	54302	85	0.434
Average		**88**	**0.450**

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Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 20 years)[1]

Assumptions

Throughout this document, kWDC is used to refer to the nameplate installed capacity of solar at STCs of 25C and 1,000 W/m2 irradiance.

Generation estimates were made in accordance with PV system guidelines[5] or, when available, are Residential Rewards Program-specific data:

- Array azimuth of 183°
- Derate factor of 0.80
- Fixed array (i.e., non-tracking)
- Array tilt of 34°

All results are normalized to installed kWDC capacity and can be scaled to actual installed capacity on a one-to-one basis (e.g., a 2 kW system will produce twice the output and peak demand savings of a 1 kW system).

Sources

1. Wisconsin PSC EUL, database 2013. See Appendix C.
2. Analysis of 2012 Residential Rewards Program data for 79 funded PV systems.
3. State of Wisconsin Public Service Commission. Focus on Energy Evaluation: Standard Calculation Recommendations for Renewable Energy Systems.
4. Lawrence Berkley National Laboratory. *Tracking the Sun VI: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2012.* July 2013. Available online: http://emp.lbl.gov/sites/all/files/lbnl-6350e.pdf.

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	06/18/2012	Original

Solar Thermal

	Measure Details
Measure Master ID	Solar Thermal, Electric, 2905 Solar Thermal, NG, 2906
Measure Unit	Per System
Measure Type	Hybrid
Measure Group	Renewable Energy
Measure Category	Solar Thermal
Sector(s)	Residential- single family, Residential- multifamily
Annual Energy Savings (kWh)	Varies by types of fuel and residence
Peak Demand Reduction (kW)	Varies by types of fuel and residence
Annual Therm Savings (Therms)	Varies by types of fuel and residence
Lifecycle Energy Savings (kWh)	Varies by types of fuel and residence
Lifecycle Therm Savings (Therms)	Varies by types of fuel and residence
Water Savings (gal/yr)	0
Effective Useful Life (years)	20[1]
Incremental Cost	Varies by project
Important Comments	

Measure Description

This measure applies to single-family and multifamily residential SWH systems. SWH systems typically use one or more rooftop thermal collector to capture solar energy and transfer that energy to heat a working fluid, such as water or antifreeze solutions. The systems are typically integrated with a backup water heating system fueled by natural gas or electricity to provide residential DHW. Thermal collectors can also be used to heat swimming pools or be used to provide space heating.[2]

Typical single-family residential SWH systems consist of one or two collectors, a 40- to 80-gallon storage tank, and associated pumps and controllers. Collectors are most commonly flat-plate, though evacuated tube collectors are also available. There are a variety of system types. One type is a closed loop glycol system, which uses an antifreeze solution as a heat transfer medium. Another type is a drainback system, which uses water as a heat transfer medium but (as the name implies) drains the fluid from the collectors when there is no heat being drawn.

In multifamily applications, systems are similar to those for single-family use but on a larger scale. System size can vary widely, depending on the number of housing units served. There is little data available at this time on regional or national applications that are typical for multifamily SWH, but most systems consist of at least six solar collectors and storage tanks of 200 gallons or more.

Solar collectors and packaged systems are tested and rated by the Solar Rating and Certification Corporation. These ratings can provide a useful and consistent benchmark for comparing the performance of different SWH systems.[3]

Description of Baseline Condition

A baseline condition is a residential single-family house or multifamily facility that uses an electric resistive or natural gas fired water heater.

Description of Efficient Condition

The efficient condition is a SWH system that is installed to supplant the use of electricity or natural gas for hot water heating.

Annual Energy-Savings Algorithm

Deemed savings for SWH systems are calculated separately for single-family and multifamily applications using the SAM developed by NREL.

Single-Family Applications

Substantial data are available on the performance of single-family SWH systems. An NREL report provides energy savings for a typical SWH system in every state, including Wisconsin.[4] This archetypal system has the following characteristics, which are consistent with residential SWH systems installed through the programs:

- Azimuth of 180° (true south)
- Collector tilt of 26.5°
- 40-square-foot gross collector area (equivalent to two typical collectors)
- 60-gallon storage tank
- 90% energy factor (electric)
- 60% energy factor (gas)/80% efficiency
- 60 gallons per day (gpd) hot water consumption

Using these parameters in NREL's SAM, annual energy savings for both electric and gas hot water heating fuel scenarios were predicted for locations nationwide.[5] For Madison, Wisconsin, the study reports typical annual energy savings of:

- 1,919 kWh for systems with electric backup hot water heating (solar fraction of 0.53)
- 73 therms for systems with gas backup hot water heating (solar fraction of 0.55)

Note that approximately 68.2% of single-family residences in the East-North Central Census region heat hot water with natural gas and 29.5% heat hot water with electricity.[4]

Multifamily Applications

A typical SWH system was modeled using SAM, using with the following key assumptions and variables:

- 20 residents at 15.6 gallons/person-day for a total daily use of 312 gallons of hot water
- 6 collectors with a total 180-square-foot gross area
- Collectors oriented at 180° (true south) and titled at 43° (latitude)

- 264-gallon storage tank
- 90% EF (electric)
- 60% EF (gas)

The results of the simulation indicate annual savings of:

- 13,060 kWh for systems with electric backup hot water heating
- 669 therms for systems with natural gas backup hot water heating

The savings estimated in both the single-family and multifamily cases should be viewed as general estimates only. Neither estimate includes losses due to shading or sub-optimal system orientation.

Coincident Peak Demand Savings

Accurately calculating peak demand savings due to SWH requires accurate knowledge of hourly hot water heating load profiles for residential customers. At this time, data is not available at that level of granularity, so peak demand savings for SWH systems should be estimated using the method provided in the Standard Calculations document.[6] These calculations assume there is a constant daily hot water heating load for the year and that the SWH system fully offsets use of the baseline hot water heater during summer peaks. This is reasonable because most SWH systems are designed to provide a very high proportion of hot water demand in the summer months. The peak demand savings for electrically backed up SWH systems are:

- 0.4 kW for single-family applications
- 2.1 kW for multifamily applications

Though SWH systems require the use of pumps and/or electronic controls, these loads are generally very small compared to the energy savings and will have a minimal impact on peak demand. These loads are included, however, in annual energy-savings projections.

There are no electrical demand savings associated with SWH systems using natural gas as the backup hot water heating fuel.

As discussed above, a deemed savings approach can be used to perform a preliminary energy-savings calculation for SWH systems, using the approach described above. Where possible, this deemed savings value should be replaced with site-specific system characteristics and modeling using SAM. Deemed energy savings are shown in the following table.

Hot Water Heating Fuel (Baseline)	MMID	Single-Family Annual Energy Savings	Multifamily Annual Energy Savings
Electric	2905	1,919 kWh per year	13,060 kWh per year
Gas	2906	73 Therms per year	669 Therms per year

Summer Coincident Peak Savings Algorithm

The demand savings for SWH systems with electric backup hot water heating can be estimated using the deemed savings values shown in the following table.

Fuel (Baseline)	MMID	Single-Family Demand Savings	Multifamily Demand Savings
Electric	2905	0.4 kW	2.1 kW
Gas	2906	0	0

Lifecycle Energy-Savings Algorithm

$kWh_{LIFECYCLE} = kWh_{SAVED} * EUL$

$Therms_{LIFECYCLE} = Therms_{SAVED} * EUL$

Where:

EUL = Effective useful life (= 20 years)[1]

Sources

1. Wisconsin PSC EUL database, 2013. See Appendix C.
2. Walker, Andy. *Solar Water Heating.* National Institute of Building Science. August 24, 2012. http://www.wbdg.org/resources/swheating.php.
3. Solar Rating & Certification Corporation. Solar Facts – System Ratings. OG-300 Certification of Solar Water Heating Systems. http://www.solar-rating.org/facts/system_ratings.html.
4. Cassard, Hannah, Paul Denholm, and Sean Ong. *Break-even Cost for Residential Solar Water Heating in the United States: Key Drivers and Sensitivities*. National Renewable Energy Laboratory. Feb 2011. http://www.nrel.gov/docs/fy11osti/48986.pdf.
5. National Renewable Energy Laboratory. System Advisor Model. April 5, 2010. Available for download at: https://sam.nrel.gov/.
6. State of Wisconsin Public Service Commission of Wisconsin. *Focus on Energy Evaluation: Standard Calculation Recommendations for Renewable Energy Systems.* Revised January 18, 2011. http://www.focusonenergy.com/sites/default/files/standardcalculationrecommendationsCY10_evaluationreport.pdf.

Revision History

Version Number	Authored by	Date	Description of Change
01	RSG	06/18/2012	Original (single family)
02	Franklin Energy Service	02/17/2012	Original (multifamily)
03	Franklin Energy Service	03/08/2013	PI update (multifamily)
04	Cadmus	10/22/2013	Combined single and multifamily workpapers, updated savings algorithms

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Appendix A: List of Acronyms

AC	Alternating current
AFUE	Annual Fuel Utilization Efficiency
BESS	Bioenvironmental and Structural System
Btu	British thermal units
CDD	Cooling degree day
CEE	Consortium for Energy Efficiency
CFL	Compact fluorescent light bulb
CMH	Ceramic metal halide
COP	Coefficient of performance
DC	Direct current
DHW	Domestic hot water
DLC	Design Lights Consortium
ECM	Electronically commutated motor
ECW	Energy Center of Wisconsin
EER	Energy efficiency ratio
EF	Energy factor
EFLH	Equivalent full load hours
EISA	Energy Independence and Security Act
EM&V	Evaluation, measurement, and verification
EPCA	Energy Policy and Conservation Act
ERV	Energy recovery ventilator
EUL	Expected useful life
FSTC	Food Service Technology Center
HDD	Heating degree day
HESCC	High-efficiency sealed combustion condensing
HESCCM	High-efficiency sealed combustion condensing modulating
HID	high-intensity discharge
HO	High output
HOU	Hours-of-use
HP	High performance
HSPF	Heating Season Performance Factor
IECC	International Energy Conservation Code
IPLV	Integrated part load volume
ISR	In-service rate
kWDC	Direct current kilowatts
LED	Light-emitting diode
NPS	Nominal Pipe Size
NREL	National Renewable Energy Laboratory
PIR	Passive infrared
PRSV	Pre-rinse spray valves
PSC	Public Service Commission of Wisconsin

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	Permanent split capacitor
PSMH	Pulse-start metal halide
PTAC	Packaged terminal air conditioner
PTHP	Packaged terminal heat pump
PV	Photovoltaic
QPL	Qualified Product List
RCA	refrigerant charge and airflow
RFP	Request for proposals
RW	Reduced wattage
SAM	System Advisor Model
SEER	Seasonal energy efficiency ratio
SP	Shaded pole
STC	Standard test conditions
SWH	Solar water heating
TE	Thermal efficiency
TMY	Typical meteorological year
TRC	Total Resource Cost
TRM	Technical Reference Manual
VFD	Variable frequency drive
VHO	Very high output
VSD	Variable speed drive

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Appendix B: Common Variables

Hours-of-Use

Compressed Air

HOU = Average annual run hours (= 5,083)[4]

Commercial/Industrial Lighting

Sector	HOU
Commercial	3,730
Industrial	4,745
Agriculture	4,698
Schools & Government	3,239

Source: State of Wisconsin Public Service Commission. Business Programs Deemed Savings Manual V1.0. Table 3.2 Lighting Hours of Use in Commercial Applications. March 22, 2010.

Multifamily Lighting (Daily HOU for In-Unit Room estimates)

HOU = Average annual run hours (= 5,950 for multifamily common areas)[5]

Room Type	Hours of Use
Bathroom	2.26
Bedroom	1.32
Dining	2.34
Kitchen	2.92
Living Room	2.67
Other (Hall and Office)	0.51

[4] United States Department of Energy Office of Energy Efficiency & Renewable Energy. *United States Industrial Electric Motor Systems Market Opportunities Assessment*. Pg 42. December 2002.

[5] Focus on Energy ACES Deemed Savings Desk Review 11/03/10 Multifamily Applications for Common Areas.

Single Family Residential Lighting (Daily HOU)

Room Type	Hours of Use
Bathroom	1.00
Bedroom	1.62
Dining	3.18
Kitchen	0.65
Living Room	2.17
Other	0.66
Average Daily Use	2.77

Source: Cadmus Research. Memo: "Focus on Energy Residential Single Family Lighting Hours of Use and Peak Coincidence Factor Findings. July 2, 2014.

Retail Lighting

Because retail lighting incentives are covered through retail price markdowns at the store level, the program does not collect participant-specific data on where purchased bulbs will be installed. General figures are calculated using the following weighting assumptions:

- Single Family Weighting, 74.7%[6]
- Multifamily Weighting, 25.3%[7]
- Single Family HOU, 2.27 hours per day[8]
- Multifamily HOU, 2.01 hours per day[9]
- Residential Weighting 93%[10]
- Commercial Weighting 7%[11]
  - Residential HOU Average, 2.20
  - Commercial HOU Average, 10.2[12]
- Single Family Coincidence Factor 7.5%[13]

6 U.S. Census Bureau, 2013 Estimates. Percent of WI Housing Stock that is single family.

7 U.S. Census Bureau, 2013 Estimates. Percent of WI Housing Stock that is multi-family.

8 Cadmus SF light logger study 2013.

9 Cadmus MF light logger study 2013.

10 Cadmus in-store intercept survey 2012.

11 Ibid.

12 Wisconsin 2010 Business Deemed Savings.

13 U.S. Census Bureau, 2013 Estimates. Percent of WI Housing Stock that is single family.

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- Multifamily Coincidence Factor 5.5%[14]
  - Residential, Averaged, Coincidence Factor 6.99%
  - Commercial Coincidence Factor 77%[15]

Average Annual HOU based on weighting metrics outlined above = 1,011

Coincidence Factor based on weighting metrics outline above = 0.1189

Coincidence Factors

Commercial/Industrial/Multifamily Lighting

Sector	CF
Commercial*	0.77
Industrial	0.77
Schools & Government	0.64
Agriculture	0.67
Multifamily Common Area	0.77
In-Residence**	0.055

* Source: Focus on Energy Business Programs Deemed Savings Manual V1.0 March 22, 2010. Table 3.2 Coincidence Factor for Lighting in Commercial Applications.
** Source: Cadmus Research. Field Study 2013: Residential Lighting. October 18, 2013. (The report was based on using CFL bulbs to replace incandescent bulbs. It's believed that LEDs will initially be treated the same as CFLs, so those values were used.)

Multifamily Residential Lighting

Exposure Type	Percent of Lamps	Coincidence Factor	Lower 90% CI	Upper 90% CI
Exposed	41%	2.08%	1.26%	2.90%
Non-Exposed	59%	7.82%	7.58%	8.07%
Overall	**100%**	**5.47%**	**5.11%**	**5.84%**

Source: Cadmus Research. Memo: "Focus on Energy Residential Multifamily Lighting Hours of Use and Peak Coincidence Factor Findings. June 30, 2014.

14 U.S. Census Bureau, 2013 Estimates. Percent of WI Housing Stock that is multi-family.

15 Wisconsin TRM version 26, 2014.

Single Family Residential Lighting

Room Type	Wisconsin CFL Distribution	Mean Peak CF	Average time-on during peak (minutes)
Bathroom	15.4%	10.8%	19.5
Bedroom	17.8%	6.8%	12.2
Kitchen	10.0%	8.8%	15.9
Living Room/Family Room	19.9%	10.0%	18.0
Other	36.9%	4.7%	8.5
Weighted Mean CF		**7.5%**	**13.5**

Source: Cadmus Research. Memo: "Focus on Energy Residential Single Family Lighting Hours of Use and Peak Coincidence Factor Findings. July 2, 2014.

Phased-In EISA 2007 Standards

Phase-in of these standards occurred in savings calculations as new requirements became effective. From 2015 forward, all baselines have been adjusted to meet these standards.

Lumen Output	Typical Wattage: Current Incandescent Technology	EISA Requirements		
		Maximum Wattage	Minimum Lifetime (hours)	Effective Date
1,490-2,600	100	72	1,000	1/1/2012
1,050-1,489	75	53	1,000	1/1/2013
750-1,049	60	43	1,000	1/1/2014
310-749	40	29	1,000	1/1/2014

Effective Full Load Hours

Residential Gas Measures

EFLH = 1,759 hours[16]

Residential Heat Pumps and Split HVAC

Air Sealing, Air Source Heat Pumps, Ground Source Heat Pumps, and Split A/C System.[17]

16 Full load hours for all residential gas measures are estimated from characterization study of Wisconsin homes (Pigg and Nevius, 2000. Online: http://www.doa.state.wi.us/docview.asp?docid=1812) with average furnace size from SPECTRUM database. Wisconsin study found 800 therms consumed by 90% AFUE furnaces (i.e. 720 therms output). With average furnace size of 72,000 Btu (13,000 furnaces from Focus Prescriptive 2012 database) 1,000 full load heating hours are estimated.

17 Full load hours were calculated using an average FLH/Cooling Degree Day from values in Illinois Statewide Technical Reference Manual and applying to Wisconsin Cooling Degree Days.

Location	$EFLH_{cooling}$	$EFLH_{heating}$
Green Bay	344	1,852
La Crosse	323	1,966
Madison	395	1,934
Milwaukee	457	1,883
Wisconsin Average	**380**	**1,909**

Flow Rates

Faucet Aerators

$GPM_{EXISTING}$ = Baseline flow rate in gallons per minute (= 2.2 GPM)[18]

Low Flow Showerheads

$GPM_{EXISTING}$ = Baseline flow rate in gallons per minute (= 2.5 GPM)[19]

Temperature (Water)

Water Heaters, Faucet Aerators and Low-Flow Showerheads

T_{WH} = Water heater temperature setpoint (= 125°F)[20]

$T_{ENTERING}$ = Temperature of water entering water heater (= 52.3°F)[21]

Faucet Aerators (Kitchen)

$T_{POINT\ OF\ USE}$ = Temperature of water at point of use (= 91°F)[22]

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18 Federal minimum at 80 psi

19 Federal minimum at 80 psi

20 The water heater set point is assumed to be 125°F. Wisconsin building code 704.06 requires landlords to set water heaters to 125°F: https://docs.legis.wisconsin.gov/statutes/statutes/704/06. Water heater set points typically range between 120°F and 140°F because temperatures below 120 are susceptible to Legionella bacteria (which lead to Legionnaires Disease) and heaters set to temperatures above 140°F can quickly scald users: http://www.nrel.gov/docs/fy12osti/55074.pdf. Most TRMs assume water heater set points of 120°F, 125°F or 130°F, though most of these assumptions are unsourced engineering assumptions. (Residential water heater set points found in TRMs include- Connecticut 2012 PSD: 130°F for gas DWH and 125°F for tank wrap, HPWH and temperature reduction. Mid Atlantic TRM V3.0: 130°F for tank wrap and pipe insulation. Illinois V2.0: 125°F for pipe insulation, gas water heater, HPWH and tank wrap and 120°F for temperature reduction. Indiana V1.0: 130°F for pipe insulation.)

21 U.S. Department of Energy. *Domestic Hot Water Scheduler.* Average water main temperature of all locations measured in Wisconsin by scheduler, weighted by city populations.

22 Cadmus. Michigan Water Meter Study. 2012.

Faucet Aerators (Bathroom)

$T_{POINT\ OF\ USE}$ = Temperature of water at point of use (= 86°F)[18]

Low-Flow Showerheads

$T_{POINT\ OF\ USE}$ = Temperature of water at point of use (= 101°F)[18]

Outside Air Temperature Bin Analysis

Bin	Max of Bin	Midpoint	GREEN BAY	LA CROSSE	MADISON	MILWAUKEE	MINOCQUA	RICE LAKE	WAUSAU	Average Hours for WI	Note
95 to 100	100	97.5	0	2	0	3	0	0	0	1	
90 to 95	95	92.5	22	51	25	18	22	4	29	24	
85 to 90	90	87.5	62	121	86	59	36	22	91	68	
80 to 85	85	82.5	275	355	339	225	222	213	335	281	
75 to 80	80	77.5	398	445	486	400	397	398	532	437	
70 to 75	75	72.5	445	489	447	497	413	508	420	460	
65 to 70	70	67.5	675	762	723	692	555	693	666	681	
60 to 65	65	62.5	871	746	770	936	852	810	699	812	
55 to 60	60	57.5	647	583	605	545	680	673	502	605	
50 to 55	55	52.5	420	510	470	547	557	541	423	495	Boiler enabled
45 to 50	50	47.5	527	549	618	603	515	557	586	565	Boiler enabled
40 to 45	45	42.5	579	597	510	723	554	477	718	594	Boiler enabled
35 to 40	40	37.5	777	826	905	883	589	632	619	747	Boiler enabled
30 to 35	35	32.5	820	719	741	720	669	675	792	734	Boiler enabled
25 to 29	30	27.5	507	425	396	423	424	366	539	440	Boiler enabled
20 to 25	25	22.5	579	457	439	531	506	365	551	490	Boiler enabled
15 to 20	20	17.5	443	319	353	390	478	420	406	401	Boiler enabled
10 to 15	15	12.5	265	227	212	228	475	367	252	289	Boiler enabled
5 to 10	10	7.5	157	174	117	97	315	296	247	200	Boiler enabled
0 to 5	5	2.5	111	144	152	116	203	286	138	164	Boiler enabled
-5 to 0	0	-2.5	81	106	157	61	136	182	115	120	Boiler enabled
-10 to -5	-5	-7.5	83	109	105	57	90	177	84	101	Boiler enabled
-15 to -10	-10	-12.5	9	23	70	6	40	69	16	33	Boiler enabled
-20 to -15	-15	-17.5	7	9	21	0	24	24	0	12	Boiler enabled
-25 to -20	-20	-22.5	0	6	9	0	8	5	0	4	Boiler enabled
-30 to -25	-25	-27.5	0	6	4	0	0	0	0	1	Boiler enabled
-35 to -30	-30	-32.5	0	0	0	0	0	0	0	0	Boiler enabled
			5365	5206	5279	5385	5583	5439	5486	5392	Boiler enabled total

Heating and Cooling Degree Days

Heating and cooling degree days for residential applications.[23]

[23] Calculated from TMY3 weather files of the seven Wisconsin locations using *ASHRAE Estimation of Degree-Days: Fundamentals*, Chapter 14. Statewide weighted values calculated using 2010 US Census data for Wisconsin.

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Location	HDD	CDD
Milwaukee	7,276	548
Green Bay	7,725	516
Wausau	7,805	654
Madison	7,599	630
La Crosse	7,397	729
Minocqua	8,616	423
Rice Lake	8,552	438
Statewide Weighted	**7,616**	**565**

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Appendix C: Effective Useful Life Table

The prescriptive EUL figures listed in the table below are based on information from CY 2013, and the hybrid and custom EUL figures are based on information from CY 2014. EULs for all measures will be reviewed and updated in CY 2015 and every odd-numbered year thereafter.

Prescriptive Measures by Measure Master ID

MMID	Measure Name	Sector(s)	EUL (years)
48	Fryer, Electric - ENERGY STAR - per frypot	Commercial, Industrial, Agriculture, Schools & Government Residential-multifamily	12
53	Steamer, Electric, 4 pan - ENERGY STAR	Industrial, Agriculture	11
		Commercial, Schools & Government	12
54	Steamer, Electric, 5 pan - ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
72	Vending Machine Controls, occupancy based, on snack machine	Commercial, Industrial, Agriculture, Schools & Government Residential-multifamily	7
123	A/C Split System < 65 MBh SEER 15	Commercial, Industrial, Agriculture, Schools & Government Residential-multifamily	15
124	A/C Split System < 65 MBh SEER 16 or greater	Commercial, Industrial, Agriculture, Schools & Government Residential-multifamily	15
192	Dimmable Ballast and Daylighting Sensor Installed on T8 2L - 4 ft Fixture	Commercial, Industrial, Agriculture, Schools & Government	10
194	In/Outboard Switching and Daylighting Sensor Install on T8 3L - 4 ft Fixture NC	Commercial, Industrial, Agriculture, Schools & Government	10
195	T8 Low Watt Relamp 8 ft - 57 Watts	Commercial, Industrial, Agriculture, Schools & Government Residential-multifamily	7
432	LED Exit Lighting - For specially targeted early replacement only	Commercial, Industrial, Agriculture, Schools & Government Residential-multifamily	8
503	Pre-Rinse Sprayer, Low Flow, Natural Gas - Direct Install	Commercial, Industrial, Agriculture, Schools & Government Residential-multifamily	5
504	Pre-Rinse Sprayer, Low Flow, Electric - Direct Install	Commercial, Industrial, Agriculture, Schools & Government Residential-multifamily	5
621	High volume low speed fans replace box fans, 20 ft. diameter	Agriculture, Schools & Government	14

MMID	Measure Name	Sector(s)	EUL (years)
622	High volume low speed fans replace box fans, 22 ft. diameter	Agriculture, Schools & Government	15
623	High volume low speed fans replace box fans, 24 ft. diameter	Agriculture, Schools & Government	15
624	Steamer, Gas, 5 pan - ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
755	Anti-sweat heater controls, on freezer case with no-heat door	Commercial, Industrial, Agriculture, Schools & Government	12
758	Anti-sweat heater controls, on refrigerated case with standard door	Commercial, Industrial, Agriculture, Schools & Government	12
759	Anti-sweat heater controls, on refrigerated case with low-heat or no-heat doors	Commercial, Industrial, Agriculture, Schools & Government	12
763	ECM replacing shaded-pole motor in refrig/freezer case	Commercial, Industrial, Agriculture, Schools & Government	16
821	Rooftop A/C, <65 MBh, EER = 12.3	Commercial, Industrial, Agriculture, Schools & Government	15
823	Rooftop A/C, <65 MBh, EER = 12.5	Commercial, Industrial, Agriculture, Schools & Government	15
828	Rooftop A/C, <65 MBh, EER = 13.0	Commercial, Industrial, Agriculture, Schools & Government	15
830	Rooftop A/C, 65 to 134 MBh, EER = 11.5	Commercial, Industrial, Agriculture, Schools & Government	15
831	Rooftop A/C, 65 to 134 MBh, EER = 11.6	Commercial, Industrial, Agriculture, Schools & Government	15
833	Rooftop A/C, 65 to 134 MBh, EER = 11.8	Commercial, Industrial, Agriculture, Schools & Government	15
847	Rooftop A/C, 65 to 134 MBh, EER = 13.2	Commercial, Industrial, Agriculture, Schools & Government	15
849	Rooftop A/C, 135 to 239 MBh, EER = 11.6	Commercial, Industrial, Agriculture, Schools & Government	15
850	Rooftop A/C, 135 to 239 MBh, EER = 11.7	Commercial, Industrial, Agriculture, Schools & Government	15
851	Rooftop A/C, 135 to 239 MBh, EER = 11.8	Commercial, Industrial, Agriculture, Schools & Government	15
852	Rooftop A/C, 135 to 239 MBh, EER = 11.9	Commercial, Industrial, Agriculture, Schools & Government	15
858	Rooftop A/C, 135 to 239 MBh, EER = 12.5	Commercial, Industrial, Agriculture, Schools & Government	15
859	Rooftop A/C, 135 to 239 MBh, EER = 12.6	Commercial, Industrial, Agriculture, Schools & Government	15
861	Rooftop A/C, 135 to 239 MBh, EER = 12.8	Commercial, Industrial, Agriculture, Schools & Government	15

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MMID	Measure Name	Sector(s)	EUL (years)
869	Rooftop A/C, 240 to 759 MBh, EER = 11.0	Commercial, Industrial, Agriculture, Schools & Government	15
871	Rooftop A/C, 240 to 759 MBh, EER = 11.2	Commercial, Industrial, Agriculture, Schools & Government	15
872	Rooftop A/C, 240 to 759 MBh, EER = 11.3	Commercial, Industrial, Agriculture, Schools & Government	15
877	Rooftop A/C, 240 to 759 MBh, EER = 11.8	Commercial, Industrial, Agriculture, Schools & Government	15
879	Rooftop A/C, 240 to 759 MBh, EER = 12.0	Commercial, Industrial, Agriculture, Schools & Government	15
897	Vending Machine, ENERGY STAR, Cold Beverage, Not Software Activated	Commercial, Industrial, Agriculture, Schools & Government Residential-multifamily	11
898	Vending Machine, ENERGY STAR, Cold Beverage, Software Activated	Commercial, Industrial, Agriculture, Schools & Government Residential-multifamily	11
954	Boiler, hot water, for space heating (thermal efficiency 85.0%-85.9%)(>300, ≤1,000 MBh input)	Commercial, Industrial, Agriculture, Schools & Government	20
958	Boiler, hot water, for space heating (thermal efficiency 89.0%-89.9%)(>300, ≤1,000 MBh input)	Commercial, Industrial, Agriculture, Schools & Government	20
963	Boiler, hot water, for space heating (thermal efficiency 94.0%-94.9%)(>300, ≤1,000 MBh input)	Commercial, Industrial, Agriculture, Schools & Government	20
964	Boiler, hot water, for space heating (thermal efficiency 95.0%-95.9%)(>300, ≤1,000 MBh input)	Commercial, Industrial, Agriculture, Schools & Government	20
986	Dishwasher, ENERGY STAR, Low Temp, Gas Heat, Under Counter	Commercial, Industrial, Agriculture, Schools & Government	11
994	Showerhead, ≤1.75gpm, natural gas - direct install	Schools & Government	9
998	Low Flow Faucet Aerators, Direct Install, Natural Gas	Commercial, Residential- multifamily	11
999	Low Flow Faucet Aerators, Direct Install, Electric	Commercial, Residential- multifamily	11
1000	Low Flow Faucet Aerators, Direct Install, Natural Gas	Schools & Government	10
1001	Low Flow Faucet Aerators, Direct Install, Electric	Schools & Government	10

MMID	Measure Name	Sector(s)	EUL (years)
1002	Low Flow Faucet Aerators, Direct Install, Natural Gas, Kitchen	Agriculture, Residential- multifamily	9
		Commercial, Industrial, Schools & Government	8
1003	Low Flow Faucet Aerators, Direct Install, Electric, Kitchen	Commercial, Industrial, Agriculture, Residential- multifamily, Schools & Government	9
1036	Multilevel control for high bay fluorescent fixtures in multi-purpose room	Commercial, Industrial, Agriculture, Schools & Government	10
1096	Rooftop A/C, <65 MBh, SEER = 14.6	Commercial, Industrial, Agriculture, Schools & Government	15
1097	Rooftop A/C, <65 MBh, SEER = 14.7	Commercial, Industrial, Agriculture, Schools & Government	15
1098	Rooftop A/C, <65 MBh, SEER = 14.8	Commercial, Industrial, Agriculture, Schools & Government	15
1102	Vending Machine Controls, sales based on snack machine	Commercial, Industrial, Agriculture, Residential- multifamily, Schools & Government	5
1125	Kitchen Hood Ventilation Controls, Temperature Only, Retrofit, Exhaust Fan Controlled	Commercial, Industrial, Agriculture, Schools & Government	11
1128	Dock Door Infiltration Reduction, new install (none existing)	Commercial, Industrial, Agriculture, Schools & Government	13
1129	Dock Door Infiltration Reduction, replaces existing	Commercial, Industrial, Agriculture, Schools & Government	10
1213	Thermal curtain, 8mm double polycarbonate walls and poly film ceiling, overhead heating, per sq. ft. of floor area	Agriculture, Schools & Government	19
1226	Triple polycarbonate glazing, replacing double pane glass on roof only, per sq. ft. of floor area	Agriculture, Schools & Government	15
1241	Repair leaking steam trap, >225 psig steam	Commercial, Industrial	6
1248	ECM evaporator fan motor replacing shaded-pole motor, ≥1/20 hp, <1hp, in walk-in cooler	Commercial, Industrial, Agriculture, Schools & Government	16
1249	ECM evaporator fan motor replacing PSC motor, ≥1/10 hp, <1 hp, in walk-in cooler	Commercial, Industrial, Agriculture, Schools & Government	16
1251	ECM evaporator fan motor replacing shaded-pole motor, ≥1/20 hp, <1hp, in walk-in freezer	Commercial, Industrial, Agriculture, Schools & Government	16
1257	Agriculture Exhaust Fan, High Efficiency - 51"	Agriculture, Schools & Government	16

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MMID	Measure Name	Sector(s)	EUL (years)
1262	Agriculture Exhaust Fan, High Efficiency - 72"	Agriculture, Schools & Government	16
1263	Repair leaking steam trap, building space conditioning system, ≤15 psig steam	Commercial, Industrial, Agriculture, Schools & Government	8
1301	Vending machine controls, occupancy based, on cold beverage machine	Commercial, Industrial, Agriculture, Residential- multifamily, Schools & Government	10
1303	Vending machine controls, sales based, on cold beverage machine	Commercial, Industrial, Agriculture, Residential- multifamily, Schools & Government	6
1305	Engine Block Heater - Timer	Agriculture	7
1309	CFL ≤ 30 Watts, replacing incandescent	Commercial, Industrial, Agriculture, Residential- multifamily, Schools & Government	6
1310	CFL High Wattage 31-115 Watts, replacing incandescent	Industrial, Agriculture, Schools & Government	8
		Commercial, Residential- multifamily	6
1313	CFL Cold Cathode Screw-In, replacing incandescent	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily	5
1314	CFL reflector flood lamps replacing incandescent reflector flood lamps	Commercial	6
		Agriculture, Residential- multifamily	7
		Industrial, Schools & Government	8
1363	T5 2L - F28T5 Fixture, Recessed Indirect 2x4, replacing 3LT8 or 4LT12	Commercial, Industrial, Agriculture, Schools & Government	15
1364	T8 2L - HPT8 Fixture or Retrofit Module, Recessed Direct or Indirect 2x4, replacing 3L or 4L T8 or T12	Commercial, Industrial, Agriculture, Schools & Government	15
1384	Metal Halide, Pulse Start, 320W replacing 400W probe start HID in wet location	Agriculture	13
1387	Metal Halide, Pulse Start, 320W replacing 400W HID	Commercial, Industrial, Agriculture, Schools & Government	13
1409	PTHP, Standard Efficiency, 8,000 – 9,999 Btuh, ≥9.2 EER, ≥2.69 COP, Retrofit Application	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily	16
1411	PTHP, Standard Efficiency, 10,000-12,999 Btuh, ≥8.77 EER, ≥2.64 COP, Retrofit Application	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily	16
1413	PTHP, Standard Efficiency, ≥13,000 Btuh, ≥8.13 EER, ≥2.56 COP, Retrofit Application	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily	16

MMID	Measure Name	Sector(s)	EUL (years)
1585	Occupancy Sensors - Wall Mount ≤ 200 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	10
1586	Occupancy Sensors - Wall Mount ≥ 201 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	9
1587	Occupancy Sensors - Ceiling Mount ≤ 500 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	9
1588	Occupancy Sensors - Ceiling Mount 501-1,000 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	10
1589	Occupancy Sensors - Ceiling Mount ≥ 1,001 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	10
1592	T8 1L-4 ft Reduced Wattage with CEE Ballast - 25 Watts	Commercial, Industrial, Agriculture, Schools & Government	14
1596	T8 1L-4 ft Reduced Wattage with CEE Ballast - 28 Watts	Commercial, Industrial, Agriculture, Schools & Government	14
1600	T8 1L-4 ft Hi Lumen Lamp with Low BF	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1602	T8 2L-4 ft Hi Lumen Lamp with Low BF	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1603	T8 3L-4 ft Hi Lumen Lamp with Low BF	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1604	T8 4L-4 ft Hi Lumen Lamp with Low BF	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1605	T8 1L-4 ft Hi Lumen Lamp with Low BF (New Construction)	Commercial, Industrial, Agriculture, Schools & Government	14
1606	T8 2L-4 ft Hi Lumen Lamp with Low BF (New Construction)	Commercial, Industrial, Agriculture, Schools & Government	14
1610	T8 1L-4 ft Hi Lumen Lamp with Low BF	Commercial, Industrial, Agriculture, Schools & Government	14
1614	T8 1L-4 ft Hi Lumen Lamp with Low BF (New Construction)	Commercial, Industrial, Agriculture, Schools & Government	14
1618	T5HO 3 lamp replacing 250-399 W HID	Agriculture	13

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MMID	Measure Name	Sector(s)	EUL (years)
1631	T8 1L-4 ft Reduced Wattage with CEE Ballast - 25 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1632	T8 1L-4 ft Reduced Wattage with CEE Ballast - 25 Watts (New Construction)	Commercial, Industrial, Agriculture, Schools & Government	14
1634	T8 1L-4 ft Reduced Wattage with CEE Ballast - 28 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1637	T8 2L-4 ft Reduced Wattage with CEE Ballast - 25 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1640	T8 2L-4 ft Reduced Wattage with CEE Ballast - 28 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1642	T8 2L-4 ft Reduced Wattage with CEE Ballast - 28 Watts (New Construction)	Commercial, Industrial, Agriculture, Schools & Government	14
1643	T8 3L-4 ft Reduced Wattage with CEE Ballast - 25 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1646	T8 3L-4 ft Reduced Wattage with CEE Ballast - 28 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1649	T8 4L-4 ft Reduced Wattage with CEE Ballast - 25 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1652	T8 4L-4 ft Reduced Wattage with CEE Ballast - 28 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1708	CFL Fixture, replacing incandescent fixture	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
1709	High / low control for 320W PSMH, per fixture controlled	Commercial, Industrial, Agriculture, Schools & Government	13
1710	LED recessed downlight - ENERGY STAR qualified	Commercial, Industrial, Agriculture, Schools & Government	15
1712	Hot Food Holding Cabinet - ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
1729	Water Heater, Residential Type - Power Vented, Tankless, Natural Gas with EF ≥0.82	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14

MMID	Measure Name	Sector(s)	EUL (years)
1731	Water Heater, Residential Type - Natural Gas, Condensing, Thermal Efficiency 90% +	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1732	Water Heater, Residential Type - Electric, ≥0.93 EF	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15
1734	Water Heater, Residential Type - Indirect, with 90% AFUE+ Modulating Hot Water Boiler	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	14
1785	Furnace, with ECM fan motor, for space heating (AFUE ≥ 90%)	Residential- multifamily	17
1786	Showerhead, 1.5 gpm, natural gas - direct install	Residential- multifamily	11
1787	Showerhead, ≤1.5 gpm, electric - direct install	Residential- multifamily	9
1788	Water Heater, Residential Type - Power Vented, Natural Gas with EF >0.64	Residential- multifamily	17
1796	CFL - 23W Direct Install, replacing incandescent	Residential- multifamily	5
1797	T8 Reduced Wattage Relamp - 25 Watts	Residential- multifamily	7
1798	T8 Reduced Wattage Relamp - 28 Watts	Residential- multifamily	7
1799	T8 Reduced Wattage Relamp 8 ft - 54 Watts	Residential- multifamily	5
1800	PTHP, Standard Efficiency, <8,000 Btuh, ≥9.45 EER, ≥2.72 COP	Residential- multifamily	17
1801	PTHP, Standard Efficiency, 8,000 – 9,999 Btuh, ≥ 9.2 EER, ≥2.69 COP, New Construction	Residential- multifamily	16
1802	PTHP, Standard Efficiency, 10,000-12,999 Btuh, ≥ 8.77 EER, ≥2.64 COP, New Construction	Residential- multifamily	16
1803	PTHP, Standard Efficiency, ≥13,000 Btuh, ≥8.13 EER, ≥2.56 EER, New Construction	Residential- multifamily	16
1804	Furnace, with ECM fan motor, for space heating (AFUE ≥ 90%), New Construction	Residential- multifamily	17
1807	LED recessed downlight - ENERGY STAR qualified, New Construction	Residential- multifamily	15
1808	LED recessed downlight - ENERGY STAR qualified	Residential- multifamily	15
1809	T8 1L-4 ft Reduced Wattage with CEE Ballast - 30 Watts	Residential- multifamily	14

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MMID	Measure Name	Sector(s)	EUL (years)
1810	T8 2L-4 ft Reduced Wattage with CEE Ballast - 30 Watts	Residential- multifamily	14
1812	T8 3L-4 ft Reduced Wattage with CEE Ballast - 30 Watts	Residential- multifamily	14
1813	T8 4L-4 ft Reduced Wattage with CEE Ballast - 30 Watts	Residential- multifamily	14
1814	ENERGY STAR Clothes Washer - in unit	Residential- multifamily	9
1815	ENERGY STAR Clothes Washer - Common Area gas water heater	Residential- multifamily	9
1816	ENERGY STAR Clothes Washer - Common area electric water heater	Residential- multifamily	9
1817	ENERGY STAR Dehumidifier	Residential- multifamily	10
1818	ENERGY STAR Dishwasher	Residential- multifamily	9
1819	ENERGY STAR Refrigerator	Residential- multifamily	14
1820	ENERGY STAR Freezer	Residential- multifamily	17
1821	CFL - 13W Direct Install, replacing incandescent	Residential- multifamily	5
1822	CFL - 20W Direct Install, replacing incandescent	Residential- multifamily	5
1823	T8 Reduced Wattage Relamp - 30 Watts	Residential- multifamily	7
1824	PTHP, High Efficiency, <8,000 Btuh, ≥12.1 EER, ≥3.4 COP, New Construction	Residential- multifamily	17
1825	PTHP, High Efficiency, <8,000 Btuh, ≥12.1 EER, ≥3.4 COP, Retrofit Application	Residential- multifamily	17
1826	PTHP, High Efficiency, 8,000 – 9,999 Btuh, ≥11.5 EER, ≥3.2 COP, New Construction	Residential- multifamily	17
1827	PTHP, High Efficiency, 8,000 – 9,999 Btuh, ≥11.5 EER, ≥3.2 COP, Retrofit Application	Residential- multifamily	17
1828	PTHP, High Efficiency, 10,000-12,999 Btuh, ≥10.9 EER, ≥3.1 COP, New Construction	Residential- multifamily	17
1829	PTHP, High Efficiency, 10,000-12,999 Btuh, ≥10.9 EER, ≥3.1 COP, Retrofit Application	Residential- multifamily	17
1830	PTHP, High Efficiency, ≥13,000 Btuh, ≥9.8 EER, ≥3.1 EER, New Construction	Residential- multifamily	17
1831	PTHP, High Efficiency, ≥13,000 Btuh, ≥9.8 EER, ≥3.1 COP, Retrofit Application	Residential- multifamily	17
1832	Faucet Aerators - Bath - Electric 1.5 gpm New Construction)	Residential- multifamily	10
1833	Faucet Aerators - Kitchen - Electric 1.5 gpm (New Construction)	Residential- multifamily	10
1834	Showerheads - Electric 1.5 gpm (New Construction)	Residential- multifamily	9

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MMID	Measure Name	Sector(s)	EUL (years)
1835	Faucet Aerators - Bath - Gas 1.5 gpm (New Construction)	Residential- multifamily	10
1836	Faucet Aerators - Kitchen - Gas 1.5 gpm (New Construction)	Residential- multifamily	10
1837	Showerheads - Gas 1.5 gpm (New Construction)	Residential- multifamily	10
1838	ENERGY STAR Clothes Washer - in unit (pre July 2010 incentive)	Residential- multifamily	9
1839	ENERGY STAR Clothes Washer - Common Area gas water heater (pre July 2010 incentive)	Residential- multifamily	9
1840	ENERGY STAR Clothes Washer - Common area electric water heater (pre July 2010 incentive)	Residential- multifamily	9
1841	ENERGY STAR Dishwasher (pre July 2010 incentive)	Residential- multifamily	9
1842	ENERGY STAR Refrigerator (pre July 2010 incentive)	Residential- multifamily	14
1843	CFL Fixture, replacing incandescent fixture (pre July 2010 incentive)	Residential- multifamily	13
1844	Occupancy Sensors - Wall Mount ≤200 Watts(pre July 2010 incentive)	Residential- multifamily	10
1845	Occupancy Sensors - Wall Mount ≥ 201 Watts(pre July 2010 incentive)	Residential- multifamily	9
1869	Outside air temperature boiler reset/cutout control	Residential- multifamily	15
1906	Agriculture Exhaust Fan, High Efficiency - 57"	Agriculture	16
1943	T8 Reduced Wattage Relamp - 25 Watts	Commercial, Industrial, Agriculture, Schools & Government	7
1976	90% AFUE Natural Gas Furnace	Residential- single family	23
1977	NG Furnace with ECM, 90% AFUE	Residential- single family	23
1978	Hot-Water Boiler, 90% AFUE (<300 MBH)	Residential- single family	20
1979	Direct Install Package	Residential- single family	DEACTIVATE
1980	NG Furnace with ECM, 90%+ AFUE (Existing)	Residential- single family	23
1981	NG Furnace with ECM, 95%+ AFUE (Existing)	Residential- single family	23
1982	Hot Water Boiler, 90%+ AFUE	Residential- single family	20
1983	Hot Water Boiler, 95%+ AFUE	Residential- single family	20
1985	Water Heater, NG, EF of ≥0.67	Residential- single family	12

MMID	Measure Name	Sector(s)	EUL (years)
1986	Condensing Water Heater, NG, 90%+	Residential- single family	12
1987	Tankless Water Heater, NG, EF of ≥0.82	Residential- single family	20
1988	Water Heater, Indirect	Residential- single family	12
1989	Water Heater, Electric, EF of ≥0.93	Residential- multifamily	12
		Commercial, Industrial, Agriculture, Schools & Government	14
		Residential- single family	15
2023	LP or Oil Furnace with ECM, 90%+ AFUE (Existing)	Residential- single family	23
2116	CFL, Non PI Direct Install, 9 Watt	Residential- single family	6
2117	CFL, Non PI Direct Install, 14 Watt	Residential- single family	6
2118	CFL, Non PI Direct Install, 19 Watt	Residential- single family	6
2119	CFL, Non PI Direct Install, 23 Watt	Residential- single family	6
2120	Faucet Aerator, Non PI Direct Install, 1.5 gpm, Kitchen, NG	Residential- single family	12
2121	Faucet Aerator, Non PI Direct Install, 1.0 gpm, Bathroom, NG	Residential- single family	12
2122	Insulation, Non PI Direct Install, 6' pipe, NG	Residential- single family	12
2123	Showerhead, Non PI Direct Install, 1.5 gpm, NG	Residential- single family	12
2124	Showerhead, Non PI Direct Install, 1.75 gpm, NG	Residential- single family	11
2125	DHW Temperature Turn Down, Non PI Direct Install, NG	Residential- single family	12
2126	Faucet Aerator, Non PI Direct Install, 1.5 gpm, Kitchen, Electric	Residential- single family	12
2127	Faucet Aerator, Non PI Direct Install, 1.0 gpm, Bathroom, Electric	Residential- single family	12
2128	Insulation, Non PI Direct Install, 6' pipe, Electric	Residential- single family	12
2129	Showerhead, Non PI Direct Install, 1.5 gpm, Electric	Residential- single family	12
2130	Showerhead, Non PI Direct Install, 1.75 gpm, Electric	Residential- single family	11
2131	DHW Temperature Turn Down, Non PI Direct Install, Electric	Residential- single family	12
2132	CFL, Direct Install, 9 Watt	Residential- single family, Residential- multifamily	6
2133	CFL, Direct Install, 14 Watt	Commercial, Industrial, Agriculture, Schools & Government, Residential- single family, Residential- multifamily	6

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MMID	Measure Name	Sector(s)	EUL (years)
2134	CFL, Direct Install, 19 Watt	Commercial, Industrial, Agriculture, Schools & Government, Residential- single family	6
2135	CFL, Direct Install, 23 Watt	Residential- single family, Residential- multifamily	6
		Commercial, Industrial, Agriculture, Schools & Government	5
2136	Faucet Aerators, Direct Install, 1.5 gpm, Kitchen, NG	Residential- single family	11
2137	Faucet Aerator, Direct Install, 1.0 gpm, Bathroom, NG	Residential- single family	11
2138	Insulation, Direct Install, 6' pipe, NG	Commercial, Industrial, Agriculture, Schools & Government, Residential- single family	12
2139	Showerhead, Direct Install, 1.5 gpm, NG	Residential- single family, Residential- multifamily	11
2140	Showerhead, Direct Install, 1.75 gpm, NG	Commercial, Industrial, Agriculture, Schools & Government, Residential- single family	9
2141	DHW Temperature Turn Down, Direct Install, NG	Residential- single family	12
2142	Faucet Aerators, Direct Install, 1.5 gpm, Kitchen, Electric	Residential- single family	11
2143	Faucet Aerator, Direct Install, 1.0 gpm, Bathroom, Electric	Residential- single family	11
2144	Insulation, Direct Install, 6' pipe, Electric	Residential- single family	14
2145	Showerhead, Direct Install, 1.5 gpm, Electric	Residential- single family, Residential- multifamily	10
2146	Showerhead, Direct Install, 1.75 gpm, Electric	Commercial, Industrial, Agriculture, Schools & Government, Residential- single family,	9
2147	DHW Temperature Turn Down, Direct Install, Electric	Residential- single family	12
2150	Cooler Miser, Direct Install	Commercial	12
2151	Faucet Aerator, Direct Install, 0.5 gpm, Bathroom, Electric	Commercial, Industrial, Agriculture, Schools & Government	11
2153	Faucet Aerator, Direct Install, 0.5 gpm, Public Bathroom, Electric	Commercial	11
2155	Faucet Aerator, Direct Install, 1.5 gpm, Kitchen, Electric	Commercial, Industrial, Agriculture, Schools & Government, Residential- multifamily	10

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MMID	Measure Name	Sector(s)	EUL (years)
2156	Faucet Aerator, Direct Install, 1.5 gpm, Kitchen, NG	Commercial, Agriculture, Schools & Government, Residential- multifamily	10
2158	Pre-Rinse Sprayer, Direct Install, 1.28 gpm, Electric	Commercial, Agriculture, Schools & Government	5
2159	Pre-Rinse Sprayer, Direct Install, 1.28 gpm, NG	Commercial, Agriculture, Schools & Government	5
2192	A/C Split System ≤65 MBh, SEER 15	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15
2193	A/C Split System ≤ 65 MBh, SEER 16 or greater	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15
2194	A/C Split System, ≤65 MBh, SEER 14	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15
2197	Anti-sweat Heater Controls, Freezer Case, Low-heat Door	Commercial, Industrial, Agriculture, Schools & Government	12
2198	Anti-sweat Heater Controls, Freezer Case, No-heat Door	Commercial, Industrial, Agriculture, Schools & Government	12
2199	Anti-sweat Heater Controls, Freezer Case, Standard Door	Commercial, Industrial, Agriculture, Schools & Government	12
2200	Anti-sweat Heater Controls, Refrigerated Case, Low-heat or No-heat Door	Commercial, Industrial, Agriculture, Schools & Government	12
2201	Anti-sweat Heater Controls, Refrigerated Case, Standard Door	Commercial, Industrial, Agriculture, Schools & Government	12
2202	Beverage Cooler Controls, Occupancy Based	Commercial, Industrial, Agriculture, Schools & Government	5
2203	Boiler Burner, 10:1 High Turn Down	Commercial, Industrial, Agriculture, Schools & Government	25
2205	Boiler Control, Linkageless	Commercial, Industrial, Agriculture, Schools & Government	11
2206	Boiler Oxygen Trim Combustion Controls	Commercial, Industrial, Agriculture, Schools & Government	5
2208	Boiler Plant Retrofit, Hybrid Plant, 1- 5 MMBh	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	20
2209	Boiler Plant Retrofit, Mid Efficiency Plant, 1- 5 MMBh	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	20
2211	Boiler Tune Up	Commercial, Industrial, Agriculture, Schools & Government	2

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MMID	Measure Name	Sector(s)	EUL (years)
2216	Boiler, Hot Water, Condensing, ≥90% AFUE, 300-1,000 MBh	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	20
2217	Boiler, Hot Water, Modulating, ≥90% AFUE, ≤175 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2218	Boiler, Hot Water, Modulating, ≥90% AFUE, 175-300 MBh	Commercial, Industrial, Agriculture, Schools & Government	20
2219	Boiler, Hot Water, Near Condensing, ≥85% AFUE, 300-1,000 MBh	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	20
2221	Boiler, Outside Temperature Reset/Cutout Control	Residential- multifamily	5
		Commercial, Industrial, Agriculture, Schools & Government	23
2234	Case Door, Freezer, Low Heat	Commercial, Industrial, Agriculture, Schools & Government	11
2235	Case Door, Freezer, No Heat	Commercial, Industrial, Agriculture, Schools & Government	11
2236	Case Door, Cooler, No Heat	Commercial, Industrial, Agriculture, Schools & Government	11
2237	Ceramic Metal Halide (CMH) Fixture, 20-70 Watts	Commercial, Industrial, Agriculture, Schools & Government	11
2238	Ceramic Metal Halide (CMH) Lamp, ≤ 25 Watts	Commercial, Industrial, Agriculture, Schools & Government	11
2239	CFL Fixture, ≤100 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2241	CFL, 14 Watt	Commercial, Industrial, Agriculture, Schools & Government	7
2243	CFL, 31-115 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5
2245	CFL, Cold Cathode, ≤32 Watt	Commercial, Industrial, Agriculture, Schools & Government	4
2246	CFL, Reflector Flood Lamps, ≤32 Watts	Residential- multifamily	5
		Commercial, Industrial, Agriculture, Schools & Government	12
2254	Compressed Air Condensate Drains, No Loss Drain	Commercial, Industrial, Agriculture, Schools & Government	20
2255	Compressed Air Controller, Pressure/Flow Controller	Commercial, Industrial, Agriculture, Schools & Government	15
2257	Compressed Air Heat Recovery, Space Heating	Commercial, Industrial, Agriculture, Schools & Government	15

MMID	Measure Name	Sector(s)	EUL (years)
2258	Compressed Air Mist Eliminators	Commercial, Industrial, Agriculture, Schools & Government	10
2259	Compressed Air Nozzles, Air Entraining	Commercial, Industrial, Agriculture, Schools & Government	15
2264	Compressed Air, Cycling Thermal Mass Air Dryers	Commercial, Industrial, Agriculture, Schools & Government	15
2269	Cooler Evaporator Fan Control	Commercial, Industrial, Agriculture, Schools & Government	16
2271	Cooler Night Curtains, Open Coolers	Commercial, Industrial, Agriculture, Schools & Government	5
2276	Delamping, T12 to T8	Commercial, Industrial, Agriculture, Schools & Government	10
2277	Delamping, T8 to T8	Commercial, Industrial, Agriculture, Schools & Government	10
2280	Dishwasher, Low Temp, Door Type, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	10
2281	Dishwasher, High Temp, Electric Booster, Door Type, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	10
2282	Dishwasher, High Temp, Electric Booster, Door Type, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2283	Dishwasher, High Temp, Electric Booster, Multi Tank Conveyor, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	11
2284	Dishwasher, High Temp, Electric Booster, Multi Tank Conveyor, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2285	Dishwasher, High Temp, Electric Booster, Single Tank Conveyor, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	10
2286	Dishwasher, High Temp, Electric Booster, Single Tank Conveyor, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2287	Dishwasher, High Temp, Electric Booster, Under Counter, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	10
2288	Dishwasher, High Temp, Electric Booster, Under Counter, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2289	Dishwasher, High Temp, Gas Booster, Door Type, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2290	Dishwasher, High Temp, Gas Booster, Multi Tank Conveyor, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2291	Dishwasher, High Temp, Gas Booster, Single Tank Conveyor, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2292	Dishwasher, High Temp, Gas Heat, Gas Booster, Under Counter, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10

MMID	Measure Name	Sector(s)	EUL (years)
2293	Dishwasher, Low Temp, Door Type, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2294	Dishwasher, Low Temp, Multi Tank Conveyor, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	10
2295	Dishwasher, Low Temp, Multi Tank Conveyor, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2296	Dishwasher, Low Temp, Single Tank Conveyor, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	10
2297	Dishwasher, Low Temp, Single Tank Conveyor, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2298	Dishwasher, Low Temp, Under Counter, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	10
2299	Dishwasher, Low Temp, Under Counter, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2300	Dock Door Infiltration Reduction, New Install	Commercial, Industrial, Agriculture, Schools & Government	10
2301	Dock Door Infiltration Reduction, Replace Existing	Commercial, Industrial, Agriculture, Schools & Government	10
2302	Dock Pit/Ramp External Seal, Added to Existing Brush Barrier	Commercial, Industrial, Agriculture, Schools & Government	10
2303	Dock Pit/Ramp External Seal, No Brush Barrier Present	Commercial, Industrial, Agriculture, Schools & Government	10
2306	ECM Compressor Fan Motor	Commercial, Industrial, Agriculture, Schools & Government	15
2307	ECM Condenser/Condensing Unit Fan Motor	Commercial, Industrial, Agriculture, Schools & Government	16
2308	ECM Evaporator Fan Motor, Walk-in Cooler, <1/20hp	Commercial, Industrial, Agriculture, Schools & Government	16
2309	ECM Evaporator Fan Motor, Walk-in Cooler, 1/20hp - 1 hp	Commercial, Industrial, Agriculture, Schools & Government	16
2310	ECM Evaporator Fan Motor, Walk-in Freezer, <1/20hp	Commercial, Industrial, Agriculture, Schools & Government	16
2311	ECM Evaporator Fan Motor, Walk-in Freezer, 1/20hp - 1 hp	Commercial, Industrial, Agriculture, Schools & Government	16
2312	ECM Motor, Cooler/Freezer Case	Commercial, Industrial, Agriculture, Schools & Government	15
2316	Fans, High Volume Low Speed, 20 ft. dia.	Agriculture, Schools & Government	15
2317	Fans, High Volume Low Speed, 22 ft. dia.	Agriculture, Schools & Government	15
2318	Fans, High Volume Low Speed, 24 ft. dia.	Agriculture, Schools & Government	13
2321	Freezer, Chest, Glass Door, < 15 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12

MMID	Measure Name	Sector(s)	EUL (years)
2322	Freezer, Chest, Glass Door, 15-29 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2323	Freezer, Chest, Glass Door, 30-49 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2324	Freezer, Chest, Glass Door, 50+ cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2325	Freezer, Chest, Solid Door, < 15 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2326	Freezer, Chest, Solid Door, 15-29 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2327	Freezer, Chest, Solid Door, 30-49 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2328	Freezer, Chest, Solid Door, 50+ cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2329	Freezer, Vertical, Glass Door, < 15 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2330	Freezer, Vertical, Glass Door, 15-29 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2331	Freezer, Vertical, Glass Door, 30-49 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2332	Freezer, Vertical, Glass Door, 50+ cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2333	Freezer, Vertical, Solid Door, < 15 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2334	Freezer, Vertical, Solid Door, 15-29 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2335	Freezer, Vertical, Solid Door, 30-49 cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2336	Freezer, Vertical, Solid Door, 50+ cu ft, ENERGY STAR	Commercial, Industrial, Schools & Government	12
2337	Fryer, ENERGY STAR, Electric	Commercial, Industrial, Schools & Government	12
2338	Fryer, ENERGY STAR, NG	Commercial, Industrial, Schools & Government	12
2339	Furnace, ECM, ≥90%+ AFUE, NG 109.9 - 120.7 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2340	Furnace, ECM, ≥90%+ AFUE, NG 120.8 - 132.9 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2341	Furnace, ECM, ≥90%+ AFUE, NG 133.0 - 146.1 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2342	Furnace, ECM, ≥90%+ AFUE, NG 146.2 - 160.8 MBh	Commercial, Industrial, Agriculture, Schools & Government	18

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MMID	Measure Name	Sector(s)	EUL (years)
2343	Furnace, ECM, ≥90%+ AFUE, NG 54.675 - 60.749 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2344	Furnace, ECM, ≥90%+ AFUE, NG 60.750 - 67.499 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2345	Furnace, ECM, ≥90%+ AFUE, NG 67.5 - 74.9 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2346	Furnace, ECM, ≥90%+ AFUE, NG 75.0 - 82.49 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2347	Furnace, ECM, ≥90%+ AFUE, NG 82.5 - 90.75 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2348	Furnace, ECM, ≥90%+ AFUE, NG 90.76 - 99.82 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2349	Furnace, ECM, ≥90%+ AFUE, NG 99.83 - 109.8 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2350	Furnace, ECM, 95%+ AFUE, NG 109.9 - 120.7 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2351	Furnace, ECM, 95%+ AFUE, NG 120.8 - 132.9 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2352	Furnace, ECM, 95%+ AFUE, NG 133.0 - 146.1 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2353	Furnace, ECM, 95%+ AFUE, NG 146.2 - 160.8 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2354	Furnace, ECM, 95%+ AFUE, NG 54.675 - 60.749 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2355	Furnace, ECM, 95%+ AFUE, NG 60.750 - 67.499 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2356	Furnace, ECM, 95%+ AFUE, NG 67.5 - 74.9 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2357	Furnace, ECM, 95%+ AFUE, NG 75.0 - 82.49 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2358	Furnace, ECM, 95%+ AFUE, NG 82.5 - 90.75 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2359	Furnace, ECM, 95%+ AFUE, NG 90.76 - 99.82 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2360	Furnace, ECM, 95%+ AFUE, NG 99.83 - 109.8 MBh	Commercial, Industrial, Agriculture, Schools & Government	18
2362	Glazing, Triple Poly Carbonate, Roof and Walls, Double Pane Replacement	Agriculture, Schools & Government	15
2363	Glazing, Triple Poly Carbonate, Roof and Walls, Single Pane Replacement	Agriculture, Schools & Government	15
2364	Glazing, Triple Poly Carbonate, Roof, Double Pane Replacement	Agriculture, Schools & Government	15

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MMID	Measure Name	Sector(s)	EUL (years)
2365	Glazing, Triple Poly Carbonate, Roof, Single Pane Replacement	Agriculture, Schools & Government	15
2366	Glazing, Triple Poly Carbonate, Walls, Double Pane Replacement	Agriculture, Schools & Government	15
2367	Glazing, Triple Poly Carbonate, Walls, Single Pane Replacement	Agriculture, Schools & Government	15
2371	Griddle, ENERGY STAR, Electric	Commercial, Industrial, Schools & Government	11
2372	Griddle, ENERGY STAR, NG	Commercial, Schools & Government	11
2373	Guest Room Energy Management Controls, Electric Heat PTAC Systems	Commercial, Residential- multifamily	10
2388	Ice Machine, CEE Tier 2, Ice Making Head, Air Cooled, Cube & Nugget, <450 lb/day	Commercial, Industrial, Agriculture, Schools & Government	11
2389	Ice Machine, CEE Tier 2, Ice Making Head, Air Cooled, Cube & Nugget, ≥1,000 lb/day	Commercial, Industrial, Agriculture, Schools & Government	11
2390	Ice Machine, CEE Tier 2, Ice Making Head, Air Cooled, Cube & Nugget, 450-499 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2391	Ice Machine, CEE Tier 2, Ice Making Head, Air Cooled, Cube & Nugget, 500-999 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2392	Ice Machine, CEE Tier 2, Ice Making Head, Air Cooled, Flake, <450 lb/day	Commercial, Industrial, Agriculture, Schools & Government	11
2393	Ice Machine, CEE Tier 2, Ice Making Head, Air Cooled, Flake, ≥1,000 lb/day	Commercial, Industrial, Agriculture, Schools & Government	11
2394	Ice Machine, CEE Tier 2, Ice Making Head, Air Cooled, Flake, 450-499 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2395	Ice Machine, CEE Tier 2, Ice Making Head, Air Cooled, Flake, 500-999 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2396	Ice Machine, CEE Tier 2, Ice Making Head, Water Cooled, Cube & Nugget, <500 lb/day	Commercial, Industrial, Schools & Government	10
2397	Ice Machine, CEE Tier 2, Ice Making Head, Water Cooled, Cube & Nugget, ≥1,436 lb/day	Commercial, Industrial, Schools & Government	10
2398	Ice Machine, CEE Tier 2, Ice Making Head, Water Cooled, Cube & Nugget, 1,000-1,435 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2399	Ice Machine, CEE Tier 2, Ice Making Head, Water Cooled, Cube & Nugget, 500-999 lb/day	Agriculture	10
2399	Ice Machine, CEE Tier 2, Ice Making Head, Water Cooled, Cube & Nugget, 500-999 lb/day	Commercial	10

MMID	Measure Name	Sector(s)	EUL (years)
2399	Ice Machine, CEE Tier 2, Ice Making Head, Water Cooled, Cube & Nugget, 500-999 lb/day	Industrial, Schools & Government	10
2400	Ice Machine, CEE Tier 2, Ice Making Head, Water Cooled, Flake, <500 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2401	Ice Machine, CEE Tier 2, Ice Making Head, Water Cooled, Flake, 1,000-1,435 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2402	Ice Machine, CEE Tier 2, Ice Making Head, Water Cooled, Flake, 500-999 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2403	Ice Machine, CEE Tier 2, Remote Condensing With Remote Compressor, Air Cooled, Cube & Nugget, <500 lbs/day	Commercial, Industrial, Agriculture, Schools & Government	11
2404	Ice Machine, CEE Tier 2, Remote Condensing With Remote Compressor, Air Cooled, Cube & Nugget, ≥1,000 lbs/day	Commercial, Industrial, Agriculture, Schools & Government	10
2405	Ice Machine, CEE Tier 2, Remote Condensing With Remote Compressor, Air Cooled, Cube & Nugget, 500-933 lbs/day	Commercial, Industrial, Agriculture, Schools & Government	10
2406	Ice Machine, CEE Tier 2, Remote Condensing With Remote Compressor, Air Cooled, Cube & Nugget, 934-999 lbs/day	Commercial, Industrial, Agriculture, Schools & Government	10
2407	Ice Machine, CEE Tier 2, Remote Condensing Without Remote Compressor, Air Cooled, Cube & Nugget, <500 lbs/day	Commercial, Industrial, Agriculture, Schools & Government	10
2408	Ice Machine, CEE Tier 2, Remote Condensing Without Remote Compressor, Air Cooled, Cube & Nugget, ≥1,000 lbs/day	Commercial, Industrial, Agriculture, Schools & Government	10
2409	Ice Machine, CEE Tier 2, Remote Condensing Without Remote Compressor, Air Cooled, Cube & Nugget, 500-999 lbs/day	Commercial, Industrial, Agriculture, Schools & Government	10
2410	Ice Machine, CEE Tier 2, Remote Condensing Without Remote Compressor, Air Cooled, Flake, ≥1,000 lbs/day	Commercial, Industrial, Agriculture, Schools & Government	10
2411	Ice Machine, CEE Tier 2, Remote Condensing Without Remote Compressor, Air Cooled, Flake, 500-999 lbs/day	Commercial, Industrial, Schools & Government	10
2412	Ice Machine, CEE Tier 2, Self Contained, Air Cooled, Cube & Nugget, <175 lb/day	Commercial, Industrial, Agriculture, Schools & Government	11
2413	Ice Machine, CEE Tier 2, Self Contained, Air Cooled, Cube & Nugget, 175-499 lb/day	Commercial, Industrial, Agriculture, Schools & Government	11

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MMID	Measure Name	Sector(s)	EUL (years)
2414	Ice Machine, CEE Tier 2, Self Contained, Air Cooled, Flake, 175-499 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2415	Ice Machine, CEE Tier 2, Self Contained, Air Cooled, Flake, 500-999 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2416	Ice Machine, CEE Tier 2, Self Contained, Water Cooled, Cube & Nugget, <200 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2417	Ice Machine, CEE Tier 2, Self Contained, Water Cooled, Cube & Nugget, 200-499 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2418	Ice Machine, CEE Tier 2, Self Contained, Water Cooled, Cube & Nugget, 500-999 lb/day	Commercial, Industrial, Agriculture, Schools & Government	10
2419	Induction Lighting, 300 Watt	Commercial, Industrial, Agriculture, Schools & Government	15
2422	Infrared Heating Units, High or Low Intensity	Commercial, Industrial, Agriculture, Schools & Government	15
2429	Insulation, Steam Fitting, Removable, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2430	Insulation, Steam Piping, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2453	LED, 8-12 Watts	Commercial, Industrial, Agriculture, Schools & Government	15
2456	LED, Reach-In Refrigerated Case, Replaces T12 or T8	Commercial, Industrial, Agriculture, Schools & Government	20
2457	LED, Reach-In Refrigerated Case, Replaces T12 or T8 without Occupancy Control	Commercial, Industrial, Agriculture, Schools & Government	20
2458	LED, Recessed Downlight, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15
2460	Lighting Controls, Bi-level, Exterior LED or Metal Halide	Commercial, Industrial, Agriculture, Schools & Government	8
2465	Metal Halide, Pulse Start, 320 Watt	Commercial, Industrial, Agriculture, Schools & Government	14
2466	Metal Halide, Pulse Start, 750 Watt	Commercial, Industrial, Agriculture, Schools & Government	15
2471	Occupancy Sensor, Ceiling Mount, ≤500 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	8
2472	Occupancy Sensor, Ceiling Mount, ≥1,001 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	8

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MMID	Measure Name	Sector(s)	EUL (years)
2473	Occupancy Sensor, Ceiling Mount, 501-1000 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	8
2474	Occupancy Sensor, Fixture Mount, ≤200 Watts	Commercial, Industrial, Agriculture, Schools & Government	8
2475	Occupancy Sensor, Fixture Mount, >200 Watts	Commercial, Industrial, Agriculture, Schools & Government	8
2476	Occupancy Sensor, High Bay Fluorescent Fixtures, Gymnasium	Commercial, Industrial, Schools & Government	9
2477	Occupancy Sensor, High Bay Fluorescent Fixtures, Industrial	Commercial, Industrial, Schools & Government	9
2478	Occupancy Sensor, High Bay Fluorescent Fixtures, Other	Commercial, Industrial, Agriculture, Schools & Government	9
2479	Occupancy Sensor, High Bay Fluorescent Fixtures, Public Assembly	Commercial, Industrial, Schools & Government	9
2480	Occupancy Sensor, High Bay Fluorescent Fixtures, Retail	Commercial, Industrial, Agriculture, Schools & Government	9
2481	Occupancy Sensor, High Bay Fluorescent Fixtures, Warehouse	Commercial, Industrial, Agriculture, Schools & Government	9
2482	Occupancy Sensor, LED Refrigerated Case Lights	Commercial, Industrial, Agriculture, Schools & Government	10
2483	Occupancy Sensor, Wall Mount, ≤200 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	8
2484	Occupancy Sensor, Wall Mount, >200 Watts	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	8
2485	Oven, Convection, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	12
2486	Oven, Convection, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	12
2487	Oven, Rack Type, Double Compartment, Focus QPL, NG	Commercial, Industrial, Agriculture, Schools & Government	12
2488	Oven, Rack Type, Single Compartment, Focus QPL, NG	Commercial, Industrial, Agriculture, Schools & Government	12
2494	Pre-Rinse Sprayer, ≤0.65 gpm, Electric	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5
2495	Pre-Rinse Sprayer, ≤0.65 gpm, NG	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5

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MMID	Measure Name	Sector(s)	EUL (years)
2509	Reach In Refrigerated Case w/ Doors replacing Open Multi Deck Case	Commercial, Industrial, Agriculture, Schools & Government	15
2510	Refrigeration Controls, Floating Head Pressure, ≤150 tons	Commercial, Industrial, Agriculture, Schools & Government	10
2513	Refrigeration Tune-up, Non Self-Contained Cooler	Commercial, Industrial, Agriculture, Schools & Government	3
2514	Refrigeration Tune-up, Non Self-Contained Freezer	Commercial, Industrial, Agriculture, Schools & Government	3
2515	Refrigeration Tune-up, Self-contained Cooler	Commercial, Industrial, Agriculture, Schools & Government	3
2516	Refrigeration Tune-up, Self-contained Freezer	Commercial, Industrial, Agriculture, Schools & Government	3
2521	Refrigerator, Chest, Glass Door, < 15 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2522	Refrigerator, Chest, Glass Door, 15-29 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2523	Refrigerator, Chest, Glass Door, 30-49 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2524	Refrigerator, Chest, Glass Door, 50+ cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2525	Refrigerator, Chest, Solid Door, < 15 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2526	Refrigerator, Chest, Solid Door, 15-29 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2527	Refrigerator, Chest, Solid Door, 30-49 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2528	Refrigerator, Chest, Solid Door, 50+ cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2529	Refrigerator, Vertical, Glass Door, < 15 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2530	Refrigerator, Vertical, Glass Door, 15-29 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2531	Refrigerator, Vertical, Glass Door, 30-49 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2532	Refrigerator, Vertical, Glass Door, 50+ cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2533	Refrigerator, Vertical, Solid Door, < 15 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2534	Refrigerator, Vertical, Solid Door, 15-29 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2535	Refrigerator, Vertical, Solid Door, 30-49 cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12

MMID	Measure Name	Sector(s)	EUL (years)
2536	Refrigerator, Vertical, Solid Door, 50+ cu ft, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government	12
2541	Steam Trap Repair, < 50 psig, General Heating	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5
2542	Steam Trap Repair, < 50 psig	Industrial	6
2544	Steam Trap Repair, > 225 psig	Industrial	6
2546	Steam Trap Repair, 126-225 psig	Industrial	6
2548	Steam Trap Repair, 50-125 psig	Industrial	6
2549	Steamer, 3 Pan, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	11
2550	Steamer, 4 Pan, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	11
2551	Steamer, 5 Pan, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	11
2552	Steamer, 5 Pan, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	11
2553	Steamer, 6 Pan, ENERGY STAR, Electric	Commercial, Industrial, Agriculture, Schools & Government	11
2554	Steamer, 6 Pan, ENERGY STAR, NG	Commercial, Industrial, Agriculture, Schools & Government	11
2556	T8 1L 4', 25W, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2557	T8 1L 4', 28W, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2558	T8 1L 4', 28W, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2559	T8 1L 4', HPT8, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2560	T8 1L, 4', 25W, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2561	T8 1L, 4', HPT8, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2562	T8 2L 4', 25W, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13

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MMID	Measure Name	Sector(s)	EUL (years)
2563	T8 2L 4', 25W, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2564	T8 2L 4', 28W, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2565	T8 2L 4', 28W, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2566	T8 2L 4', HPT8, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2567	T8 2L 4', HPT8, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2568	T8 2L 4', HPT8, CEE, replacing 8' 1L T12HO	Commercial, Industrial, Agriculture, Schools & Government	15
2569	T8 2L 4', HPT8, CEE, replacing 8' 2L T12	Commercial, Industrial, Agriculture, Schools & Government	15
2571	T8 3L 4', 25W, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2572	T8 3L 4', 25W, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2573	T8 3L 4', 28W, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2574	T8 3L 4', 28W, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2575	T8 3L 4', HPT8, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2576	T8 3L 4', HPT8, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2577	T8 4L 4', 25W, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13

MMID	Measure Name	Sector(s)	EUL (years)
2578	T8 4L 4', 25W, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2579	T8 4L 4', 28W, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2580	T8 4L 4', 28W, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2581	T8 4L 4', HPT8, CEE, BF ≤ 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2582	T8 4L 4', HPT8, CEE, BF > 0.78	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2583	T8 4L 4', HPT8, CEE, replacing 8' 2L T12	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15
2584	T8 4L 4', HPT8, CEE, replacing 8' 2L T12HO	Commercial, Industrial, Agriculture, Schools & Government	15
2585	T8 4L 4', HPT8, CEE, replacing 8' 2L T12VHO	Commercial, Industrial, Agriculture, Schools & Government	15
2590	T8, Low Watt Relamp, 25 Watts, 4'	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5
2591	T8, Low Watt Relamp, 28 Watts, 4'	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5
2592	Thermal Curtain, 8mm Double Polycarbonate Walls and Ceiling, Overhead Heating	Commercial, Industrial, Agriculture, Schools & Government	19
2593	Thermal Curtain, 8mm Double Polycarbonate Walls and Ceiling, Under Bench Heating	Commercial, Industrial, Agriculture, Schools & Government	19
2594	Thermal Curtain, 8mm Double Polycarbonate Walls and Poly Film Ceiling, Overhead Heating	Commercial, Industrial, Agriculture, Schools & Government	19
2595	Thermal Curtain, 8mm Double Polycarbonate Walls and Poly Film Ceiling, Under Bench Heating	Commercial, Industrial, Agriculture, Schools & Government	19
2596	Thermal Curtain, Double Pane Glass Walls and Ceiling, Overhead Heating	Commercial, Industrial, Agriculture, Schools & Government	15

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MMID	Measure Name	Sector(s)	EUL (years)
2597	Thermal Curtain, Double Pane Glass Walls and Ceiling, Under Bench Heating	Commercial, Industrial, Agriculture, Schools & Government	15
2598	Thermal Curtain, Double Pane Glass Walls and Poly Film Ceiling, Overhead Heating	Commercial, Industrial, Agriculture, Schools & Government	15
2599	Thermal Curtain, Double Pane Glass Walls and Poly Film Ceiling, Under Bench Heating	Commercial, Industrial, Agriculture, Schools & Government	15
2601	Thermal Curtain, Poly Film Walls and Ceiling, Overhead Heating	Commercial, Industrial, Agriculture, Schools & Government	15
2602	Thermal Curtain, Poly Film Walls and Ceiling, Under Bench Heating	Commercial, Industrial, Agriculture, Schools & Government	15
2603	Thermal Curtain, Single Pane Glass Walls and Ceiling, Overhead Heating	Commercial, Industrial, Agriculture, Schools & Government	15
2604	Thermal Curtain, Single Pane Glass Walls and Ceiling, Under Bench Heating	Commercial, Industrial, Agriculture, Schools & Government	15
2605	Thermal Curtain, Single Pane Glass Walls and Poly Film Ceiling, Overhead Heating	Commercial, Industrial, Agriculture, Schools & Government	15
2606	Thermal curtain, Single Pane Glass Walls and Poly Film Ceiling, Under Bench Heating	Commercial, Industrial, Agriculture, Schools & Government	15
2608	Unit Heater, ≥90% Thermal Efficiency	Commercial, Industrial, Agriculture, Schools & Government	15
2611	Vending Machine Controls, Occupancy Based, Cold Beverage Machine	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	10
2612	Vending Machine Controls, Occupancy Based, Snack Machine	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5
2613	Vending Machine Controls, Sales Based, Cold Beverage Machine	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5
2614	Vending Machine Controls, Sales Based, Snack Machine	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5
2615	Vending Machine, Cold Beverage, Not Software Activated, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	11
2616	Vending Machine, Cold Beverage, Software Activated, ENERGY STAR	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	11
2620	Ventilation Controls, Kitchen Hood, Temp only, Adder for MUA, New	Commercial, Industrial, Agriculture, Schools & Government	10
2621	Ventilation Controls, Kitchen Hood, Temp only, Adder for MUA, Retrofit	Commercial, Industrial, Agriculture, Schools & Government	10

MMID	Measure Name	Sector(s)	EUL (years)
2622	Ventilation Controls, Kitchen Hood, Temp only, Exhaust Only, New	Commercial, Industrial, Agriculture, Schools & Government	10
2623	Ventilation Controls, Kitchen Hood, Temp only, Exhaust Only, Retrofit	Commercial, Industrial, Agriculture, Schools & Government	10
2624	Ventilation Controls, Kitchen Hood, with Optical, Adder for MUA, New	Commercial, Industrial, Agriculture, Schools & Government	10
2625	Ventilation Controls, Kitchen Hood, with Optical, Adder for MUA, Retrofit	Commercial, Industrial, Agriculture, Schools & Government	10
2626	Ventilation Controls, Kitchen Hood, with Optical, Exhaust Only, New	Commercial, Industrial, Agriculture, Schools & Government	10
2627	Ventilation Controls, Kitchen Hood, with Optical, Exhaust Only, Retrofit	Commercial, Industrial, Agriculture, Schools & Government	10
2628	Ventilation Fan, 36" Dia.	Agriculture, Schools & Government	16
2629	Ventilation Fan, 42" Dia.	Agriculture, Schools & Government	16
2630	Ventilation Fan, 48" Dia.	Agriculture, Schools & Government	16
2631	Ventilation Fan, 50" Dia.	Agriculture, Schools & Government	16
2632	Ventilation Fan, 51" Dia.	Agriculture, Schools & Government	16
2633	Ventilation Fan, 52" Dia.	Agriculture, Schools & Government	16
2634	Ventilation Fan, 54" Dia.	Agriculture, Schools & Government	16
2635	Ventilation Fan, 55" Dia.	Agriculture, Schools & Government	16
2636	Ventilation Fan, 57" Dia.	Agriculture, Schools & Government	16
2637	Ventilation Fan, 60" Dia.	Agriculture, Schools & Government	16
2638	Ventilation Fan, 72" Dia.	Agriculture, Schools & Government	16
2651	Water Heater, ≥0.67 EF, Storage, NG	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	10
2652	Water Heater, ≥ 0.82 EF, Tankless, NG	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	13
2658	Water Heater, Indirect, 90% AFUE Boiler, NG	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15
2660	Waterer, Livestock, < 250 Watts, R10 Insulation	Agriculture, Schools & Government	10
2666	Chiller System Tune Up, Air Cooled, ≤ 500 Tons	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5
2667	Chiller System Tune Up, Air Cooled, > 500 Tons	Commercial, Industrial, Agriculture, Schools & Government	5
2668	Chiller System Tune Up, Water Cooled, ≤ 500 Tons	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5

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MMID	Measure Name	Sector(s)	EUL (years)
2669	Chiller System Tune Up, Water Cooled, > 500 Tons	Commercial, Industrial, Agriculture, Schools & Government	5
2670	CFL, ≤32 Watt	Commercial, Industrial, Agriculture, Schools & Government	5
2671	Coil Cleaning, Direct Install, Self Contained Unit	Commercial	4
2673	Fryer, Large Vat, ENERGY STAR, Electric	Commercial	12
2674	Fryer, Large Vat, ENERGY STAR, NG	Commercial	12
2675	Lighting, High/Low Control for 320W PSMH	Commercial, Industrial, Agriculture, Schools & Government	14
2677	Hot Food Holding Cabinet, V = 13-28 cu. ft., ENERGY STAR	Commercial, Industrial, Schools & Government	12
2678	Hot Food Holding Cabinet, V < 13 cu. ft., ENERGY STAR	Commercial, Industrial, Schools & Government	12
2679	Hot Food Holding Cabinet, V ≥ 28 cu. ft., ENERGY STAR	Commercial, Industrial, Schools & Government	12
2681	LED Lamp, Direct Install, Walk-in Cooler	Commercial	15
2682	LED Lamp, Direct Install, Walk-in Freezer	Commercial	15
2686	Faucet Aerator, Direct Install, 0.5 gpm, Public Restroom, Electric	Commercial, Industrial, Agriculture, Schools & Government	9
2687	Faucet Aerator, Direct Install, 0.5 gpm, Public Restroom, NG	Commercial, Industrial, Agriculture, Schools & Government	10
2688	Faucet Aerator, Direct Install, 0.5 gpm, Employee Restroom, Electric	Commercial	10
2689	Faucet Aerator, Direct Install, 0.5 gpm, Employee Restroom, NG	Commercial	10
2691	LED Fixture, Canopy	Commercial, Industrial, Agriculture, Schools & Government	12
2692	LED Fixture, Canopy, Dusk to Dawn	Commercial, Industrial, Agriculture, Schools & Government	12
2693	LED Fixture, Exterior Pole Mounted	Commercial, Industrial, Agriculture, Schools & Government	12
2695	LED Fixture, Exterior Wall-Pack, Dusk to Dawn	Commercial, Industrial, Agriculture, Schools & Government	12
2697	LED Fixture, Parking Garage, 24 Hour	Commercial, Industrial, Agriculture, Schools & Government	12
2698	LED Fixture, Parking Garage, Dusk to Dawn	Commercial, Industrial, Agriculture, Schools & Government	12
2699	PTHP, <8,000 Btuh	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15

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MMID	Measure Name	Sector(s)	EUL (years)
2700	PTHP, ≥13,000 Btuh	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15
2701	PTHP, 10,000-12,999 Btuh	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15
2702	PTHP, 8,000 – 9,999 Btuh	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	15
2703	T5 2L Recessed Indirect Fixture, F28, replacing 3 or 4L - T8 or T12	Commercial, Industrial, Agriculture, Schools & Government	15
2704	T8 2L 4', Recessed Indirect Fixture, HPT8, replacing 3 or 4L - T8 or T12	Commercial, Industrial, Agriculture, Schools & Government	15
2705	Ice Machine, CEE Tier 2, Remote Condensing Without Remote Compressor, Air Cooled, Flake, <500 lbs/day	Commercial, Industrial, Agriculture, Schools & Government	10
2706	Night Curtains, Open Multideck Coolers	Commercial, Industrial, Agriculture, Schools & Government	5
2707	T8, Low Watt Relamp, 54 Watts, 8'	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	5
2708	High/Low Control, 320 Watt PSMH	Commercial, Industrial, Agriculture, Schools & Government	14
2709	Metal Halide, Electronic Ballast, Pulse Start, 320 Watt	Commercial, Industrial, Agriculture	14
2711	Insulation, Project Based, Attic,	Residential- single family	35
2712	Insulation, Project Based, Wall,	Residential- single family	25
2732	CFL, Direct Install, 13 Watt	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	6
2734	Faucet Aerator, Direct Install, 1.5 gpm, Bathroom, Electric	Commercial, Industrial, Schools & Government, Residential- multifamily	9
		Agriculture	9
2735	Faucet Aerator, Direct Install, 1.5 gpm, Bathroom, NG	Industrial, Agriculture, Schools & Government, Residential- multifamily	12
		Commercial	13
2736	LED, Direct Install, Exit Sign, Retrofit	Residential- multifamily	8
2740	CFL, Direct Install, 18 Watt	Residential- multifamily	6
2741	Insulation, Direct Install, 3' Pipe, Electric	Residential- multifamily	15
2742	Insulation, Direct Install, 3' Pipe, NG	Residential- multifamily	15
2743	Boiler, Hot Water, Modulating, ≥90% AFUE,≤300 MBh	Residential- multifamily	20

MMID	Measure Name	Sector(s)	EUL (years)
2744	Boiler Tune Up	Residential- multifamily	2
2753	CFL, ≤32 Watts, Common Area	Residential- multifamily	2
2754	CFL, ≤32 Watt, In Unit	Residential- multifamily	10
2756	Clothes Washer, Common Area, Electric, ENERGY STAR	Residential- multifamily	14
2757	Clothes Washer, Common Area, NG, ENERGY STAR	Residential- multifamily	14
2758	Clothes Washer, In Unit, ENERGY STAR	Residential- multifamily	14
2759	Dehumidifier, Electric, ENERGY STAR	Residential- multifamily	14
2761	Dishwasher, Electric, ENERGY STAR	Residential- multifamily	14
2762	Freezer, ENERGY STAR	Residential- multifamily	14
2763	Furnace, ECM, ≥90%+ AFUE, NG	Residential- multifamily	21
2764	Furnace, ECM, ≥95%+ AFUE, NG	Residential- multifamily	18
2767	LED, Common Area	Residential- multifamily	8
2768	LED, Exit Sign, Retrofit	Residential- multifamily	8
		Commercial, Industrial, Agriculture, Schools & Government	16
2769	LED, In Unit	Residential- multifamily	15
2770	Refrigerator, ENERGY STAR	Residential- multifamily	12
2772	Steam Trap Repair, < 10 psig, Radiator	Residential- multifamily	5
2792	Insulation, Direct Install, Pipe, Per Foot, 2" Thickness, Electric	Commercial, Industrial, Agriculture, Schools & Government	14
2793	Insulation, Direct Install, Pipe, Per Foot, 2" Thickness, NG	Commercial, Industrial, Agriculture, Schools & Government	14
2794	Insulation, Direct Install, Pipe, Per Foot, 1" Thickness, Electric	Industrial, Agriculture, Schools & Government	14
		Commercial	16
2795	Insulation, Direct Install, Pipe, Per Foot, 1" Thickness, NG	Industrial, Agriculture, Schools & Government	14
		Commercial	16
2797	Occupancy Sensor, With Co-Pay, Wall Mount, ≤200 Watts	Commercial, Industrial, Agriculture, Schools & Government	9
2798	Occupancy Sensor, With Co-Pay, Wall Mount, >200 Watts	Commercial, Industrial, Agriculture, Schools & Government	9
2810	Timer, Engine Block Heater	Commercial, Industrial, Agriculture, Schools & Government	8
2820	Ground Source Heat Pump, Electric Back-up	New Construction-Residential- single family, Residential- single family	18
2821	Ground Source Heat Pump, NG Back-up	New Construction-Residential- single family, Residential- single family	18
2825	Water Heater Fuel Switching, Electric to NG	Commercial, Industrial, Agriculture, Schools & Government	15

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MMID	Measure Name	Sector(s)	EUL (years)
2826	Roof Top Tune Up, ≤7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	9
2827	Roof Top Upgrade, DCV, ≤7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	15
2828	Roof Top Upgrade, DCV & Economizer, ≤7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	15
2829	Roof Top Upgrade, Economizer, ≤7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	15
2830	Roof Top Upgrade, Thermostat, ≤7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	15
2831	Roof Top Upgrade, Thermostat & DCV, ≤7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	15
2832	Roof Top Upgrade, Thermostat & Economizer, ≤7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	15
2833	Roof Top Upgrade, Thermostat, DCV, & Economizer, ≤7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	15
2834	Roof Top Tune Up, >7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	9
2835	Roof Top Upgrade, Thermostat, >7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	15
2836	Roof Top Upgrade, DCV, >7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	15
2837	Roof Top Upgrade, Thermostat and DCV, >7.5 Tons	Commercial, Industrial, Agriculture, Schools & Government	15
2839	Bonus, T12 Bounty, 1 Lamp Fixture	Commercial, Industrial, Agriculture, Schools & Government	1
2840	Bonus, T12 Bounty, 2 Lamp Fixture	Commercial, Industrial, Agriculture, Schools & Government	1
2841	Bonus, T12 Bounty, 3 Lamp Fixture	Commercial, Industrial, Agriculture, Schools & Government	1
2842	Bonus, T12 Bounty, 4 Lamp Fixture	Commercial, Industrial, Agriculture, Schools & Government	1
2884	T8 4L Replacing 250-399 Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2885	T8 6L Replacing 400-999 Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2886	T8 8L Replacing 400-999 Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2887	T8 8L ≤ 500Watt, Replacing ≥1,000Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2888	T8 10L ≤ 500Watt, Replacing ≥1,000Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14

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MMID	Measure Name	Sector(s)	EUL (years)
2889	T8 (2) 6L ≤ 500att, Replacing ≥1,000Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2890	T5HO 2L Replacing 250-399 Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2891	T5HO 3L Replacing 250-399 Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2892	T5HO 4L Replacing 400-999 Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2893	T5HO 6L Replacing 400-999 Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2894	T5HO 6L ≤ 500Watt, Replacing ≥1,000Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2895	T5HO 8L ≤ 500Watt, Replacing ≥1,000Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2896	T5HO (2) 4L ≤ 500Watt, Replacing ≥1,000Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2897	T5HO (2) 6L ≤ 800Watt, Replacing ≥1,000 Watt HID	Commercial, Industrial, Agriculture, Schools & Government	14
2955	Refrigerator, Recycling and Replacement	Residential- single family	8
2956	Freezer, Recycling and Replacement	Residential- single family	8
2957	Refrigerator, MESP Referral, Recycling and Replacement	Residential- multifamily	8
2958	Refrigerator, Recycling and Replacement Referral	Residential- multifamily	8
2959	CFL, Retail Store Markdown	Upstream	8
2971	LED Lamp, Direct Install, Walk-in Cooler or Freezer	Commercial	15
2979	LED, Exit Sign, Retrofit, Over Program Limit	Commercial, Industrial, Agriculture, Schools & Government, Residential-multifamily	16
2980	LED, Retail Store Markdown	Upstream	15
2985	ECM, Addition or Replacement for a Furnace	Residential- single family	23

Hybrid and Custom Measures by Measure Master ID

MMID	Measure Name	Source	EUL (years)
2007	Ground Source Heat Pump	DEER 2008	15
2007	Ground Source Heat Pump	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15

MMID	Measure Name	Source	EUL (years)
212	Coarse Bubble Aeration	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2191	A/C Coil Cleaning, Ultraviolet	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2196	Air Compressor, Variable Speed Drive, Constant Speed Replacement	DEER 2008	15
2204	Boiler Burner, Not Otherwise Specified	Engineering Judgment	20
2207	Boiler Oxygen Trim Controls	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2210	Boiler System, Automatic Chemical Feed Component	Engineering Judgment	15
2212	Boiler Tune-up, Industrial Process	CT 2013 TRM	5
2213	Boiler, Combustion Management System	Engineering Judgment	15
2214	Boiler, Dedicated Steam During Non-heating Months	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2215	Boiler, Flue Gas Heat Recovery	DEER 2008	15
2220	Boiler, Not Otherwise Specified	DEER 2008	20
2228	Building Envelope, Glazing Retrofit	GDS 2007	20
2229	Building Envelope, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	25
223	Blower Purge Dryer	GDS 2007	15
2230	Building Envelope, Reduce Air Infiltration	DEER 2008	20
2231	Building Envelope, Skylights	DEER 2008	20
2232	Building Envelope, Window Replacement	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2233	Burners, Recuperative	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
224	Cycling Air Dryer	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2247	Chiller System, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2248	Chiller System, Water Free Cooling Controls and Equipment	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2249	Chiller, High Efficiency, Air Cooled, Replacement	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2250	Chiller, High Efficiency, Water Cooled < 150 Tons, Replacement	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2251	Chiller, High Efficiency, Water Cooled >= 300 Tons, Replacement	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2252	Chiller, High Efficiency, Water Cooled 150-299 Tons, Replacement	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20

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MMID	Measure Name	Source	EUL (years)
2253	Circulation Fan, High Efficiency, Ag	Focus on Energy Evaluation - Business Program: Measure Life Study 2009; Similar Heat Recovery Measure	15
2256	Compressed Air Heat Recovery, Non-space Heating	Engineering Judgment	15
2260	Compressed Air System Isolation	Engineering Judgment	15
2261	Compressed Air System Leak Survey and Repair, Year 1	Engineering Judgment	4
2262	Compressed Air System Leak Survey and Repair, Year 2	Engineering Judgment	4
2263	Compressed Air System Leak Survey and Repair, Year 3	Engineering Judgment	4
2265	Compressed Air, Not Otherwise Specified	Engineering Judgment	15
2266	Compressed Air, Process Load Reduction	DEER 2008 - Economizer	15
2267	Compressor, Duct in Outside Air	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2268	Cooler Curtain	DEER 2008	5
2270	Cooler Night Covers	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	5
2272	Dairy Refrigeration, Scroll Compressors, Ag	Engineering Judgment	15
2273	Damper Controls, Automatic	DEER 2008	10
2274	Daylighting Controls, Automatic	Engineering Judgment	8
2275	Delamping, Not Otherwise Specified	Engineering Judgment	12
2278	Demand Limiting Controls	DEER 2008	15
2279	Destratification	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2304	Domestic Hot Water, Not Otherwise Specified	DEER 2008	13
2305	Drycooler, Computer Room Air Conditioner Economizer	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2313	ECM Motor, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2314	Energy Recovery Ventilator	DEER 2008	15
2319	Fans, High Volume Low Speed (HVLS), Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009; Similar Heat Recovery Measure	15
232	Laundry Heat Recovery	Engineering Judgment	15
2320	Food Service, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2361	Furnace, Stack, Melting	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15

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MMID	Measure Name	Source	EUL (years)
2368	Grain Dryer, Energy Efficient	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2369	Greenhouse Roof Vents	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2370	Greenhouse Thermal blanket	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2374	Guest Room Energy Management Controls, Not Otherwise Specified	Engineering Judgment	8
2375	Heat Exchanger, Pre-heat Combustion Air	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2376	Heat Recovery Tank, No Heating Element, Ag, Electric or NG	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2377	Heat Recovery, Compressor Heat Used For Space Heating	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2378	Heat Recovery, Compressor Heat Used To Pre-heat DHW	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2379	Heat Recovery, Not Otherwise Specified	DEER 2008	15
2381	HVAC Controls, Air Side Economizer, Free Cooling	Engineering Judgment	10
2382	HVAC Controls, Scheduling/Setpoint Optimization	MA 2013 TRM	15
2383	HVAC Energy Management System	Engineering Judgment	15
2384	HVAC Zone Increase	DEER 2008	15
2385	HVAC, Low Temp System w/ Condensing Boilers	Engineering Judgment	20
2386	HVAC, Not Otherwise Specified	Engineering Judgment	15
2387	HVAC, Variable Refrigerant Flow/Volume Systems	Engineering Judgment	15
2420	Induction Lighting, Not Otherwise Specified	Engineering Judgment	12
2421	Industrial Oven or Furnace, Not Otherwise Specified	GDS 2007	15
2423	Insulation, Attic, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	25
2424	Insulation, Boiler Expansion Tank	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2425	Insulation, Boiler Plumbing	GDS 2007	15
2426	Insulation, Ceiling	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	25
2427	Insulation, Condensate Tank	GDS 2007	15
2428	Insulation, Roof	GDS 2007	25
2431	Insulation, Wall, Not Otherwise Specified	VT 2013 TRM	25

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MMID	Measure Name	Source	EUL (years)
2432	Insulation, Water Heater, Not Otherwise Specified	Engineering Judgment	6
2433	Irrigation Measure, Not Otherwise Specified	Engineering Judgment	15
2434	Irrigation Pressure Reduction, Nozzle Installation & Motor Downsizing	Engineering Judgment	15
2435	IT Systems, Cold Aisle Containment	Engineering Judgment	15
2436	IT Systems, Not Otherwise Specified	Engineering Judgment	15
2437	IT Systems, Printer Consolidation	Engineering Judgment	15
2438	IT Systems, Server Consolidation	Engineering Judgment	15
2439	IT Systems, Server Virtualization	Engineering Judgment	15
2440	IT Systems, Server Virtualization, Not Otherwise Specified	Engineering Judgment	15
2441	IT Systems, Uninterruptible Power Supply	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2442	Kiln Lumber Drying	Engineering Judgment	12
2443	Laundry Equipment - Not Otherwise Specified	Engineering Judgment	15
2444	Laundry, Not Otherwise Specified	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	15
2454	LED, Loading Dock Fixture	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	12
2455	LED, Not Otherwise Specified	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	12
2459	LED, Traffic Lights	GDS 2007	12
246	Overhead Door Seals	DEER 2008	20
2461	Lighting Controls, Not Otherwise Specified	Engineering Judgment	8
2462	Lighting Layout Reconfiguration	Engineering Judgment	10
2463	Lighting, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	12
2464	Mechanical Sub-Cooling	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2468	Milk Pasteurization System, Ag, Electric	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2469	Milk Pasteurization System, Ag, NG	Engineering Judgment	15
2470	Motor, Not Otherwise Specified	GDS 2007	15
2489	Overhead Door Retrofit	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2490	Plastics Equipment, Radiant Heater Band Retrofit	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2491	Plate Heat Exchanger and Well Water Pre-Cooler	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15

MMID	Measure Name	Source	EUL (years)
2492	Plate Heat Exchanger, Milk Pipeline, VFD On Milk Vacuum Pump, Ag	Engineering Judgment	15
2493	Pool, Not Otherwise Specified	Engineering Judgment	15
2496	Pressure Screen Rotor	Focus on Energy Evaluation - Business Program: Measure Life Study 2009; Similar Heat Recovery Measure	15
2497	Process Heat Recovery, Condensing Heat Exchanger	Focus on Energy Evaluation - Business Program: Measure Life Study 2009; Similar Heat Recovery Measure	15
2498	Process Heat Recovery, Not Otherwise Specified	Engineering Judgment	15
2499	Process, Not Otherwise Specified	Engineering Judgment	15
2504	Pumping and Piping System Efficiency Improvement	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2505	Pumping, Shift To Off-peak	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2506	Pumps, Impeller Trim	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	5
2507	Radiant Tube Inserts	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	5
2508	Radiant Tube Inserts, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	5
2511	Refrigeration Economizer, Ambient Subcooling	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2517	Refrigeration, Central Parallel Rack System Replacing Individual Units	MA 2013 TRM	10
2518	Refrigeration, Defrost Controls	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2519	Refrigeration, Liquid Pressure Amplifiers	Engineering Judgment	5
2520	Refrigeration, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	16
2537	Regenerative Thermal Oxidizer (RTO)	Engineering Judgment	12
2538	Repulper Rotor	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2539	Rooftop Unit	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2540	Steam System Isolation	DEER 2008	20
2543	Steam Trap Repair, > 225 psig, General Heating	DEER 2008	6
2545	Steam Trap Repair, 126-225 psig, General Heating	DEER 2008	6

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MMID	Measure Name	Source	EUL (years)
2547	Steam Trap Repair, 50-125 psig, General Heating	Engineering Judgment	6
2589	T8, CEE, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	12
2600	Thermal Curtain, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2607	Ultraviolet, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2609	Unit Heater, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2610	Variable Speed Drive, Chilled Water Pump or Cooling Tower Condensing Pump	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2619	Ventilation Controls, Kitchen Exhaust Hood	VT 2013 TRM - Variable Frequency Drive (VFD)	10
2639	VFD, Ag Second Use Water System	DEER 2008	15
2640	VFD, Boiler Draft Fan	DEER 2008	15
2641	VFD, Cooling Tower Fan	DEER 2008	15
2642	VFD, Dairy Vacuum Pump, Ag	DEER 2008	15
2643	VFD, HVAC Fan	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2644	VFD, HVAC Heating Pump	VT 2013 TRM	15
2645	VFD, Not Otherwise Specified	VT 2013 TRM - Variable Frequency Drive (VFD)	15
2646	VFD, Pool Pump Motor	VT 2013 TRM - Variable Frequency Drive (VFD)	15
2647	VFD, Process Fan	VT 2013 TRM - Variable Frequency Drive (VFD)	15
2648	VFD, Process Pump	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2650	Waste Water Treatment, Not Otherwise Specified	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2654	Water Heater, >90% TE, Condensing, Residential	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2655	Water Heater, Dual Thermostat, Ag, NG	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2656	Water Heater, Fuel Switching, Electric to NG	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15

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MMID	Measure Name	Source	EUL (years)
2657	Water Heater, Fuel Switching, Electric to NG, Ag	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2659	Water Heater, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	13
2661	Waterer, Livestock, Not Otherwise Specified, Ag	GDS 2007	10
2662	Weather Stripping Around Doors, Replacement	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2663	Welder, Replace w/ High Efficiency Unit	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	13
2664	Well and Pump Installation	Engineering Judgment	15
2676	High Intensity Discharge Lighting, Not Otherwise Specified	Engineering Judgment	12
2680	HVAC Controls, Not Otherwise Specified	GDS 2007	15
2690	Insulation, Attic	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	25
2694	LED Fixture, Exterior Wall-Pack Fixture	GDS 2007	12
2710	Air Sealing, Project Based	CT 2013 TRM	20
2722	Ventilation Controls, Demand Controlled Ventilation	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2723	Evaporative Condensers Replace Air-Cooled Condensers	Engineering Judgment	10
2724	Ventilation Controls, Exhaust/Supply For Paint/Spray Booth	Engineering Judgment	10
2725	Refrigeration System Tune-up, Agriculture	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2726	VFD, Chilled Water Distribution Pump	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2727	Aeration, Not Otherwise Specified	GDS 2007	15
2745	Air Sealing	Non-Energy Saving Measure - No EUL	20
2746	Benchmarking	DEER 2008	1
2747	Boiler, >= 90% AFUE, NG	DEER 2008	20
2748	Boiler, 85-90% AFUE, NG	Engineering Judgment	20
2749	Booster Coils, Replace Electric With NG	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2750	Booster Heater, Dishwasher, Replace Electric With NG	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2751	Booster Heater, Kitchen, Replace Electric With NG	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	12

MMID	Measure Name	Source	EUL (years)
2755	Chiller, High Efficiency, Water Cooled, Replacement	Consistent with other waste water treatment measures. Engineering Judgment	20
2760	DHW Plant Replacement	Engineering Judgment	15
2765	HID, Not Otherwise Specified	GDS 2007	12
2766	Insulation, Sill Box	Engineering Judgment	25
2771	Space Heating, Replace Electric Units With NG Units	DEER 2008	15
2773	Windows, Energy Star	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2774	Insulation, DHW Plumbing	Engineering Judgment	10
2775	Ventilation Controls	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	10
2778	Water Heater, Dual Thermostat, Ag, Electric	Engineering calculation using 10000 hours with 3730 annual hours of operation.	15
2784	CFL, Direct Install, 15 Watt	Engineering calculation using 10000 hours with 3730 annual hours of operation.	3
2785	CFL, Direct Install, 42 Watt	Engineering calculation using 10000 hours with 3730 annual hours of operation.	3
2786	CFL, Direct Install, 7 Watt	Engineering calculation using 10000 hours with 3730 annual hours of operation.	3
2787	CFL, Direct Install, 5 Watt	DEER 2008	3
279	Air-Conditioning Economizer, Automatic	Engineering Judgment	10
2799	T8 1L 4', 28W, CEE, BF > 0.78	Engineering Judgment	12
2800	T8 1L 4', With Co-Pay, 28W, CEE, BF > 0.78	Engineering Judgment	12
2801	T8 2L 4', 28W, CEE, BF > 0.78	Engineering Judgment	12
2802	T8 2L 4', With Co-Pay, 28W, CEE, BF > 0.78	Engineering Judgment	12
2803	T8 3L 4', 28W, CEE, BF > 0.78	Engineering Judgment	12
2804	T8 3L 4', With Co-Pay, 28W, CEE, BF > 0.78	Engineering Judgment	12
2805	T8 4L 4', 28W, CEE, BF > 0.78	Engineering Judgment	12
2806	T8 4L 4', With Co-Pay, 28W, CEE, BF > 0.78	Engineering Judgment	12
2807	T8 4L or T5HO 2L Replacing 250-399 W HID	Engineering Judgment	12
2808	T8 6L or T5HO 4L Replacing 400-999 W HID	Engineering Judgment	12
2809	T8 or T5HO, Replacing >=1000 Watt HID	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	12
281	Air Rotation or Air Turnover Units to Minimize Stratification	Engineering calculation using 10000 hours with 3730 annual hours of operation.	15
2811	CFL, Direct Install, 9 Watt	Engineering calculation using 10000 hours with 3730 annual hours of operation.	3
2812	CFL, Direct Install, 13 Watt	Engineering calculation using 10000 hours with 3730 annual hours of operation.	3

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MMID	Measure Name	Source	EUL (years)
2813	CFL, Direct Install, 14 Watt	Engineering calculation using 10000 hours with 3730 annual hours of operation.	3
2815	CFL, Direct Install, 23 Watt	Engineering calculation using 10000 hours with 3730 annual hours of operation.	3
2816	CFL, Direct Install, 18 Watt	Engineering Judgment	3
2819	Solar PV	CT 2013 TRM	20
2822	Solar Thermal, Electric	CT 2013 TRM	20
2823	Solar Thermal, NG	VT 2013 TRM - Variable Frequency Drive (VFD)	20
2824	VFD, Ag Primary Use Water System	Focus on Energy Evaluation - Business Program: Measure Life Study 2009; Similar Heat Recovery Measure	15
284	Exhaust Air Heat Recovery System	Engineering Judgment	15
2848	Compressed Air Process Load Shifting	CT 2013 TRM - Make-up Air Unit	20
285	Ventilation Filtration vs Make Up Air System	CT 2013 TRM	15
2853	Ventilation Controls, Demand Control Ventilation For Air Handling Units	Engineering calculation using 10000 hours with 3730 annual hours of operation.	10
2862	CFL, Direct Install, 16 Watt	Engineering Judgment	3
287	Mechanical Vent Dampers	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
289	Desiccant Dehumidifier	DEER 2008	15
2900	Ground Source Heat Pump, Electric Back-up	DEER 2008	15
2901	Ground Source Heat Pump, NG Back-up	DEER 2008	15
2903	Ground Source Heat Pump, LP Back-up	DEER 2008	15
2904	Ground Source Heat Pump, No Back-up	CT 2013 TRM	15
2905	Solar Thermal, Electric	CT 2013 TRM	20
2906	Solar Thermal, NG	Engineering Judgment	20
2908	Wind	Engineering Judgment	20
2909	Biogas	Engineering Judgment	20
2910	Biomass	CT 2013 TRM	20
2911	Solar Thermal, Not Otherwise Specified	DEER 2008	20
2912	Ground Source Heat Pump, Not Otherwise Specified	DEER 2008	15
2916	Boiler, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	20
2917	Chiller System, Not Otherwise Specified	Engineering Judgment	20
2918	Compressed Air System, Not Otherwise Specified	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15

MMID	Measure Name	Source	EUL (years)
2919	Domestic Hot Water, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	13
2920	Heat Recovery, Not Otherwise Specified	Engineering Judgment	15
2921	HVAC Controls, Not Otherwise Specified	Engineering Judgment	15
2922	HVAC, Not Otherwise Specified	Engineering Judgment	15
2923	IT Systems, Not Otherwise Specified	DEER 2008	15
2924	Lighting Controls, Not Otherwise Specified	Engineering Judgment	8
2925	Motors, Not Otherwise Specified	Engineering Judgment	15
2926	Pool, Not Otherwise Specified	Engineering Judgment	5
2927	Process, Not Otherwise Specified	Engineering Judgment	15
2928	Refrigeration, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
2929	Unit Heater/Make Up Air/Exhaust, Not Otherwise Specified	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	15
2931	LED Fixture, Canopy	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	12
2932	LED Fixture, Exterior Pole Mounted	CT 2013 TRM - Demand Controlled Ventilation (DCV)	12
2933	Roof Top Upgrade, DCV & Economizer, <=7.5 Tons	CT 2013 TRM - Demand Controlled Ventilation (DCV)	10
2934	Roof Top Upgrade, DCV, <=7.5 Tons	CT 2013 TRM - Demand Controlled Ventilation (DCV)	10
2935	Roof Top Upgrade, DCV, >7.5 Tons	DEER 2008 - Economizer	10
2936	Roof Top Upgrade, Economizer, <=7.5 Tons	CT 2013 TRM - Demand Controlled Ventilation (DCV)	10
2937	Roof Top Upgrade, Thermostat & DCV, <=7.5 Tons	DEER 2008 - Economizer	10
2938	Roof Top Upgrade, Thermostat & Economizer, <=7.5 Tons	CT 2013 TRM - Demand Controlled Ventilation (DCV)	10
2939	Roof Top Upgrade, Thermostat and DCV, >7.5 Tons	Focus on Energy Evaluation - Business Program: Measure Life Study 2009 - Rooftop Unit	10
2940	Roof Top Upgrade, Thermostat, <=7.5 Tons	Focus on Energy Evaluation - Business Program: Measure Life Study 2009 - Rooftop Unit	15
2941	Roof Top Upgrade, Thermostat, >7.5 Tons	CT 2013 TRM - Demand Controlled Ventilation (DCV)	15
2942	Roof Top Upgrade, Thermostat, DCV, & Economizer, <=7.5 Tons	Engineering calculation using 10000 hours with 3730 annual hours of operation.	10
2944	CFL, Direct Install, 20 Watt	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	3

MMID	Measure Name	Source	EUL (years)
2948	LED, Direct Install, 10 Watt, Replacing MR16 (Reflector Halogen)	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	12
2949	LED, Direct Install, 12 Watt	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	12
2950	LED, Direct Install, 13 Watt	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	12
2951	LED, Direct Install, 18 Watt	Engineering Judgment. LED lifetimes range from 25,000 to 50,000 hours	12
2952	LED, Direct Install, 3 Watt	DEER 2008	12
2954	VFD, Dairy Milk Pump	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
296	Chiller Optimization Controls	Engineering Judgment	10
2960	T8 or T5HO ≤155W, Replacing 250-399W HID, Not Otherwise Specified	Engineering Judgment	12
2961	T8 or T5HO ≤250W, Replacing 400-999W HID, Not Otherwise Specified	Engineering Judgment	12
2962	T8 or T5HO 251-365W, Replacing 400-999W HID, Not Otherwise Specified	Engineering Judgment	12
2963	T8 or T5HO ≤500W, Replacing >=1000W HID, Not Otherwise Specified	Engineering Judgment	12
2964	T8 or T5HO ≤800W, Replacing 1000W HID, Not Otherwise Specified	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	12
299	Replace Constant Volume HVAC with VAV	Engineering Judgment	15
3004	Lighting Controls, Bilevel, Exterior and Parking Garages	Engineering Judgment	8
3016	Ventilation Controls, Parking Lot	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	5
3022	A/C Split or Packaged System, High Efficiency	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
3045	Water Heater, High Usage, >=90% TE, NG	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	13
3046	Water Heater, High Usage, >= 0.82 EF, Tankless, NG	VT 2013 TRM; Focus on Energy Evaluation - Business Program: Measure Life Study 2009	13
3047	Water Heater, High Usage, >= 2 EF, Heat Pump Storage, Electric	DEER 2008	13
3059	A/C Coil Cleaning, < 10 tons	DEER 2008	3
3060	A/C Coil Cleaning, > 20 tons	DEER 2008	3
3061	A/C Coil Cleaning, 10-20 tons	DEER 2008	3

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MMID	Measure Name	Source	EUL (years)
3062	A/C Refrigerant Charge Correction, < 10 tons	DEER 2008	10
3063	A/C Refrigerant Charge Correction, > 20 tons	DEER 2008	10
3064	A/C Refrigerant Charge Correction, 10-20 tons	DEER 2008 - Economizer	10
3066	Economizer, RTU Optimization	Engineering Judgment	10
309	Air Filtration for Exhaust Air System	Engineering Judgment	15
3115	Lighting Controls, Bilevel, Interior	Engineering Judgment	8
3116	Lighting Controls, Photocell with Internal Timer	Focus on Energy Evaluation - Business Program: Measure Life Study 2009; Similar Heat Recovery Measure	8
312	Refrigeration Waste Heat Recovery	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
3120	Programmable Thermostat, RTU Optimization Advanced	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	5
3121	Programmable Thermostat, RTU Optimization Standard	Engineering Judgment	5
315	Cooler Economizer	CT 2013 TRM	16
371	Combustion Management System on Boiler	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
409	Greenhouse Perimeter Insulation	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
525	Variable Displacement Compressor	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
548	Compressed Air Nozzles	Focus on Energy Evaluation - Business Program: Measure Life Study 2009	15
598	Greenhouse Climate Controls	DEER 2008	10

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Appendix D: Incremental Costs

MMID	Measure Name	Source	Incremental Cost
566	PC Network Energy Management System	Historical Project Data	$36.97
598	Greenhouse Climate Controls, Hybrid	Historical Project Data	$790.00
1981	Gas Furnace with ECM, 95+ AFUE (Existing)	CLEAResult surveyed 40 Trade Allies at length concerning cost points at various AFUE increments, both with and without staging and with or without ECMs. CLEAResult took the average reported cost for a 92% furnace with no staging and no ECM and subtracted that amount from the average reported cost for a 95% multi-stage with ECM.	$345.93
1983	Hot Water Boiler, 95%+ AFUE	Trade Ally Survey	$3,105.00
1985	Water Heater, Power Vented, EF ≥0.67	Existing Cost Figure	$14.32
1986	Water Heater, Condensing	2010. This value comes from the middle of the range ($1985) of installed costs from the above source minus the $865 installed cost of the baseline. These units are only recently on the market and a review of available pricing support this number.	$1,120.00
1987	Tankless Water Heater, EF 0.82+	DEER/RSMeans	$454.09
1988	Water Heater, Indirect	Existing Cost Data/Workpaper	$204.88
1989	Water Heater, Electric, EF 0.93 or greater	DEER/RSMeans	$25.16
1993	Level 1: 10-19.9%	Cadmus has no additional data to change original assumptions.	$1,200.00
1994	Level 2: 20-29.9%	Cadmus has no additional data to change original assumptions.	$1,450.00
1995	Level 3: 30-39.9%	Cadmus has no additional data to change original assumptions.	$3,600.00
1996	Level 4: 40 or greater%	Cadmus has no additional data to change original assumptions.	$11,100.00
1997	Level 1: 10-19.9%	Cadmus has no additional data to change original assumptions.	$1,200.00
1998	Level 2: 20-29.9%	Cadmus has no additional data to change original assumptions.	$1,450.00
1999	Level 3: 30-39.9%	Cadmus has no additional data to change original assumptions.	$3,600.00

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MMID	Measure Name	Source	Incremental Cost
2000	Level 4: 40 or greater%	Cadmus has no additional data to change original assumptions.	$11,100.00
2023	LP/Oil Gas Furnace with ECM, 90%+ AFUE	Existing Cost Figure	$432.00
2116	CFL, 9 Watt	Light bulb sales data obtained by Cadmus for California- 2010 through 2012. Note that the CFL average lamp costs include incented lamps.	$1.21
2117	CFL, 14 Watt	Light bulb sales data obtained by Cadmus for California- 2010 through 2012. Note that the CFL average lamp costs include incented lamps.	$0.37
2118	CFL, 19 Watt	Light bulb sales data obtained by Cadmus for California- 2010 through 2012. Note that the CFL average lamp costs include incented lamps.	$0.38
2119	CFL, 23 Watt	Light bulb sales data obtained by Cadmus for California- 2010 through 2012. Note that the CFL average lamp costs include incented lamps.	$1.03
2120	Faucet Aerator, Non PI Direct Install, 1.5 gpm, Kitchen, NG	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures. Please provide a more robust source citation that includes program name, date range, etc.	$5.00
2121	Faucet Aerator, Non PI Direct Install, 1.0 gpm, Bathroom, NG	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures. Please provide a more robust source citation that includes program name, date range, etc.	$3.00
2122	Insulation, Non PI Direct Install, 6' pipe, NG	RSMeans	$23.76
2123	Low-flow Showerhead, 1.5 gpm, Gas MF	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$5.00
2124	Low-flow Showerhead, 1.75 gpm, Gas	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$5.00
2125	DHW Temperature Turn Down, Non PI Direct Install, NG	Existing Cost Figure	$-

MMID	Measure Name	Source	Incremental Cost
2126	Faucet Aerator, Non PI Direct Install, 1.5 gpm, Kitchen, Electric	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$5.00
2127	Faucet Aerator, Non PI Direct Install, 1.0 gpm, Bathroom, Electric	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$3.00
2128	Insulation, Non PI Direct Install, 6' pipe, Electric	RSMeans	$23.76
2129	Low-flow Showerhead, 1.5 gpm, Electric	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$5.00
2130	Low-flow Showerhead, 1.75 gpm, Electric	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$5.00
2131	DHW Temperature Turn Down, Non PI Direct Install, Electric	Existing Cost Figure	$-
2132	CFL, Direct Install, 9 Watt	MMID 2116	$1.21
2133	CFL, Direct Install, 14 Watt	MMID 2117	$0.37
2134	CFL, Direct Install, 19 Watt	MMID 2118	$0.38
2135	CFL, Direct Install 23W	MMID 2119	$1.03
2136	Faucet Aerators, Direct Install, 1.5 gpm, Kitchen, NG	MMID 2126	$5.00
2137	Faucet Aerator, Direct Install, 1.0 gpm, Bathroom, NG	MMID 2127	$3.00
2138	Pipe Insulation 6', Gas	MMID 2128	$23.76
2139	Low-flow Showerhead, 1.5 gpm, Gas	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$5.00
2140	Water Saving Showerheads, Direct Install, NG	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$5.00
2141	DHW Temperature Turn Down, Direct Install, NG	MMID 2131	$-
2145	Low-Flow Showerhead, 1.5 gpm, Electric MF	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$5.00
2146	Water Saving Showerheads, Direct Install, Electric	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$5.00
2147	DHW Temperature Turn Down, Electric & Gas	MMID 2131	$-
2150	Cooler Miser-Direct Install	Implementer Data	$205.33

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MMID	Measure Name	Source	Incremental Cost
2155	Low Flow Faucet Aerators, Direct Install, Electric, Kitchen	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$8.00
2156	Low Flow Faucet Aerators, Direct Install, Natural Gas, Kitchen	Cadmus agrees that program data is the best source for future measure cost, and including installation is ideal for direct install measures.	$8.00
2158	Pre-rinse Spray Valve, Electric MF	Niagara m/n N2180 per www.conservationmart.com/p-301-niagara-128-gpm-prerinse-kitchen-spray-n2180.aspx	$37.50
2159	Pre-rinse Spray Valve, Gas MF	Niagara m/n N2180 per www.conservationmart.com/p-301-niagara-128-gpm-prerinse-kitchen-spray-n2180.aspx	$37.50
2192	A/C Split System < 65 MBh SEER 15	Online Retailers/RSMeans	$663.59
2193	A/C Split System < 65 MBh SEER 16 or greater	Online Retailers/RSMeans	$712.61
2194	A/C Split System < 65 MBh SEER 14	Online Retailers/RSMeans	$390.46
2196	VSD Air Compressor, Hybrid	Illinois TRM	$1446+$127/hp
2197	Anti-sweat heater controls, on freezer case with low-heat door	RTF, SDG&E Working Paper (cost per door assuming 2.5 ft door)	$95.00
2198	Anti-sweat heater controls, on freezer case with no-heat door	RTF, SDG&E Working Paper (cost per door assuming 2.5 ft door)	$95.00
2199	Anti-sweat heater controls, on freezer case with standard door	RTF, SDG&E Working Paper (cost per door assuming 2.5 ft door)	$95.00
2200	Anti-sweat heater controls, on refrigerated case with low-heat or no-heat doors	RTF, SDG&E Working Paper (cost per door assuming 2.5 ft door)	$95.00
2201	Anti-sweat heater controls, on refrigerated case with standard door	RTF, SDG&E Working Paper (cost per door assuming 2.5 ft door)	$95.00
2203	High Turn Down Burner - NEW	Historical Project Data	$26,034.00
2205	Linkageless Boiler Control, per hp	2010. Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Industrial, Commercial, and Institutional Boilers, Prepared by the Sector Policies and Programs Division Office of Air Quality Planning and Standards U.S. Environmental Protection Agency Research Triangle Park, North Carolina 27711, October 2010, Table 1. ICI Boilers – Summary of Greenhouse Gas Emission Reduction Measures, pg. 8	$26,000.00

MMID	Measure Name	Source	Incremental Cost
2206	Boiler oxygen trim controls, per hp	2011. CODES AND STANDARDS ENHANCEMENT INITIATIVE (CASE) PROCESS BOILERS, 2013 California Building Energy Efficiency Standards, California Utilities Statewide Codes and Standards Team, October 2011, pg. 22	$29,416.00
2209	Boiler Plant 1M - 5M, Mid Efficiency - NEW	Historical Project Data	$16.43/MBh
2211	Boiler Tune-up - service buy down	Online Research	$119.95
2217	Boiler, hot water, high efficiency modulating, for space heating (AFUE ≥90%)	Existing Cost Figure	$2,857.55
2218	Boiler, Hot Water Modulating, ≥90% AFUE, >300 MBH	Historical Project Data	$50.25/MBh
2221	Boiler Control - Outside Air Reset/Cutout	2006. Nexant. Questar DSM Market Characterization Report. August 9, 2006	$612.00
2234	Case door, freezer, low heat	2013. Based on manufacturers cost data and EVT experience.	$145.00
2235	Case door, freezer, no heat	2013. Based on manufacturers cost data and EVT experience.	$290.00
2236	Case door, refrigerated, no heat	2013. Based on manufacturers cost data and EVT experience.	$72.50
2237	HO T-5, 10 Lamp Fixture: Interior, Metal Halide, > 600 ≤1080 Watt, Direct Install	Implementer's cost (other rows), Cadmus estimate for labor duration and RSMeans for labor cost.	$-
2237	HO T-5, 2 Lamp/T-8, 4 Lamp Fixture: Interior Replacing Metal Halide, > 200 < 400 W, Direct Install	Implementer's cost (other rows), Cadmus estimate for labor duration and RSMeans for labor cost.	$156.14
2237	HO T-5, 4 Lamp/T-8, 6 Lamp Fixture: Interior Metal Halide, >400 ≤600 W, Direct Install	Implementer's cost (other rows) and Cadmus estimate for labor duration and RSMeans for labor cost.	$163.56
2237	Metal Halide Ceramic 20-70 Watts - Replaces Incandescent	2012-2013 application data.	$147.37
2238	Ceramic Metal Halide Lamp, ≤25 Watts	MMID 3208	$43.54
2239	CFL Fixture, ≤100 Watts	From MMID 3203/3204	$7.29
2243	CFL High Wattage 31-115 Watts, replacing incandescent	Online research on 1000bulbs.com comparing 250 watt PAR38 Halogen ($15 average) with 50-65 watt CFL ($18 average).	$3.00

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MMID	Measure Name	Source	Incremental Cost
2245	CFL Cold Cathode Screw-In, replacing incandescent	Online Research	$7.16
2246	CFL reflector flood lamps replacing incandescent reflector flood lamps	Online research on 1000bulbs.com comparing 250 watt PAR38 Halogen ($15 average) with 50-65 watt CFL ($18 average).	$3.00
2249	High Efficiency Chillers - Retrofit, air cooled all sizes	2008. Calculated as the simple average of screw and reciprocating air-cooled chiller incremental costs from DEER2008. This assumes that baseline shift from IECC 2009 to IECC 2012 carries the same incremental costs. Values should be verified during evaluation	$127/ton
2250	High Efficiency Chillers - Retrofit, water cooled < 150 tons	2008. Calculated as the simple average of screw and reciprocating air-cooled chiller incremental costs from DEER2008. This assumes that baseline shift from IECC 2009 to IECC 2012 carries the same incremental costs. Values should be verified during evaluation	$128/ton
2251	High Efficiency Chillers - Retrofit, water cooled ≥300 tons	2008. Calculated as the simple average of screw and reciprocating air-cooled chiller incremental costs from DEER2008. This assumes that baseline shift from IECC 2009 to IECC 2012 carries the same incremental costs. Values should be verified during evaluation	$48/ton
2252	High Efficiency Chillers - Retrofit, water cooled ≥150 tons and < 300 tons	2008. Calculated as the simple average of screw and reciprocating air-cooled chiller incremental costs from DEER2008. This assumes that baseline shift from IECC 2009 to IECC 2012 carries the same incremental costs.	$70/ton
2253	Agricultural Circulation Fan, High Efficiency, Per Inch od Fan Diameter -	'Per Illinois TRM v3.0 (pg 68): ag circulation or exhaust fan incremental cost (all sizes) is $150 each.	$150.00
2254	No Loss Air Condensate Drains New	Online Pricing Research	$624.10
2255	Pressure/Flow Controllers, New	RSMeans and Online Research	$151.13
2258	Compressed Air Mist Eliminators, New	Historical Project Data	$21.55/hp
2259	Compressed Air Nozzles, Air Entraining	Historical Project Data	$36.42/nozzle
2261	Compressed Air System Leak Survey and Repair	Historical Project Data	$9.81/hp
2262	Compressed Air System Leak Survey and Repair, Year 2	Historical Project Data	$6.41/hp

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MMID	Measure Name	Source	Incremental Cost
2263	Compressed Air System Leak Survey and Repair, Year 3	Historical Project Data	$5.71/hp
2264	Cycled Refrigeration Thermal Mass Air Dryers New	Product Research	$10.20
2269	Cooler Evaporator Fan Control	RSMeans	$275.00
2271	Night Curtains for Open Coolers, per linear foot	Historical Project Data	$38.21
2272	Scroll Compressors for Dairy Refrigeration, Hybrid	Historical Project Data	$6,201.00
2276	Delamping, Direct Install, 4-Foot Lamp	Cadmus estimate for labor duration and RSMeans for labor cost.	$3.92
2277	Delamping, T8 to T8	Cadmus estimate for labor duration and RSMeans for labor cost.	$3.92
2280	Dishwasher, Low Temp, Door Type, Energy Star, Energy Star, Electric	Illinois TRM	$530.00
2281	Dishwasher, High Temp, Electric Booster, Door Type, Energy Star, Electric	Energy Star Calculator	$770.00
2282	Dishwasher, High Temp, Electric Booster, Door Type, Energy Star, NG	Energy Star Calculator	$770.00
2283	Dishwasher, High Temp, Electric Booster, Multi Tank Conveyor, Energy Star, Electric	Energy Star Calculator	$970.00
2284	Dishwasher, High Temp, Electric Booster, Multi Tank Conveyor, Energy Star, NG	Energy Star Calculator	$970.00
2285	Dishwasher, High Temp, Electric Booster, Single Tank Conveyor, Energy Star, Electric	Energy Star Calculator	$2,050.00
2286	Dishwasher, High Temp, Electric Booster, Single Tank Conveyor, Energy Star, NG	Energy Star Calculator	$2,050.00
2287	Dishwasher, High Temp, Electric Booster, Under Counter, Energy Star, Electric	Illinois TRM	$1,000.00
2288	Dishwasher, High Temp, Electric Booster, Under Counter, Energy Star, NG	Illinois TRM	$1,000.00

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MMID	Measure Name	Source	Incremental Cost
2289	Dishwasher, High Temp, Gas Booster, Door Type, Energy Star, NG	Energy Star Calculator	$770.00
2290	Dishwasher, High Temp, Gas Booster, Multi Tank Conveyor, Energy Star, NG	Energy Star Calculator	$970.00
2291	Dishwasher, High Temp, Gas Booster, Single Tank Conveyor, Energy Star, NG	Energy Star Calculator	$2,050.00
2292	Dishwasher, High Temp, Gas Heat, Gas Booster, Under Counter, Energy Star, NG	Illinois TRM	$1,000.00
2293	Dishwasher, Low Temp, Door Type, Energy Star, NG	Illinois TRM	$530.00
2294	Dishwasher, Low Temp, Multi Tank Conveyor, Energy Star, Electric	Energy Star Calculator	$970.00
2295	Dishwasher, Low Temp, Multi Tank Conveyor, Energy Star, NG	Energy Star Calculator	$970.00
2296	Dishwasher, Low Temp, Single Tank Conveyor, Energy Star, Electric	Illinois TRM	$170.00
2297	Dishwasher, Low Temp, Single Tank Conveyor, Energy Star, NG	Illinois TRM	$170.00
2298	Dishwasher, Low Temp, Under Counter, Energy Star, Electric	Illinois TRM	$530.00
2299	Dishwasher, Low Temp, Under Counter, Energy Star, NG	Illinois TRM	$530.00
2301	Dock Ramp/Pit Seal, Replacement	Online/Book Research	$1,250.00
2301	Dock Seals, Replacement	Online/Book Research	$1,370.41
2302	Dock Seal, Added to Existing Barrier	Online/Book Research	$1,370.41
2303	Dock Ramp/Pit Seal, From SPECTRUM	Online/Book Research	$1,250.00
2303	Dock Seals, New	Online/Book Research	$1,370.41
2305	Drycooler, Computer Room Air Conditioner Economizer	Existing Cost Figure	$340.17
2306	Compressor Cooler Motor, ECM - New	Online Research	$80.00
2307	ECM Condenser/Condensing Unit Fan Motor	Online Research	$80.00

MMID	Measure Name	Source	Incremental Cost
2308	ECM Evaporator fan motor replacing shaded-pole motor, <1/20 hp, in walk-in cooler	Online/Book Research	$61.61
2309	ECM Evaporator fan motor replacing shaded-pole motor, ≥1/20 hp, <1hp, in walk-in cooler	Online/Book Research	$61.59
2310	ECM Evaporator fan motor replacing shaded-pole motor, <1/20 hp, in walk-in freezer	Online/Book Research	$61.61
2311	ECM Evaporator fan motor replacing shaded-pole motor, ≥1/20 hp, <1hp, in walk-in freezer	Online/Book Research	$61.59
2312	ECM replacing shaded-pole motor in refrig/freezer case	Illinois TRM	$50.00
2314	Energy Recovery Ventilator	Online Research	$1,500.00
2314	Energy recovery ventilator, Hybrid	Historical Project Data	$6.14/CFM
2316	High Volume Low Speed fans replace Box Fans, 20 ft	RSMeans	$4,235.25
2317	High Volume Low Speed fans replace Box Fans, 22 ft	RSMeans	$4,689.88
2318	High Volume Low Speed fans replace Box Fans, 24 ft	RSMeans	$4,689.88
2321	Freezer, Chest, Glass Door, < 15 cu ft, Energy Star	Illinois TRM	$142.00
2322	Freezer, Chest, Glass Door, 15-29 cu ft, Energy Star	Illinois TRM	$166.00
2323	Freezer, Chest, Glass Door, 30-49 cu ft, Energy Star	Illinois TRM	$166.00
2324	Freezer, Chest, Glass Door, 50+ cu ft, Energy Star	Illinois TRM	$407.00
2325	Freezer, Chest, Solid Door, < 15 cu ft, Energy Star	Illinois TRM	$142.00
2326	Freezer, Chest, Solid Door, 15-29 cu ft, Energy Star	Illinois TRM	$166.00
2327	Freezer, Chest, Solid Door, 30-49 cu ft, Energy Star	Illinois TRM	$166.00
2328	Freezer, Chest, Solid Door, 50+ cu ft, Energy Star	Illinois TRM	$407.00
2329	Freezer, Vertical, Glass Door, < 15 cu ft, Energy Star	Illinois TRM	$142.00

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MMID	Measure Name	Source	Incremental Cost
2330	Freezer, Vertical, Glass Door, 15-29 cu ft, Energy Star	Illinois TRM	$166.00
2331	Freezer, Vertical, Glass Door, 30-49 cu ft, Energy Star	Illinois TRM	$166.00
2332	Freezer, Vertical, Glass Door, 50+ cu ft, Energy Star	Illinois TRM	$407.00
2333	Freezer, Vertical, Solid Door, < 15 cu ft, Energy Star	Illinois TRM	$142.00
2334	Freezer, Vertical, Solid Door, 15-29 cu ft, Energy Star	Illinois TRM	$166.00
2335	Freezer, Vertical, Solid Door, 30-49 cu ft, Energy Star	Illinois TRM	$166.00
2336	Freezer, Vertical, Solid Door, 50+ cu ft, Energy Star	Illinois TRM	$407.00
2337	Fryer, Electric, ENERGY STAR	Energy Star Calculator	$210.00
2338	Fryer, Gas, ENERGY STAR	Illinois TRM	$1,200.00
2350	Furnace, with ECM fan motor, for space heating (AFUE ≥95%), 109.9 - 120.7 MBh	Navigant Incremental Cost Study	$1,688.71
2352	Furnace, with ECM fan motor, for space heating (AFUE ≥95%), 133.0 - 146.1 MBh	Navigant Incremental Cost Study	$1,708.52
2354	Furnace, with ECM fan motor, for space heating (AFUE ≥95%), 54.675 - 60.749 MBh	Navigant Incremental Cost Study	$1,629.71
2355	Furnace, with ECM fan motor, for space heating (AFUE ≥95%), 60.750 - 67.499 MBh	Navigant Incremental Cost Study	$1,629.71
2356	Furnace, with ECM fan motor, for space heating (AFUE ≥95%), 67.5 - 74.9 MBh	Navigant Incremental Cost Study	$1,640.50
2357	Furnace, with ECM fan motor, for space heating (AFUE ≥95%), 75.0 - 82.5 MBh	Navigant Incremental Cost Study	$1,650.50
2358	Furnace, with ECM fan motor, for space heating (AFUE ≥95%), 82.5 - 90.75 MBh	Navigant Incremental Cost Study	$1,650.50
2359	Furnace, with ECM fan motor, for space heating (AFUE ≥95%), 90.76 - 99.82 MBh	Navigant Incremental Cost Study	$1,660.50

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MMID	Measure Name	Source	Incremental Cost
2360	Furnace, with ECM fan motor, for space heating (AFUE ≥95%), 99.83 - 109.8 MBh	Navigant Incremental Cost Study	$1,670.50
2362	Glazing, Triple Poly Carbonate, Roof and Walls, Double Pane Replacement	Implementer research	$0.30/ft
2363	Glazing, Triple Poly Carbonate, Roof and Walls, Single Pane Replacement	Implementer research	$0.30/ft
2364	Glazing, Triple Poly Carbonate, Roof, Double Pane Replacement	Implementer research	$0.30/ft
2365	Glazing, Triple Poly Carbonate, Roof, Single Pane Replacement	Implementer research	$0.30/ft
2366	Glazing, Triple Poly Carbonate, Walls, Double Pane Replacement	Implementer research	$0.30/ft
2367	Glazing, Triple Poly Carbonate, Walls, Single Pane Replacement	Implementer research	$0.30/ft
2371	Griddle, Electric, ENERGY STAR	Energy Star Calculator	$-
2372	Griddle, Gas, ENERGY STAR	Energy Star Calculator	$360.00
2373	Guest Room Energy Management Controls, Electric Heat PTAC Systems	Illinois TRM	$260.00
2374	Guest Room Energy Management Controls, Not Otherwise Specified	MMID 2373	$260.00
2376	Heat Recovery Tank, No Heating Element, Ag, Electric or NG	Historical Project Data	$3,674.00
2419	Induction Lighting, 300 Watt	Implementer's cost and Cadmus estimate for labor duration and RSMeans for labor cost.	$774.39
2422	Infrared Heating Units, High or Low Intensity - Existing Building,	Online/Book Research	$4.35
2429	Steam Fittings Insulation - New	Online/Book Research	$45.44
2430	Steam Piping Insulation - New	Online/Book Research	$22.76
2434	Irrigation Pressure Reduction, Nozzle Installation	Project quote; assumes labor cost and proportionately minimal cost for fixing nozzles	$2,000.00
2454	LED loading dock light fixture, Hybrid	Cadmus estimate for labor duration and RSMeans for labor cost. and http://loadingdocksupply.com/led_dock_lights	$409.40
2456	LED Reach-In Refrigerated Case Lighting replaces T12 or T8	Existing cost figure. Used S&G figure as median, assuming it reflects that BIP will account for a lot of the projects	$145.44

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MMID	Measure Name	Source	Incremental Cost
2457	LED Reach-In Refrigerated Case Lighting replaces T12 or T8- with Occupancy Control	MMID 2456. Likely understates because doesn't account for occupancy sensor cost.	$145.44
2458	LED Down Lights	Existing Cost Figure	$46.01
2471	Occupancy Sensors - Ceiling Mount ≤500 Watts	MMID 2473	$120.00
2472	Occupancy Sensors - Ceiling Mount ≥1001 Watts	WESCO Distribution pricing+labor	$120.00
2473	Occupancy Sensors - Ceiling Mount 501-1000 Watts	WESCO Distribution pricing+labor	$120.00
2474	Occupancy Sensors - Fixture Mount ≤200 Watts	Navigant Incremental Cost Study	$115.00
2475	Occupancy Sensors - Fixture Mount > 200 Watts	Navigant Incremental Cost Study	$115.00
2482	LED Case Lights with Occupancy Control - NEW	Existing cost figure	$220.50
2482	Occupancy Sensors - for LED Refrigerated Case Lights, per door controlled	Existing Cost Figure	$22.00
2483	Occupancy Sensors - Wall Mount ≤200 Watts	WESCO Distribution pricing+labor	$35.00
2484	Occupancy Sensors - Wall Mount ≥201 Watts	WESCO Distribution pricing+labor	$35.00
2485	Oven, Convection, Electric, ENERGY STAR - per cavity	Energy Star Calculator	$50.00
2486	Oven, Convection, Gas, ENERGY STAR - per cavity	Energy Star Calculator	$50.00
2487	Oven, Rack Type, Gas, Double Compartment, High Efficiency	Existing Cost Figure	$5,558.13
2488	Oven, Rack Type, Gas, Single Compartment, High Efficiency	Existing Cost Figure	$2,719.88
2490	Plastics equipment, efficient radiant heater band retrofit	Existing Cost Figure	$12,757.21
2491	Plate Heat Exchanger and Well Water Pre-Cooler	Vermont TRM	$4,595.00
2494	PreRinse Sprayers, 0.65 GPM Ultra Low Flow- Electric NEW	Online Research	$51.54
2495	PreRinse Sprayers, 0.65 GPM Ultra Low Flow- Gas NEW	Online Research	$51.54
2496	Pressure Screen Rotor	Workpaper	variable

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MMID	Measure Name	Source	Incremental Cost
2507	Radiant tube inserts installed in exhaust of radiant tube burners, Hybrid	Existing Cost Figure	$34,021.91
2509	Open Multideck Cases Replaced by Reach-in Cases with Doors-New	Online/Book Research	$700.00
2510	Floating Head Pressure Control-New	Online/Book Research	$235.38
2513	Refrigeration Tune-up, Non Self-Contained Cooler	Historical Project Data	$30/ton
2514	Refrigeration Tune-up, Non Self-Contained Freezer	Historical Project Data	$36/ton
2515	Refrigeration Tune-up, Self-contained Cooler	Historical Project Data	$230/ton
2516	Refrigeration Tune-up, Self-contained Freezer	Historical Project Data	$245/ton
2521	Refrigerator, Chest, Glass Door, < 15 cu ft, Energy Star	Illinois TRM	$143.00
2522	Refrigerator, Chest, Glass Door, 15-29 cu ft, Energy Star	Illinois TRM	$164.00
2523	Refrigerator, Chest, Glass Door, 30-49 cu ft, Energy Star	Illinois TRM	$164.00
2524	Refrigerator, Chest, Glass Door, 50+ cu ft, Energy Star	Illinois TRM	$249.00
2525	Refrigerator, Chest, Solid Door, < 15 cu ft, Energy Star	Illinois TRM	$143.00
2526	Refrigerator, Chest, Solid Door, 15-29 cu ft, Energy Star	Illinois TRM	$164.00
2527	Refrigerator, Chest, Solid Door, 30-49 cu ft, Energy Star	Illinois TRM	$164.00
2528	Refrigerator, Chest, Solid Door, 50+ cu ft, Energy Star	Illinois TRM	$249.00
2529	Refrigerator, Vertical, Glass Door, < 15 cu ft, Energy Star	Illinois TRM	$143.00
2530	Refrigerator, Vertical, Glass Door, 15-29 cu ft, Energy Star	Illinois TRM	$164.00
2531	Refrigerator, Vertical, Glass Door, 30-49 cu ft, Energy Star	Illinois TRM	$164.00
2532	Refrigerator, Vertical, Glass Door, 50+ cu ft, Energy Star	Illinois TRM	$249.00
2533	Refrigerator, Vertical, Solid Door, < 15 cu ft, Energy Star	Illinois TRM	$143.00

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MMID	Measure Name	Source	Incremental Cost
2534	Refrigerator, Vertical, Solid Door, 15-29 cu ft, Energy Star	Illinois TRM	$164.00
2535	Refrigerator, Vertical, Solid Door, 30-49 cu ft, Energy Star	Illinois TRM	$164.00
2536	Refrigerator, Vertical, Solid Door, 50+ cu ft, Energy Star	Illinois TRM	$249.00
2538	Repulper Rotor	Workpaper	variable
2542	Repair leaking steam trap, <50 psig steam (Industrial Only)	Online/Book Research	$453.79
2543	Repair leaking steam trap, >225 psig, General Heating	Online/Book Research	$1,005.89
2544	Repair leaking steam trap, >225 psig steam (Industrial Only)	Online/Book Research	$1,602.50
2545	Repair leaking steam trap, 126-225 psig, General Heating	Multiple studies	$350.00
2546	Repair leaking steam trap, 126-225 psig steam (Industrial Only)	Online/Book Research	$1,007.71
2547	Repair leaking steam trap, 50-125 psig, General Heating	Online/Book Research	$888.52
2548	Repair leaking steam trap, 50-125 psig steam (Industrial Only)	Online/Book Research	$916.44
2549	Steamer, Electric, 3 pan - ENERGY STAR	California Workpapers	$2,490.00
2550	Steamer, Electric, 4 pan - ENERGY STAR	California Workpapers	$2,490.00
2551	Steamer, Electric, 5 pan - ENERGY STAR	California Workpapers	$2,490.00
2552	Steamer, Gas, 5 pan - ENERGY STAR	California Workpapers	$998.00
2553	Steamer, Electric, 6 pan - ENERGY STAR	California Workpapers	$2,490.00
2554	Steamer, Gas, 6 pan - ENERGY STAR	California Workpapers	$998.00
2556	T8 1L-4 ft Reduced Wattage with CEE Ballast - 25 Watts (Low BF)	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.45
2557	T8 1L-4 ft Reduced Wattage with CEE Ballast - 28 Watts (Low BF)	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.07

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MMID	Measure Name	Source	Incremental Cost
2558	T8 1L 4', 28W, CEE, BF > 0.78	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.07
2559	T8 1L-4 ft Hi Lumen Lamp with CEE Ballast	Implementer's assessment plus Cadmus estimate for labor duration and RSMeans for labor cost. Assumed CEE ballast as baseline.	$3.85
2560	T8 1L-4 ft Reduced Wattage with CEE Ballast - 25 Watts	Implementer's assessment plus Cadmus estimate for labor duration and RSMeans for labor cost. Assumed CEE ballast as baseline.	$2.45
2560	T8 2L-4 ft Reduced Wattage with CEE Ballast - 25 Watts	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$4.90
2561	T8 1L-4 ft Hi Lumen Lamp with CEE Ballast (Low BF)	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$7.70
2562	T8 2L-4 ft Reduced Wattage with CEE Ballast - 25 Watts (Low BF)	Implementer's assessment plus Cadmus estimate for labor duration and RSMeans for labor cost. Assumed CEE ballast as baseline.	$4.90
2563	T8 2L 4', 25W, CEE, BF > 0.78	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$4.90
2564	T8 2L-4 ft Reduced Wattage with CEE Ballast - 28 Watts (Low BF)	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$4.13
2565	T8 2L-4 ft Reduced Wattage with CEE Ballast - 28 Watts	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$4.13
2566	T8 2L-4 ft Hi Lumen Lamp with CEE Ballast (Low BF)	Implementer's assessment plus Cadmus estimate for labor duration and RSMeans for labor cost. No add'l cost for ballast.	$15.40
2567	T8 2L-4 ft Hi Lumen Lamp with CEE Ballast	Implementer's assessment plus Cadmus estimate for labor duration and RSMeans for labor cost. No add'l cost for ballast.	$15.40
2568	T8 2L-4ft High Performance Tandem Replacing T12HO/VHO 2L-8 ft - From Spectrum	Implementer's cost, plus Cadmus estimate for labor duration and RSMeans for labor cost.	$130.98

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MMID	Measure Name	Source	Incremental Cost
2569	T8 2L 4', HPT8, CEE, replacing 8' 2L T12	Implementer's cost, plus Cadmus estimate for labor duration and RSMeans for labor cost.	$130.98
2571	T8 3L-4 ft Low Watt with CEE Ballast - 25 Watts (Low BF)	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$7.35
2572	T8 3L-4 ft Reduced Wattage with CEE Ballast - 25 Watts	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$7.35
2573	T8 3L-4 ft Reduced Wattage with CEE Ballast - 28 Watts (Low BF)	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$6.20
2574	T8 3L 4', 28W, CEE, BF > 0.78	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$6.20
2575	T8 3L-4 ft Hi Lumen Lamp with CEE Ballast (Low BF)	Implementer’s assessment plus Cadmus estimate for labor duration and RSMeans for labor cost. Assumes CEE ballast as baseline.	$11.55
2576	T8 3L-4 ft Hi Lumen Lamp with CEE Ballast	Implementer’s assessment plus Cadmus estimate for labor duration and RSMeans for labor cost. Assumes CEE ballast as baseline.	$11.55
2577	T8 4L-4 ft Low Watt with CEE Ballast - 25 Watts (Low BF)	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$9.80
2578	T8 4L-4 ft Reduced Wattage with CEE Ballast - 25 Watts	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$9.80
2579	T8 4L-4 ft Reduced Wattage with CEE Ballast - 28 Watts (Low BF)	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$8.27
2580	T8 4L 4', 28W, CEE, BF > 0.78	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$8.27

MMID	Measure Name	Source	Incremental Cost
2581	T8 4L-4 ft Hi Lumen Lamp with CEE Ballast (Low BF)	Implementer's assessment plus Cadmus estimate for labor duration and RSMeans for labor cost. Assumes CEE ballast as baseline.	$15.40
2582	T8 4L-4 ft Hi Lumen Lamp with CEE Ballast	Implementer's assessment plus Cadmus estimate for labor duration and RSMeans for labor cost. Assumes CEE ballast as baseline.	$15.40
2590	T8 Low Watt Relamp - 25 Watts	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.45
2591	T8 Low Watt Relamp - 28 Watts	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.07
2592	Thermal Curtain, 8mm Double Polycarbonate Walls and Ceiling, Overhead Heating	Implementer Assessment	$2.15
2593	Thermal Curtain, 8mm Double Polycarbonate Walls and Ceiling, Under Bench Heating	Implementer Assessment	$2.15
2594	Thermal Curtain, 8mm Double Polycarbonate Walls and Poly Film Ceiling, Overhead Heating	Implementer Assessment	$2.15
2595	Thermal Curtain, 8mm Double Polycarbonate Walls and Poly Film Ceiling, Under Bench Heating	Implementer Assessment	$2.15
2596	Thermal Curtain, Double Pane Glass Walls and Ceiling, Overhead Heating	Implementer Assessment	$2.15
2597	Thermal Curtain, Double Pane Glass Walls and Ceiling, Under Bench Heating	Implementer Assessment	$2.15
2598	Thermal Curtain, Double Pane Glass Walls and Poly Film Ceiling, Overhead Heating	Implementer Assessment	$2.15
2599	Thermal Curtain, Double Pane Glass Walls and Poly Film Ceiling, Under Bench Heating	Implementer Assessment	$2.15
2601	Thermal Curtain, Poly Film Walls and Ceiling, Overhead Heating	Implementer Assessment	$2.15
2602	Thermal Curtain, Poly Film Walls and Ceiling, Under Bench Heating	Implementer Assessment	$2.15

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MMID	Measure Name	Source	Incremental Cost
2603	Thermal Curtain, Single Pane Glass Walls and Ceiling, Overhead Heating	Implementer Assessment	$2.15
2604	Thermal Curtain, Single Pane Glass Walls and Ceiling, Under Bench Heating	Implementer Assessment	$2.15
2605	Thermal Curtain, Single Pane Glass Walls and Poly Film Ceiling, Overhead Heating	Implementer Assessment	$2.15
2606	Thermal curtain, Single Pane Glass Walls and Poly Film Ceiling, Under Bench Heating	Implementer Assessment	$2.15
2608	Unit Heater, ≥90% thermal efficiency, per input MBh, for retrofit	Focus on Energy Study	$14.01
2611	Vending Machine Controls, occupancy based, on cold beverage machine	Online Research	$160.00
2612	Snack Machine - Install Vending Miser Controller	Online Research	$156.00
2613	Beverage Cooler Controls	Online Research	$170.00
2613	Vending Machine Controls, sales based, on cold beverage machine	Online Research	$372.00
2614	Vending Machine Controls, Sales Based, Snack Machine	Online Research	$5,840.17
2615	Vending Machine, ENERGY STAR, Cold Beverage, Not Software Activated	Existing Cost Figure	$206.59
2616	Vending Machine Controller, Direct Install, Cooled Machine	MMID 2611	$160.00
2620	Kitchen Hood Ventilation Controls, Temperature Only, New System, Bonus for controlling MUA fan	Existing Cost Figure	$500.00
2621	Kitchen Hood Ventilation Controls, Temperature Only, Retrofit, Bonus for controlling MUA fan	Existing Cost Figure	$1,000.00
2622	Kitchen Hood Ventilation Controls, Temperature Only, New System, Exhaust Fan Controlled	Existing Cost Figure	$994.00

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MMID	Measure Name	Source	Incremental Cost
2623	Kitchen Hood Ventilation Controls, Temperature Only, Retrofit, Exhaust Fan Controlled	Existing Cost Figure	$1,988.00
2624	Kitchen Hood Ventilation Controls, Temp and Optical, New System, Bonus for controlling MUA fan	Existing Cost Figure	$500.00
2625	Kitchen Hood Ventilation Controls, Temp and Optical, Retrofit, Bonus for controlling MUA fan	California studies	$1,566.91
2626	Ventilation Controls, Kitchen Hood, with Optical, Exhaust Only, New	Existing Cost Figure	$994.00
2627	Kitchen Hood Ventilation Controls, Temp and Optical, Retrofit, Exhaust Fan Controlled	Existing Cost Figure	$1,988.00
2628	Agricultural Exhaust Fan, High Efficiency - 36"	Implementer Assessment	$150.00
2629	Agricultural Exhaust Fan, High Efficiency - 42"	MMIDs 2628 and 2630	$150.00
2630	Agricultural Exhaust Fan, High Efficiency - 48"	Implementer Assessment	$150.00
2631	Agricultural Exhaust Fan, High Efficiency - 50"	MMID 2630	$150.00
2632	Agricultural Exhaust Fan, High Efficiency - 51"	MMID 2630	$150.00
2633	Agricultural Exhaust Fan, High Efficiency - 52"	MMID 2630	$150.00
2634	Agricultural Exhaust Fan, High Efficiency - 54"	Historical Project Data	$1,139.00
2635	Agricultural Exhaust Fan, High Efficiency - 55"	MMID 2635	$1,139.00
2636	Agricultural Exhaust Fan, High Efficiency - 57"	Historical Project Data	$1,695.00
2637	Agricultural Exhaust Fan, High Efficiency - 60"	Historical Project Data	$2,010.00
2638	Agricultural Exhaust Fan, High Efficiency - 72"	Historical Project Data	$2,287.00
2639	VFD, Ag Second Use Water System	NEEP Incremental Cost Study	$130/hp
2640	VFD, Boiler Draft Fan	NEEP Incremental Cost Study	$130/hp

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MMID	Measure Name	Source	Incremental Cost
2641	VFD, Cooling Tower Fan	NEEP Incremental Cost Study	$130/hp
2642	VFD, Dairy Vacuum Pump, Ag	Vermont Program Data	$4,000.00
2643	VFD Fan, Hybrid	NEEP Incremental Cost Study	$130/hp
2644	VFD, HVAC Heating Pump	NEEP Incremental Cost Study	$130/hp
2646	VFD, Pool Pump Motor	NEEP Incremental Cost Study	$130/hp
2647	VFD, Process Fan	NEEP Incremental Cost Study	$130/hp
2648	VFD Pump, Hybrid	NEEP Incremental Cost Study	$130/hp
2651	Storage Water Heater EF >0.67	Ohio TRM	$400.00
2652	Water Heater, ≥0.82 EF, Tankless, Residential, NG	Ohio TRM	$605.00
2653	DHW - Ag, Hybrid	Implementer Assessment	$1,200.00
2655	Water Heater, Dual Thermostat, Ag, NG	Historical Project Data	$5,908.00
2657	Water Heater, Fuel Switching, Electric to NG, Ag	MMID 2825	$500.00
2658	Water Heater, Residential Type - Indirect, with 90% AFUE+ Modulating Hot Water Boiler	Online Research and Navigant Incremental Cost Study	$3,356.49
2660	Waterer, Livestock, <250 Watts	Illinois TRM	$710.33
2665	T8 Reduced Wattage Relamp 8 ft - 54 Watts	Existing Cost Figure	$4.33
2666	Air Cooled Chiller System Tune Up, Service Buy Down ≤500 Tons	Act On Energy TRM	$35/ton
2667	Air Cooled Chiller System Tune Up, Service Buy Down>500 Tones	Act On Energy TRM	$35/ton
2668	Chiller Tune-Up	Act On Energy TRM	$35/ton
2668	Water Cooled Chiller System Tune Up, Service Buy Down ≤500 Tons	Act On Energy TRM	$35/ton
2669	Water Cooled Chiller System Tune Up, Service Buy Down >500 Tons	Act On Energy TRM	$35/ton
2670	CFL ≤30 Watts, replacing incandescent	MMID 2243	$3.00
2671	Coil cleaning, self contained unit - New	Existing Cost Figure	$13.72
2673	Fryer, Large Vat, Electric, High Efficiency	Energy Star Calculator	$-
2674	Fryer, Large Vat, Gas, High Efficiency	Energy Star Calculator	$1,120.00

MMID	Measure Name	Source	Incremental Cost
2677	Hot Food Holding Cabinet - ENERGY STAR, 13 ≤ V < 28 cu ft	Illinois TRM	$1,800.00
2678	Hot Food Holding Cabinet - ENERGY STAR, V < 13 cu ft	Illinois TRM	$1,500.00
2679	Hot Food Holding Cabinet - ENERGY STAR, V ≥ 28 cu ft	Illinois TRM	$1,200.00
2686	Low Flow Faucet Aerators (Public Restroom), Direct Install, Electric	Historical Project Data	$2.00
2687	Low Flow Faucet Aerators (Public Restroom), Direct Install, Natural Gas	Historical Project Data	$2.00
2688	Faucet Aerators, Direct Install, Electric	Historical Project Data	$8.00
2689	Faucet Aerators, Direct Install, NG	Historical Project Data	$8.00
2691	LED Canopy Fixture - New	Cadmus estimate for labor duration and RSMeans for labor cost. and GreenElectricalSupply.com	$332.94
2692	LED Canopy Fixture, Dusk to Dawn	Cadmus estimate for labor duration and RSMeans for labor cost. and GreenElectricalSupply.com	$332.94
2693	LED Pole Mounted - New	Cadmus estimate for labor duration and RSMeans for labor cost. and GreenElectricalSupply.com	$1,062.40
2694	LED Wall Pack - New	Cadmus estimate for labor duration and RSMeans for labor cost. and GreenElectricalSupply.com	$196.40
2695	LED Wall Pack, Dusk to Dawn	Cadmus estimate for labor duration and RSMeans for labor cost. and GreenElectricalSupply.com	$196.40
2699	PTHP, <8000 Btuh, ≥12.3 EER, ≥3.2 COP, Retrofit Application	Illinois TRM	$49/PTHP
2700	PTHP, ≥13000 Btuh, ≥12.3 EER, ≥3.2 COP, Retrofit Application	Illinois TRM	$105/PTHP
2701	PTHP, 10000-12999 Btuh, ≥12.3 EER, ≥3.2 COP, Retrofit Application	Illinois TRM	$84/PTHP
2702	PTHP, 8000 - 9999 Btuh, ≥12.3 EER, ≥3.2 COP, Retrofit Application	Illinois TRM	$63/PTHP
2703	T5 2L - F28T5 Fixture, Recessed Indirect 2x4, replacing 3LT8 or 4LT12	1000bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost.	$185.50

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MMID	Measure Name	Source	Incremental Cost
2704	T8 2L - HPT8 Fixture or Retrofit Module, Recessed Direct or Indirect 2x4, replacing 3L or 4L T8 or T12	1000bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost.	$167.17
2705	Ice Machine, CEE Tier 2, Remote Condensing Without Remote Compressor, Air Cooled, Flake, <500 lbs/day	Illinois TRM	$981.00
2709	Metal Halide, Electronic Ballast, Pulse Start, 320 Watt	Implementer's cost + labor	$105.60
2711	Insulation, Project Based, Attic	Navigant Incremental Cost Study	$2.69
2712	Insulation, Sidewall, Foam	Average of four existing figures provided for different sizes.	$380.00
2713	Insulation, Foundation - Interior	Navigant Incremental Cost Study	$2.93
2714	Insulation, Sill Box	Navigant Incremental Cost Study	$5.97
2721	Ground Source Heat Pump	Cost data compiled at the end of each CY	ActualCost
2725	Dairy Tune Up, Hybrid	Historical Project Data	$212.00
2726	VFD, Chilled Water Distribution Pump	NEEP Incremental Cost Study	$130/HP
2732	CFL, Direct Install 13W	MMID 2117	$0.37
2734	Faucet Aerator, Direct Install, 1.5 gpm, Bathroom, Electric	Historical Project Data	$2.00
2735	Faucet Aerator, Direct Install, 1.5 gpm, Bathroom, NG	Historical Project Data	$2.00
2736	LED Exit Sign, Direct Install	WESCO Distribution pricing+labor	$105.60
2740	CFL, Direct Install, 18 Watt	Online Research	$2.86
2741	Insulation, Direct Install, 3' Pipe, Electric	RSMeans	$11.88
2742	Insulation, Direct Install, 3' Pipe, NG	RSMeans	$11.88
2743	Boiler, hot water, high efficiency modulating, for space heating (AFUE ≥90%)(175 - 300 MBh)	Historical Project Data	$50.82/MBH
2744	Boiler Tune Up	Online Research	$119.95
2753	CFL - Common Area	Online Research	$2.71
2754	CFL - In Unit	Online Research	$2.71
2756	Clothes Washer, ENERGY STAR Tier 3, Electric	Online Research	$325.40
2757	Clothes Washer, ENERGY STAR Tier 3, Gas	Online Research	$325.40

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MMID	Measure Name	Source	Incremental Cost
2760	Domestic Hot Water Plant Replacement	Historical Project Data	$27.07/MBH
2764	Furnace, with ECM fan motor, for space heating (AFUE ≥95%)	Navigant Incremental Cost Study	$1,667.84
2767	LED Lamps - Common Area	Implementer Assessment	$15.00
2768	LED Exit Fixture or Retrofit Kits	RSMeans	$91.61
2769	LED Lamps - In Unit	Implementer Assessment	$15.00
2772	Steam Trap Radiator Repair or Replace	Online/Book Research	$219.40
2778	Water Heater, Dual Thermostat, Ag, Electric	Historical Project Data	$1,468.00
2784	CFL, Direct Install, 15 Watt	MMID 2117	$0.37
2785	CFL, Direct Install, 42 Watt ≥2,600 Lumens	Online Research	$4.00
2786	CFL, Direct Install, 7 Watt	MMID 2116	$1.21
2787	CFL, Direct Install, 9 Watt	MMID 2813	$0.37
2792	Insulation, Direct Install, Pipe, Per Foot, 2" Thickness, Electric	RSMeans	$7.30
2793	Pipe Insulation for Hot Water, Direct Install, 2-inch, NG	RSMeans	$7.92
2794	Pipe Insulation for Hot Water, Direct Install, 1-inch, NG	RSMeans	$3.96
2795	Insulation, Direct Install, Pipe, Per Foot, 1" Thickness, NG	RSMeans	$3.64
2797	Occupancy Sensor, With Co-Pay, Wall Mount, ≤200 Watts	WESCO Distribution pricing+labor	$35.00
2798	Occupancy Sensor, With Co-Pay, Wall Mount, >200 Watts	WESCO Distribution pricing+labor	$35.00
2799	T8 1L-4 ft Reduced Wattage with CEE Ballast - 28 Watts	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.07
2800	T8 1L 4', With Co-Pay, 28W, CEE, BF > 0.78	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.07
2801	T8 2L 4', 28W, CEE, BF > 0.78	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$4.13
2802	T8 2L 4', With Co-Pay, 28W, CEE, BF > 0.78	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor	$4.13

MMID	Measure Name	Source	Incremental Cost
		duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	
2803	T8 3L-4 ft Reduced Wattage with CEE Ballast - 28 Watts	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$6.20
2804	T8 3L 4', With Co-Pay, 28W, CEE, BF > 0.78	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$6.20
2805	T8 4L-4 ft Reduced Wattage with CEE Ballast - 28 Watts	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$8.27
2806	T8 4L 4', With Co-Pay, 28W, CEE, BF > 0.78	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$8.27
2807	T8 4L or T5HO 2L Replacing 250-399 W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$156.14
2808	T8 6L or T5HO 4L Replacing 400-999 W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$163.56
2809	T8 10 lamp replacing 1000W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$215.29
2809	T8 8 lamp replacing 1000W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$273.80
2810	Engine Block Heater Timer	Existing Cost Figure	$25.00
2811	CFL, Direct Install, 9 Watt	MMID 2116	$1.21
2812	CFL, Direct Install, 13 Watt ≥800 Lumens	MMID 2813	$0.37
2813	CFL Reflector, Direct Install, 14 Watt	Light bulb sales data obtained by Cadmus for California- 2010 through 2012. Note that the CFL average lamp costs include incented lamps.	$0.37
2813	CFL Reflector, Direct Install, 23 Watt	Light bulb sales data obtained by Cadmus for California- 2010 through 2012. Note that the CFL average lamp costs include incented lamps.	$1.03
2815	CFL, Direct Install, 23 Watt 1,400 to 1,599 Lumens	Light bulb sales data obtained by Cadmus for California- 2010 through 2012. Note that the CFL average lamp costs include incented lamps.	$1.03

MMID	Measure Name	Source	Incremental Cost
2816	CFL, Direct Install, 18 Watt	MMID 2118	$0.38
2819	Solar PV	Cost data compiled at the end of each CY	ActualCost
2820	Ground Source Heat Pump, Electric Back-up	Cost data compiled at the end of each CY	ActualCost
2821	Ground Source Heat Pump, NG Back-up	Cost data compiled at the end of each CY	ActualCost
2824	VFD, Ag Primary Use Water System	NEEP Incremental Cost Study	$130/HP
2825	Water Heater, Electric to Gas Conversion	Existing Cost Figure	$500.00
2826	Rooftop Tune Up - < 7.5 Ton w/ All Options Office, Hybrid	Existing Cost Figure	$1,250.00
2827	Rooftop Tune Up - < 7.5 Ton w/ DCV Only Office, Hybrid	Existing Cost Figure	$850.00
2828	Rooftop Tune Up - < 7.5 Ton w/ Eco & DCV Office, Hybrid	Existing Cost Figure	$1,250.00
2829	Rooftop Tune Up - < 7.5 Ton w/ Eco Only Office, Hybrid	Existing Cost Figure	$1,050.00
2830	Rooftop Tune Up - < 7.5 Ton w/ Programmable Thermostat Only Office, Hybrid	Existing Cost Figure	$250.00
2831	Rooftop Tune Up - < 7.5 Ton w/ Programmable Thermostat & DCV Office, Hybrid	Existing Cost Figure	$850.00
2832	Rooftop Tune Up - < 7.5 Ton w/ Programmable Thermostat & Eco Office, Hybrid	Existing Cost Figure	$1,050.00
2833	Roof Top Upgrade, Thermostat, DCV, & Economizer, ≤7.5 Tons	Existing Cost Figure	$1,250.00
2834	Rooftop Tune Up > 7.5 Ton w/ All Options Office, Hybrid	Existing Cost Figure	$1,250.00
2835	Rooftop Tune Up > 7.5 Ton w/ Programmable Thermostat Office, Hybrid	Existing Cost Figure	$250.00
2836	Rooftop Tune Up > 7.5 Ton w/ DCV Office, Hybrid	Existing Cost Figure	$850.00
2837	Roof Top Upgrade, Thermostat and DCV, >7.5 Tons	Existing Cost Figure	$1,250.00
2853	Demand Control Ventilation for AHU or Rooftop - New	Historical Project Data	$1.32/CFM
2862	CFL, Direct Install 18W	Light bulb sales data obtained by Cadmus for California- 2010 through 2012. Note that the	$0.37

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MMID	Measure Name	Source	Incremental Cost
		CFL average lamp costs include incented lamps.	
2884	T8 4 lamp replacing 250-399W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$156.14
2885	T8 (2) 6 lamp replacing 1000W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$327.12
2885	T8 6 lamp replacing 400-999W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$163.56
2886	T8 8 lamp replacing 400-999W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$215.29
2887	T8 8L ≤500W, Replacing ≥1000 W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$215.29
2888	T8 10L ≤500W, Replacing ≥1000 W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$273.80
2889	T8 (2) 6L ≤500W, Replacing ≥1000 W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$327.12
2890	T5HO 2 lamp replacing 250-399W HID	Implementer's cost (other rows), Cadmus estimate for labor duration and RSMeans for labor cost.	$156.14
2891	T5HO 3L Replacing 250-399 W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$195.49
2892	T5HO 4 lamp replacing 400-900W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$163.56
2893	T5HO 6 lamp replacing 400-999W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$210.22
2894	T5HO 6 lamp <500W replacing 1000W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$210.22
2895	T5HO 8 lamp or (2) T5HO 4 Lamp <500W replacing 1000W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$262.28
2896	T5HO (2) 4L ≤500W, Replacing ≥1000 W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$327.12
2897	T5HO (2) 6L ≤800W, Replacing ≥1000 W HID	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$420.44
2900	Ground Source Heat Pump, Electric Back-up	Cost data compiled at the end of each CY	ActualCost
2901	Ground Source Heat Pump, NG Back-up	Cost data compiled at the end of each CY	ActualCost
2902	Water Heater, Power Vented, EF 0.67-0.82, Storage, NG	0	$-
2903	Ground Source Heat Pump, LP Back-up	Cost data compiled at the end of each CY	ActualCost

MMID	Measure Name	Source	Incremental Cost
2904	Ground Source Heat Pump, No Back-up	Cost data compiled at the end of each CY	ActualCost
2905	Solar Thermal, Electric	Cost data compiled at the end of each CY	ActualCost
2906	Solar Thermal, NG	Cost data compiled at the end of each CY	ActualCost
2908	Wind	Cost data compiled at the end of each CY	ActualCost
2909	Biogas	Cost data compiled at the end of each CY	ActualCost
2910	Biomass	Cost data compiled at the end of each CY	ActualCost
2931	LED Fixture, Canopy	Cadmus estimate for labor duration and RSMeans for labor cost. and GreenElectricalSupply.com	$332.94
2932	LED Fixture, Exterior Pole Mounted	Cadmus estimate for labor duration and RSMeans for labor cost. and GreenElectricalSupply.com	$1,062.40
2933	Roof Top Upgrade, DCV & Economizer, ≤7.5 Tons	MMID 2828	$1,250.00
2934	Roof Top Upgrade, DCV, ≤7.5 Tons	MMID 2827	$850.00
2935	Roof Top Upgrade, DCV, >7.5 Tons	MMID 2827	$850.00
2936	Roof Top Upgrade, Economizer, ≤7.5 Tons	MMID 2829	$1,050.00
2937	Roof Top Upgrade, Thermostat & DCV, ≤7.5 Tons	MMID 2831	$850.00
2938	Roof Top Upgrade, Thermostat & Economizer, ≤7.5 Tons	MMID 2832	$1,050.00
2939	Roof Top Upgrade, Thermostat and DCV, >7.5 Tons	MMID 2831	$850.00
2940	Roof Top Upgrade, Thermostat, ≤7.5 Tons	MMID 2830	$250.00
2941	Roof Top Upgrade, Thermostat, >7.5 Tons	MMID 2830	$250.00
2942	Roof Top Upgrade, Thermostat, DCV, & Economizer, ≤7.5 Tons	MMID 2826	$1,250.00
2954	VFD Dairy, Hybrid	Vermont Program Data	$3,004.00
2955	Refrigerator Recycling	Program Data	$85.00
2956	Freezer Recycling	Program Data	$85.00
2959	CFL, Markdown 17 watts or less	Light bulb sales data obtained by Cadmus for California- 2010 through 2012. Note that the CFL average lamp costs include incented lamps.	$0.37

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MMID	Measure Name	Source	Incremental Cost
2959	CFL, Markdown 18 to 24 watts	Light bulb sales data obtained by Cadmus for California- 2010 through 2012. Note that the CFL average lamp costs include incented lamps.	$0.38
2960	T8 or T5HO ≤155W, Replacing 250-399W HID, Not Otherwise Specified	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$156.14
2961	T8 or T5HO ≤250W, Replacing 400-999W HID, Not Otherwise Specified	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$163.56
2962	T8 or T5HO 251-365W, Replacing 400-999W HID, Not Otherwise Specified	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$215.29
2963	T8 or T5HO ≤500W, Replacing ≥1000W HID, Not Otherwise Specified	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$273.80
2964	T8 or T5HO ≤800W, Replacing 1000W HID, Not Otherwise Specified	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$342.04
2971	LED Lamp, Direct Install, Walk-in Cooler or Freezer	WESCO Distribution pricing+labor	$15.00
2979	LED, Exit Sign, Retrofit, Over Program Limit	WESCO Distribution pricing+labor	$35.00
2984	LED Fixture, Downlights, Accent Lights and Monopoint, ≤18 Watts, Common Area	Historical Project Data + Labor Cost	$80.13
2986	Insulation, Attic, R-11 to R-38	RSMeans	$0.99
2987	Water Heater, Heat Pump, EF ≥2.0, Electric	MMID 3047	$2,893.00
2989	ECM, Furnace, New or Replacement	Implementer Assessment	$172.00
2990	Furnace And A/C, ECM, 95% + AFUE, ≥16 SEER	Implementer Assessment	$1,451.66
2992	Air Source Heat Pump, ≥16 SEER	Illinois TRM	$1,274.10
3001	Delamping, 200-399 Watt Fixture	Implementer's cost of labor	$15.00
3002	Delamping, ≥400 Watt Fixture	Implementer's cost of labor	$15.00
3003	LED, Replacing Neon Sign	Implementer's cost of labor	$55.00
3016	Ventilation Controls, Parking Lot	Historical Project Data	$607.00
3017	Showerheads, Retail Store Markdown	Historical Project Data	$5.00
3018	Waterer, Livestock, Energy Free	Historical Project Data	$741.00

MMID	Measure Name	Source	Incremental Cost
3019	Lighting Fixture, Agricultural Daylighting ≤155 Watts	Implementer's cost of labor	$325.87
3020	Lighting Fixture, Agricultural Daylighting 156 - 250 Watts	Implementer's cost of labor	$325.87
3021	Lighting Fixture, Agricultural Daylighting 251 - 365 Watts	Implementer's cost of labor	$535.04
3022	Room A/C	2014. Based on a review of TRM incremental cost assumptions from Vermont, Wisconsin, and California. This assumes that baseline shift from IECC 2009 to IECC 2012 carries the same incremental costs. Values should be verified during evaluation	$100/ton
3022	Split System A/C	2014. Based on a review of TRM incremental cost assumptions from Vermont, Wisconsin, and California. This assumes that baseline shift from IECC 2009 to IECC 2012 carries the same incremental costs. Values should be verified during evaluation	$100/ton
3023	T5, Reduced Wattage, Replacing T5 Or T5HO	Online Research	$15.04
3024	T5HO, Reduced Wattage, Replacing Standard T5 Or T5HO	Online Research	$12.63
3025	Faucet Aerator, Kitchen, Gas	Historical Project Data	$8.00
3026	Faucet Aerator, Kitchen, Electric	Historical Project Data	$8.00
3027	Faucet Aerator, Bath, Gas	Historical Project Data	$8.00
3028	Faucet Aerator, Bath, Electric	Historical Project Data	$8.00
3029	Faucet Aerator, 1.5 gpm, Shower, NG	Historical Project Data	$12.00
3030	Faucet Aerator, 1.5 gpm, Shower, Electric	Historical Project Data	$12.00
3031	CFL, Reduced Wattage, Pin Based, 18 Watt, Replacing CFL	Online research on GU24 18 watt CFL on 1000bulbs.com; prices range from $4 -$7.30, compared to $3.75 (from light bulb sales data obtained by Cadmus). Plus $1 labor cost for replacement.	$3.00
3032	CFL, Reduced Wattage, Pin Based, 26 Watt, Replacing CFL	Online research on GU24 26 watt CFL on 1000bulbs.com; prices range from $3.40 - $6.50, compared to $3.18 (from light bulb sales data obtained by Cadmus). Plus $1 labor cost for replacement.	$2.77
3033	CFL, Reduced Wattage, Pin Based, 32 Watt, Replacing CFL	Assumed same as 42 watt.	$-

MMID	Measure Name	Source	Incremental Cost
3034	CFL, Reduced Wattage, Pin Based, 42 Watt, Replacing CFL	Online research on GU24 26 watt CFL on 1000bulbs.com; prices range from $7 -$11.33, compared to $7 - $13.25 (also on 1000bulbs.com).	$-
3036	HID, Reduced Wattage, Replacing 1000 Watt HID, Exterior	MMIDs 3206-3215	$43.54
3037	HID, Reduced Wattage, Replacing 400 Watt HID, Exterior	MMIDs 3206-3215	$43.54
3038	HID, Reduced Wattage, Replacing 320 Watt HID, Exterior	MMIDs 3206-3215	$43.54
3039	HID, Reduced Wattage, Replacing 250 Watt HID, Exterior	MMIDs 3206-3215	$43.54
3040	HID, Reduced Wattage, Replacing 175 Watt HID, Exterior	MMIDs 3206-3215	$43.54
3041	T5HO, Exterior Reduced Wattage, Replacing 250-399 Watt HID	Implementer's Cost	$150.00
3042	T5HO, Exterior Reduced Wattage, Replacing 400-999 Watt HID	Implementer's Cost	$150.00
3043	T5HO, Exterior < 500 Watts, Replacing ≥1000 Watt HID	Implementer's Cost	$200.00
3045	Water Heater, High Usage, ≥90% TE, NG	Historical Project Data	$7,303.00
3046	Water Heater, High Usage, ≥0.82 EF, Tankless, NG	Historical Project Data	$1,120.00
3047	Water Heater, High Usage, ≥2 EF, Heat Pump Storage, Electric	Historical Project Data	$2,893.00
3056	LED Fixture, Replacing 320 Watt HID, Parking Garage, 24 Hour	MMID 3103	$150.00
3059	A/C Coil Cleaning, < 10 tons	Act On Energy TRM	$35/ton
3060	A/C Coil Cleaning, > 20 tons	Act On Energy TRM	$35/ton
3061	A/C Coil Cleaning, 10-20 tons	Act On Energy TRM	$35/ton
3062	A/C Refrigerant Charge Correction, < 10 tons	Act On Energy TRM	$35/ton
3063	A/C Refrigerant Charge Correction, > 20 tons	Act On Energy TRM	$35/ton
3064	A/C Refrigerant Charge Correction, 10-20 tons	Act On Energy TRM	$35/ton
3065	Ceramic Metal Halide, 575 Watt, Replacing 1000 Watt HID, High Bay	Workpaper	$100.00
3066	Economizer, RTU Optimization	Workpaper	$155.00

MMID	Measure Name	Source	Incremental Cost
3067	HID, Reduced Wattage, Replacing 1000 Watt HID, Interior	Workpaper	$35.00
3068	HID, Reduced Wattage, Replacing 175 Watt HID, Interior	Workpaper	$35.00
3069	HID, Reduced Wattage, Replacing 175 Watt HID, Parking Garage	Workpaper	$35.00
3070	HID, Reduced Wattage, Replacing 250 Watt HID, Interior	Workpaper	$35.00
3071	HID, Reduced Wattage, Replacing 250 Watt HID, Parking Garage	Workpaper	$35.00
3072	HID, Reduced Wattage, Replacing 320 Watt HID, Interior	Workpaper	$35.00
3073	HID, Reduced Wattage, Replacing 400 Watt HID, Interior	Workpaper	$35.00
3074	Induction, 750 Watt, Replacing 1000 Watt HID, High Bay	Workpaper	$750.00
3075	Induction, PSMH/CMH, ≤250 Watt, Replacing 320-400 Watt HID, High Bay	Workpaper	$290.00
3076	Metal Halide, Electronic Ballast Pulse Start - 250W replacing 400W HID	Implementer's cost	$159.05
3077	Metal Halide, Electronic Ballast Pulse Start - 320W replacing 400W HID	Implementer's cost + labor	$100.26
3078	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 150-175 Watt HID, Exterior	Workpaper	$15.00
3079	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 150-175 Watt HID, Parking Garage, 24 Hour	Workpaper	$15.00
3080	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 150-175 Watt HID, Parking Garage, Dusk to Dawn	Workpaper	$15.00
3081	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 250 Watt HID, Exterior	Workpaper	$100.00
3082	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 250 Watt HID, Parking Garage, 24 Hour	Workpaper	$100.00

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MMID	Measure Name	Source	Incremental Cost
3083	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 250 Watt HID, Parking Garage, Dusk to Dawn	Workpaper	$100.00
3084	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 320 Watt HID, Exterior	Workpaper	$340.00
3085	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 320-400 Watt HID, Exterior	Workpaper	$290.00
3086	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 400 Watt HID, Exterior	Workpaper	$240.00
3087	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 70-100 Watt HID, Exterior	Workpaper	$50.00
3088	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 70-100 Watt HID, Parking Garage, 24 Hour	Workpaper	$50.00
3089	Induction, PSMH/CMH, or Linear Fluorescent, Replacing 70-100 Watt HID, Parking Garage, Dusk to Dawn	Workpaper	$50.00
3090	Induction, PSMH/CMH, Replacing 250 Watt HID, High Bay	Workpaper	$100.00
3091	LED Fixture, <155 Watts, Replacing 250 Watt HID, High Bay	GreenElectricalSupply.com and Cadmus estimate for labor duration and RSMeans for labor cost.	$401.32
3092	LED Fixture, <250 Watts, Replacing 320-400 Watt HID, High Bay	GreenElectricalSupply.com and Cadmus estimate for labor duration and RSMeans for labor cost.	$588.40
3093	LED Fixture, <250 Watts, Replacing 400 Watt HID, High Bay	GreenElectricalSupply.com and Cadmus estimate for labor duration and RSMeans for labor cost.	$588.40
3094	LED Fixture, <365 Watts, Replacing 400 Watt HID, High Bay	GreenElectricalSupply.com and Cadmus estimate for labor duration and RSMeans for labor cost.	$688.40
3095	LED Fixture, <500 Watts, Replacing 1000 Watt HID, High Bay	GreenElectricalSupply.com and Cadmus estimate for labor duration and RSMeans for labor cost.	$1,563.40

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MMID	Measure Name	Source	Incremental Cost
3096	LED Fixture, <800 Watts, Replacing 1000 Watt HID, High Bay	GreenElectricalSupply.com and Cadmus estimate for labor duration and RSMeans for labor cost.	$1,563.40
3097	LED Fixture, Bilevel, Stairwell and Passageway	Workpaper	$120.00
3098	LED Fixture, Downlights, Accent Lights and Monopoint, > 18 Watts, Common Area	Workpaper	$60.00
3099	LED Fixture, Replacing 150-175 Watt HID, Exterior	Workpaper	$100.00
3100	LED Fixture, Replacing 150-175 Watt HID, Parking Garage, 24 Hour	Workpaper	$100.00
3101	LED Fixture, Replacing 150-175 Watt HID, Parking Garage, Dusk to Dawn	Workpaper	$100.00
3102	LED Fixture, Replacing 250 Watt HID, Exterior	Workpaper	$150.00
3103	LED Fixture, Replacing 250 Watt HID, Parking Garage, 24 Hour	Workpaper	$150.00
3104	LED Fixture, Replacing 250 Watt HID, Parking Garage, Dusk to Dawn	Workpaper	$150.00
3105	LED Fixture, Replacing 320 Watt HID, Exterior	Workpaper	$250.00
3106	LED Fixture, Replacing 320-400 Watt HID, Exterior	Workpaper	$300.00
3107	LED Fixture, Replacing 400 Watt HID, Exterior	Workpaper	$350.00
3108	LED Fixture, Replacing 70-100 Watt HID, Exterior	Workpaper	$100.00
3109	LED Fixture, Replacing 70-100 Watt HID, Parking Garage, 24 Hour	Workpaper	$100.00
3110	LED Fixture, Replacing 70-100 Watt HID, Parking Garage, Dusk to Dawn	Workpaper	$100.00
3111	LED Troffer, 2x4, Replacing 4' 3-4 Lamp T8 Troffer	past online research on LED troffer data.	$214.00
3112	LED, ≤40 Watt, ENERGY STAR, Replacing Incandescent	lighting sales data obtained by Cadmus.	$12.75

MMID	Measure Name	Source	Incremental Cost
3113	LED, > 40 Watt, ENERGY STAR, Replacing Incandescent	2014 application data.	$20.00
3114	LED, Horizontal Case Lighting	WESCO distribution pricing + labor	$86.00
3117	Linear Fluorescent, Bilevel, Stairwell and Passageway	Workpaper	$120.00
3118	Oven, Combination, Energy Star, Electric	Nicor Gas Deemed Values	$4,300.00
3119	Oven, Combination, Energy Star, NG	Illinois TRM	$4,300.00
3120	Programmable Thermostat, RTU Optimization Advanced	Historical Project Data	$638.42
3121	Programmable Thermostat, RTU Optimization Standard	Historical Project Data	$473.28
3122	T8 2L 4', HPT8 or RWT8, Replacing T12 1L 8', 0.78 < BF < 1.00	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$4.90
3123	T8 2L 4', HPT8 or RWT8, Replacing T12 1L 8', BF ≤0.78	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$4.90
3124	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', 0.78 < BF < 1.00	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$4.90
3125	T8 2L-4ft High Performance HBF Replacing T12HO 1L-8 ft	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$4.90
3126	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', BF > 1.00	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$4.90
3127	T8 4L-4-4ft High Performance Replacing T12 2L-8 ft	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3128	T8 4L 4', HPT8 or RWT8, Replacing T12 2L 8', BF ≤0.78	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3129	T8 4L-4ft High Performance Replacing T12HO 2L-8 ft -	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3130	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', BF ≤0.78	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3131	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', BF > 1.00	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3132	T8 4L-4ft High Performance Replacing T12HO/VHO 2L-8 ft	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3133	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', BF ≤0.78	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3134	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', BF > 1.00	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3135	Low Watt T8 Lamps	Average of MMID 2590 and MMID 2591	$2.26

MMID	Measure Name	Source	Incremental Cost
3136	Dishwasher, High Temp, Electric Booster, Pots/Pans Type, Energy Star, Electric	Implementer's Assessment	$500.00
3137	Dishwasher, High Temp, Electric Booster, Pots/Pans Type, Energy Star, NG	Implementer's Assessment	$500.00
3138	Dishwasher, High Temp, Gas Booster, Pots/Pans Type, Energy Star, NG	Implementer's Assessment	$500.00
3139	Dishwasher, Low Temp, Pots/Pans Type, Energy Star, Electric	Implementer's Assessment	$500.00
3140	Dishwasher, Low Temp, Pots/Pans Type, Energy Star, NG	Implementer's Assessment	$500.00
3141	LED, ≤8W	Implementer's Assessment	$7.50
3142	LED, > 12W (Max 20W) Flood Lamp	Implementer's Assessment	$16.70
3143	LED, MR16, 8-12W	Implementer's Assessment	$9.90
3144	T8 2L 4', HPT8 or RWT8, Replacing T12 1L 8', 0.78 < BF < 1.00, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$4.90
3145	T8 2L 4', HPT8 or RWT8, Replacing T12 1L 8', BF ≤0.78, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$4.90
3146	T8 4L 4', HPT8 or RWT8, Replacing T12 2L 8', 0.78 < BF < 1.00, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3147	T8 4L 4', HPT8 or RWT8, Replacing T12 2L 8', BF ≤0.78, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3148	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', BF > 1.00, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3149	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', 0.78 < BF < 1.00, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$4.90
3150	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', BF ≤0.78, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$4.90
3151	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', BF > 1.00, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80

MMID	Measure Name	Source	Incremental Cost
3152	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', 0.78 < BF < 1.00, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3153	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', BF ≤0.78, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3154	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', BF > 1.00, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3155	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', 0.78 < BF < 1.00, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3156	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', BF ≤0.78, Parking Garage	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3157	LED, Porch Fixture, Energy Star	Workpaper	$40.00
3158	LED Fixture, Downlights, Accent Lights and Monopoint, ≤18 Watts, In Unit	Historical Project Data	$88.38
3159	LED, Energy Star, Replacing Incandescent > 40W, In Unit	Implementer's Assessment	$16.70
3160	LED, Energy Star, Replacing Incandescent > 40W, Common Area	Implementer's Assessment	$16.70
3161	LED, Energy Star, Replacing Incandescent ≤40W, In Unit	Implementer's Assessment	$7.50
3162	LED, Energy Star, Replacing Incandescent ≤40W, Common Area	Implementer's Assessment	$7.50
3163	T8 1L 4', HPT8, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.07
3164	T8 1L 4', 28W, CEE, BF > 0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.07
3165	T8 1L 4', 28W, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.07

MMID	Measure Name	Source	Incremental Cost
3166	T8 1L 4', 25W, CEE, BF > 0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.45
3167	T8 1L 4', 25W, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$2.45
3168	T8 2L 4', HPT8, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$4.06
3169	T8 2L 4', 28W, CEE, BF > 0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$4.13
3170	T8 2L 4', 28W, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$4.13
3171	T8 2L 4', 25W, CEE, BF > 0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$4.90
3172	T8 2L 4', 25W, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$4.90
3173	T8 3L 4', HPT8, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$6.09
3174	T8 3L 4', 28W, CEE, BF > 0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$6.20
3175	T8 3L 4', 28W, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$6.20
3176	T8 3L 4', 25W, CEE, BF > 0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor	$7.35

MMID	Measure Name	Source	Incremental Cost
		duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	
3177	T8 3L 4', 25W, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$7.35
3178	T8 4L 4', HPT8, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$8.12
3179	T8 4L 4', 28W, CEE, BF > 0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$8.27
3180	T8 4L 4', 28W, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$8.27
3181	T8 4L 4', 25W, CEE, BF > 0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$9.80
3182	T8 4L 4', 25W, CEE, BF ≤0.78, Parking Garage	2014 application data; verified against 1000 bulbs.com and Cadmus estimate for labor duration and RSMeans for labor cost. Assumes T8 and CEE ballast as baseline.	$9.80
3183	Strip Curtain, Walk-In Freezers and Coolers	WESCO Distribution Pricing + Labor	$45.00
3184	Delamping, Direct Install, 8-Foot Lamp	Implementer's Labor Cost	$2.00
3186	Water Heater, Geothermal Heat Pump	Cost data compiled at the end of each CY	ActualCost
3188	Hot Water Boiler, 95%+ AFUE	MMID 1983	$3,105.00
3195	Linear Fluorescent, 2L 4'RWT8 Replacements, 24 Hours, CALP	Workpaper	$110.90
3196	T8 2L-4ft High Performance Tandem Replacing T12 2L-8ft	RSMeans	$9.80
3197	CFL Fixture, Interior or Exterior, 24 Hours, CALP	RSMeans	$2.33
3198	CFL Hardwired Interior Fixture, Direct Install - 28 Watt	Existing Cost Figure	$68.00

MMID	Measure Name	Source	Incremental Cost
3199	CFL Hardwired Exterior Fixture, Direct Install - 18 Watt > 1,100 Lumens	Existing Cost Figure	$68.00
3200	LED, Exit Sign, Retrofit, CALP	Workpaper	$52.67
3201	Occupancy Sensor, Wall or Ceiling Mount ≤200 Watts, CALP	Workpaper	$87.54
3202	Occupancy Sensor, Wall or Ceiling Mount >200 Watts, CALP	Workpaper	$87.54
3203	CFL Fixture, replacing incandescent fixture	Online Research	$7.29
3204	CFL Fixtures	Online Research	$7.29
3205	CFL Fixture, ≤100 Watts, with Copay	MMIDSs 3203-3204	$7.29
3206	ELO, CMH Lamp, 330 Watts, Replacing 400 Watt HID	Workpaper	$43.54
3207	ELO, CMH Lamp With Controls, 330 Watts, Replacing 400 Watt HID	Workpaper	$43.54
3208	ELO, CMH Lamp, 205 Watts, Replacing 250 Watt HID	Workpaper	$43.54
3209	ELO, CMH Lamp With Controls, 205 Watts, Replacing 250 Watt HID	Workpaper	$43.54
3210	ELO, CMH System, 210-220 Watts, Replacing 400 Watt HID	Workpaper	$43.54
3211	ELO, CMH System With Controls, 210-220 Watts, Replacing 400 Watt HID	Workpaper	$43.54
3212	ELO, CMH System, 140-150 Watts, Replacing 250 Watt HID	Workpaper	$43.54
3213	ELO, CMH System With Controls, 140-150 Watts, Replacing 250 Watt HID	Workpaper	$43.54
3214	ELO, CMH System, 90 Watts, Replacing 150-175 Watt HID	Workpaper	$43.54
3215	ELO, CMH System With Controls, 90 Watts, Replacing 150-175 Watt HID	Workpaper	$43.54
3216	ELO, LED ≤ 200 Watts, Replacing 400 Watt HID	Workpaper	$1,295.21
3217	ELO, LED ≤ 200 Watts With Controls, Replacing 400 Watt HID	Workpaper	$1,295.21

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MMID	Measure Name	Source	Incremental Cost
3218	ELO, LED ≤ 125 Watts, Replacing 250 Watt HID	Workpaper	$1,295.21
3219	ELO, LED ≤ 125 Watts With Controls, Replacing 250 Watt HID	Workpaper	$1,295.21
3220	ELO, LED ≤ 60 Watts, Replacing 150-175 Watt HID	Workpaper	$1,295.21
3221	ELO, LED ≤ 60 Watts With Controls, Replacing 150-175 Watt HID	Workpaper	$1,295.21
3223	Coil Brush, Direct Install	Workpaper	$-
3232	LED, 2x4, Replacing T12 2L	Workpaper	$110.00
3233	LED, 2x4, Replacing T12 3L	Workpaper	$110.00
3234	LED, 2x4, Replacing T12 4L	Workpaper	$110.00
3235	LED, 2x4, Replacing T8 2L	Workpaper	$110.00
3236	LED, 2x4, Replacing T8 3L	Workpaper	$110.00
3237	LED, 2x4, Replacing T8 4L	Workpaper	$110.00
3238	LED, 2x2, Replacing T12 2L U-Tube	RSMeans	$16.69
3239	LED, 2x2, Replacing T8 2L U-Tube	RSMeans	$16.69
3240	T8, 2’ Lamps, Replacing T12 Single U-Tube	Workpaper	$40.00
3241	T8, 2’ Lamps, Replacing T12 Dual U-Tube	RSMeans	$1.22
3242	T8, 2’ Lamps, Replacing T8 Single U-Tube	RSMeans	$1.22
3243	T8, 2’ Lamps, Replacing T8 Dual U-Tube	RSMeans	$1.22
3244	Process Exhaust Filtration	Historical Project Data	$2.89/CFM
3251	Lighting Controls, Bilevel, Exterior and Parking Garage Fixtures, Dusk to Dawn	Implementer's cost.	$111.00
3252	Lighting Controls, Bilevel, Parking Garage Fixtures, 24 Hour	Implementer's cost.	$111.00
3253	Lighting Controls, Photocell with Internal Timer or Wireless Schedule, Exterior	Implementer's cost.	$108.57
3254	Occupancy Sensor, High Bay Fixtures, Gymnasium	RSMeans	$95.00
3255	Occupancy Sensor, High Bay Fixtures, Industrial	RSMeans	$95.00

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MMID	Measure Name	Source	Incremental Cost
3256	Occupancy Sensor, High Bay Fixtures, Retail	RSMeans	$95.00
3257	Occupancy Sensor, High Bay Fixtures, Warehouse	RSMeans	$95.00
3258	Occupancy Sensor, High Bay Fixtures, Public Assembly	RSMeans	$95.00
3259	Occupancy Sensor, High Bay Fixtures, Other	RSMeans	$95.00
3260	Bi Level Controls, High Bay Fixtures, Gymnasium	RSMeans	$95.00
3261	Bi Level Controls, High Bay Fixtures, Industrial	RSMeans	$95.00
3262	Bi Level Controls, High Bay Fixtures, Retail	RSMeans	$95.00
3263	Bi Level Controls, High Bay Fixtures, Warehouse	RSMeans	$95.00
3264	Bi Level Controls, High Bay Fixtures, Public Assembly	RSMeans	$95.00
3265	Bi Level Controls, High Bay Fixtures, Other	RSMeans	$95.00
3266	Demand Control Ventilation, RTU Optimization	RSMeans	$95.00
3268	Duct Sealing	Workpaper	$450.00
3269	Steam Trap Repair, < 50 psig, General Heating, 7/32"	Consistent with Other Measures	$385.72
3270	Steam Trap Repair, < 50 psig, General Heating, 1/4"	Consistent with Other Measures	$408.41
3271	Steam Trap Repair, < 50 psig, General Heating, 5/16"	Consistent with Other Measures	$431.10
3272	Steam Trap Repair, < 50 psig, General Heating, 3/8"	Consistent with Other Measures	$453.79
3273	LED, 8 watts	RSMeans	$15.00
3274	LED, 12 watts	RSMeans	$7.50
3275	Boiler Plant Retrofit, Hybrid Plant, ≥1 MMBh	Historical Project Data	$25.65
3276	Boiler, Hot Water, Condensing, ≥90% AFUE, ≥300 mbh	Historical Project Data	$25.26
3277	Boiler, Hot Water, Near Condensing, ≥85% AFUE, ≥300 mbh	Historical Project Data	$14.72
3279	LED, Direct Install, 9.5 Watt	Implementer's Assessment	$7.07
3280	VFD, Constant Torque	Historical Project Data	$149.50

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MMID	Measure Name	Source	Incremental Cost
3284	Strip Curtain, Walk-In Freezers and Coolers, SBP A La Carte	WESCO Distribution Pricing + Labor	$45.00
3285	LED Fixture, <155 Watts, Replacing 250 Watt HID, High Bay, SBP A La Carte	RSMeans	$401.32
3286	LED Fixture, <250 Watts, Replacing 320-400 Watt HID, High Bay, SBP A La Carte	RSMeans	$588.40
3287	LED Fixture, <250 Watts, Replacing 400 Watt HID, High Bay, SBP A La Carte	RSMeans	$588.40
3288	LED Fixture, <365 Watts, Replacing 400 Watt HID, High Bay, SBP A La Carte	RSMeans	$688.40
3289	LED Fixture, Replacing 150-175 Watt HID, Exterior, SBP A La Carte	Workpaper	$100.00
3290	LED Fixture, Replacing 320-400 Watt HID, Exterior, SBP A La Carte	Workpaper	$350.00
3291	LED Troffer, 2x4, Replacing 4' 3-4 Lamp T8 Troffer, SBP A La Carte	Workpaper	$110.00
3292	Occupancy Sensor, High Bay Fluorescent Fixtures, Retail, SBP A La Carte	Workpaper	$70.00
3293	Occupancy Sensor, High Bay Fluorescent Fixtures, Warehouse, SBP A La Carte	Workpaper	$70.00
3294	Occupancy Sensor, High Bay Fluorescent Fixtures, Public Assembly, SBP A La Carte	Workpaper	$70.00
3295	Occupancy Sensor, High Bay Fluorescent Fixtures, Gymnasium, SBP A La Carte	Workpaper	$70.00
3296	Occupancy Sensor, High Bay Fluorescent Fixtures, Other, SBP A La Carte	Workpaper	$70.00
3297	Occupancy Sensor, High Bay Fluorescent Fixtures, Industrial, SBP A La Carte	Workpaper	$70.00
3298	LED, Reach-In Refrigerated Case, Replaces T12 or T8, SBP A La Carte	WESCO distribution pricing + labor	$86.00

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MMID	Measure Name	Source	Incremental Cost
3299	LED, Reach-In Refrigerated Case, Replaces T12 or T8 w/ Occupancy Control, SBP A La Carte	WESCO distribution pricing + labor	$86.00
3300	T8 2L 4', HPT8, CEE, replacing 8' 1L T12HO, SBP A La Carte	Workpaper	$41.00
3301	LED Fixture, Replacing 250 Watt HID, Exterior, SBP A La Carte	Workpaper	$150.00
3302	LED Fixture, Replacing 320 Watt HID, Exterior, SBP A La Carte	Workpaper	$250.00
3303	LED Fixture, Replacing 400 Watt HID, Exterior, SBP A La Carte	Workpaper	$350.00
3304	LED Fixture, Replacing 70-100 Watt HID, Exterior, SBP A La Carte	Workpaper	$100.00
3305	T8 6L or T5HO 4L Replacing 400-999 W HID, SBP A La Carte	Itron Database+RSMeans	$163.56
3306	T8 or T5HO, Replacing ≥1000 Watt HID, SBP A La Carte	Itron Database+RSMeans	$342.04
3307	T8 2L 4', HPT8 or RWT8, Replacing T12 1L 8', 0.78 < BF < 1.00, SBP A La Carte	Workpaper	$41.00
3308	T8 2L 4', HPT8 or RWT8, Replacing T12 1L 8', BF ≤0.78, SBP A La Carte	Workpaper	$41.00
3309	T8 4L 4', HPT8 or RWT8, Replacing T12 2L 8', 0.78 < BF < 1.00, SBP A La Carte	Itron Database+RSMeans	$9.80
3310	T8 4L 4', HPT8 or RWT8, Replacing T12 2L 8', BF ≤0.78, SBP A La Carte	Itron Database+RSMeans	$9.80
3311	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', BF > 1.00, SBP A La Carte	Workpaper	$41.00
3312	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', 0.78 < BF < 1.00, SBP A La Carte	Workpaper	$41.00
3313	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', BF ≤0.78, SBP A La Carte	Workpaper	$41.00
3314	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', 0.78 < BF < 1.00, SBP A La Carte	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80

MMID	Measure Name	Source	Incremental Cost
3315	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', BF ≤0.78, SBP A La Carte	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3316	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', BF > 1.00, SBP A La Carte	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3317	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', 0.78 < BF < 1.00, SBP A La Carte	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3318	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', BF ≤0.78, SBP A La Carte	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3319	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', BF > 1.00, SBP A La Carte	Implementer's cost plus Cadmus estimate for labor duration and RSMeans for labor cost.	$9.80
3320	Delamping, T12 to T8, 8', SBP A La Carte	Implementer's cost for labor.	$2.00
3321	Delamping, 200-399 Watt Fixture, SBP A La Carte	Implementer's cost.	$15.00
3322	Delamping, ≥400 Watt Fixture, SBP A La Carte	Implementer's cost.	$15.00
3323	LED, 2x2, Replacing T12 2L U-Tube, SBP A La Carte	RSMeans	$16.69
3324	LED, 2x2, Replacing T8 2L U-Tube, SBP A La Carte	RSMeans	$16.69
3325	T8, 2’ Lamps, Replacing T12 Single U-Tube, SBP A La Carte	Workpaper	$40.00
3326	T8, 2’ Lamps, Replacing T12 Dual U-Tube, SBP A La Carte	RSMeans	$1.22
3327	T8, 2’ Lamps, Replacing T8 Single U-Tube, SBP A La Carte	Workpaper	$40.00
3328	T8, 2’ Lamps, Replacing T8 Dual U-Tube, SBP A La Carte	RSMeans	$1.22
3329	T8 4L Replacing 250-399 W HID, SBP A La Carte	RSMeans	$156.14
3330	T5HO 2L Replacing 250-399 W HID, SBP A La Carte	Workpaper	$132.61
3331	T8 6L Replacing 400-999 W HID, SBP A La Carte	RSMeans	$163.56
3332	T5HO 4L Replacing 400-999 W HID, SBP A La Carte	RSMeans	$163.56

MMID	Measure Name	Source	Incremental Cost
3333	T8 8L ≤500W, Replacing ≥1000 W HID, SBP A La Carte	RSMeans	$215.29
3334	T5HO 6L ≤500W, Replacing ≥1000 W HID, SBP A La Carte	RSMeans	$210.22
3335	LED, Horizontal Case Lighting, SBP A La Carte	WESCO distribution pricing + labor	$86.00
3336	T8 2L 4', recessed Indirect Fixture, HPT8 replacing 3 or 4L - T8 or T12, SBP A La Carte	RSMeans	$14.06
3337	Bi Level Controls, High Bay Fixtures, Gymnasium, SBP A La Carte	RSMeans	$95.00
3338	Bi Level Controls, High Bay Fixtures, Industrial, SBP A La Carte	RSMeans	$95.00
3339	Bi Level Controls, High Bay Fixtures, Other, SBP A La Carte	RSMeans	$95.00
3340	Bi Level Controls, High Bay Fixtures, Public Assembly, SBP A La Carte	RSMeans	$95.00
3341	Bi Level Controls, High Bay Fixtures, Retail, SBP A La Carte	RSMeans	$95.00
3342	Bi Level Controls, High Bay Fixtures, Warehouse, SBP A La Carte	RSMeans	$95.00
3343	Lighting Controls, Bilevel, Exterior and Parking Garage Fixtures, Dusk to Dawn, SBP A La Carte	Workpaper	$150.00
3344	Lighting Controls, Bilevel, Parking Garage Fixtures, 24 Hour, SBP A La Carte	Workpaper	$150.00
3345	Lighting Controls, Photocell with Internal Timer or Wireless Schedule, Exterior, SBP A La Carte	Workpaper	$30.00
3346	LED, 8 Watts, SBP Package	Workpaper	$15.00
3347	LED, 12 Watts, SBP Package	RSMeans	$7.50
3348	LED Troffer, 2x4, Replacing 4' 3-4 Lamp T8 Troffer, SBP Package	Workpaper	$110.00
3349	CFL, 31-115 Watts, SBP Package	Historical Program Data	$3.00
3350	Insulation, Direct Install, Pipe, Per Foot, 1" Thickness, Electric, SBP Package	http://bc3.pnnl.gov/sites/default/files/Cost-Estimation-for-Materials-and-Installation-of-Hot-Water-Piping-Insulation.pdf	$2/ft

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MMID	Measure Name	Source	Incremental Cost
3351	Insulation, Direct Install, Pipe, Per Foot, 1" Thickness, NG, SBP Package	http://bc3.pnnl.gov/sites/default/files/Cost-Estimation-for-Materials-and-Installation-of-Hot-Water-Piping-Insulation.pdf	$2/ft
3352	LED, 8-12 Watts, SBP Package	Average of MMIDs 3346-3347	$11.25
3353	LED, Replacing Neon Sign, SBP Package	Workpaper	$55.00
3354	CFL, ≤32 Watt, SBP Package	Average of Data from other recommendations	$3.19
3355	Faucet Aerator, Direct Install, 1.5 gpm, Bathroom, Electric, SBP Package	historical project data	$2.00
3356	Faucet Aerator, Direct Install, 1.5 gpm, Bathroom, NG, SBP Package	Historical Program Data	$2.00
3357	Occupancy Sensor, Wall Mount, >200 Watts, SBP Package	RSMeans	$35.00
3358	Showerhead, Direct Install, 1.75 gpm, Electric, SBP Package	Historical Program Data	$5.00
3359	Showerhead, Direct Install, 1.75 gpm, NG, SBP Package	Historical Program Data	$5.00
3360	LED, Exit Sign, Retrofit, SBP Package	WESCO distribution pricing + labor	$35.00
3361	Occupancy Sensor, Wall Mount, ≤200 Watts, SBP Package	RSMeans	$35.00
3362	Vending Machine Controls, Occupancy Based, Cold Beverage Machine, SBP Package	MMID 2611	$160.00
3363	LED, ≤8W, SBP Package	Workpaper	$15.00
3364	LED, > 12W (Max 20W) Flood Lamp, SBP Package	MMID 3142	$16.70
3365	LED, MR16, 8-12W, SBP Package	RSMeans	$9.90
3366	LED, 2x2, Replacing T12 2L U-Tube, SBP Package	RSMeans	$16.69
3367	LED, 2x2, Replacing T8 2L U-Tube, SBP Package	RSMeans	$16.69
3368	Faucet Aerator, Direct Install, .5 gpm Public Restroom, Elec, SBP Package	Historical Program Data	$2.00
3369	Faucet Aerator, Direct Install, .5 gpm Public Restroom, NG, SBP Package	Historical Program Data	$2.00
3370	Faucet Aerator, Direct Install, .5 gpm Employee Restroom, Elec, SBP Package	Historical Program Data	$2.00

MMID	Measure Name	Source	Incremental Cost
3371	Faucet Aerator, Direct Install, .5 gpm employee Restroom, NG, SBP Package	Historical Program Data	$2.00
3372	T8 2L 4', recessed Indirect Fixture, HPT8 replacing 3 or 4L - T8 or T12, SBP Package	RSMeans	$14.06
3385	LED, Non PI Direct Install, 13.5 Watt	Workpaper	$12.50
3387	LED, 1x4, replacing T8 or T12, 2L	Workpaper	$110.00
3388	LED, 1x4 replacing T8 or T12, 2L, SBP A La Carte	Workpaper	$110.00
3389	LED, 1x4 replacing T8 or T12, 2L, SBP Package	Workpaper	$110.00
3390	HPT8, 1x4, replacing T12 or T8, 2L	Workpaper	$45.00
3391	HPT8, 1x4, replacing T12 or T8, 2L, SBP A La Carte	Workpaper	$45.00
3392	HPT8, 1x4, replacing T12 or T8, 2L, SBP Package	Workpaper	$45.00
3393	LED Fixture, ≤180 Watts, Replacing 4 lamp T5 or 6 lamp T8, High Bay, DLC Listed	Workpaper	$300.00
3394	LED Fixture, Downlights, ≤18 Watts, Replacing 1 lamp pin based CFL Downlight	Workpaper	$51.16
3395	LED Fixture, Downlights, >18 Watts, Replacing 2 lamp pin based CFL Downlight	Workpaper	$215.35
3396	LED Fixture, Downlights, ≤100 Watts, ≥4000 Lumens, Interior	Workpaper	$60.00
3397	LED Fixture, Downlights, ≤100 Watts, ≥4000 Lumens, Exterior	Workpaper	$60.00
3398	LED Fixture, Downlights, ≥6000 Lumens, Interior	Workpaper	$60.00
3399	LED Fixture, Downlights, ≥6000 Lumens, Exterior	Workpaper	$60.00
3400	LED Fixture, 2x2, Low Output, DLC Listed	RSMeans	$23.16
3401	LED Fixture, 2x2, High Output, DLC Listed	RSMeans	$23.16
3402	LED Lamp, Energy Star, Replacing Incandescent Lamp ≤40 Watts, Exterior	Workpaper	$15.00

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MMID	Measure Name	Source	Incremental Cost
3403	LED Lamp, Energy Star, Replacing Incandescent Lamp >40 Watts, Exterior	Workpaper	$15.00
3404	LED Fixture, Downlights, >18 Watts, Replacing Incandescent Downlight, Exterior	Workpaper	$84.98
3405	LED Fixture, Downlights, ≤18 Watts, Replacing Incandescent Downlight, Exterior	Workpaper	$66.29
3407	LED Fixture, Replacing 1000 Watt HID, Exterior	Workpaper	$1,214.33
3408	PSMH/CMH, Replacing 1000 Watt HID, Exterior	Workpaper	$50.83
3409	Retrofit Open Refrigerated Cases with Doors	Historical Project Data	$126.53/foot
3413	CFL, Non PI Direct Install, 13 Watt	MMID 2117	$0.37
3414	Ice Machine, CEE Tier 2, Air Cooled, Self Contained, 0-499 lbs/day	Illinois TRM/California Workpapers	$981.00
3415	Ice Machine, CEE Tier 2, Water Cooled, Self Contained, 0-499 lbs/day	Illinois TRM/California Workpapers	$981.00
3416	Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, 0-499 lbs/day	Illinois TRM/California Workpapers	$981.00
3417	Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, 500-999 lbs/day	Illinois TRM/California Workpapers	$1,485.00
3418	Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, ≥1,000 lbs/day	Illinois TRM/California Workpapers	$1,812.00
3419	Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, <500 lbs/day	Illinois TRM/California Workpapers	$981.00
3420	Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, 500-999 lbs/day	Illinois TRM/California Workpapers	$981.00
3421	Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, ≥1,000 lbs/day	Illinois TRM/California Workpapers	$1,812.00

MMID	Measure Name	Source	Incremental Cost
3422	Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, 0-499 lbs/day	Illinois TRM/California Workpapers	$981.00
3423	Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, 500-999 lbs/day	Illinois TRM/California Workpapers	$1,485.00
3424	Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, ≥1,000 lbs/day	Illinois TRM/California Workpapers	$1,812.00
3425	LED, 8ft, Replacing T12 or T8, 1L	Labor cost: p. 453, Hours p.259, Interior LED Fixtures 3010 (2 crew, 1.311 hr), Crew no. R-31, Electrician rate. RSMeans Green Building Cost Data, 2014. Material cost, market review, see costs tab.	$52.92
3426	LED, 8ft, Replacing T12 or T8, 1L, SBP A La Carte	Labor cost: p. 453, Hours p.259, Interior LED Fixtures 3010 (2 crew, 1.311 hr), Crew no. R-31, Electrician rate. RSMeans Green Building Cost Data, 2014. Material cost, market review, see costs tab.	$52.92
3427	LED, 8ft, Replacing T12 or T8, 1L, SBP Package	Labor cost: p. 453, Hours p.259, Interior LED Fixtures 3010 (2 crew, 1.311 hr), Crew no. R-31, Electrician rate. RSMeans Green Building Cost Data, 2014. Material cost, market review, see costs tab.	$52.92
3428	LED, 8ft, Replacing T12 or T8, 2L	Workpaper	$370.00
3429	LED, 8ft, Replacing T12 or T8, 2L, SBP A La Carte	Workpaper	$370.00
3430	LED, 8ft, Replacing T12 or T8, 2L, SBP Package	Workpaper	$370.00
3431	LED, 8ft, Replacing T12HO or T8HO, 1L	Workpaper	$370.00
3432	LED, 8ft, Replacing T12HO or T8HO, 1L, SBP A La Carte	Workpaper	$370.00
3433	LED, 8ft, Replacing T12HO or T8HO, 1L, SBP Package	Workpaper	$370.00
3434	LED, 8ft, Replacing T12HO or T8HO, 2L	Workpaper	$370.00
3435	LED, 8ft, Replacing T12HO or T8HO, 2L, SBP A La Carte	Workpaper	$370.00
3436	LED, 8ft, Replacing T12HO or T8HO, 2L, SBP Package	Workpaper	$370.00

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MMID	Measure Name	Source	Incremental Cost
3439	LED, Non-PI Direct Install, 13.5 Watt, With Co-Pay	Workpaper	$12.50
3440	NG Furnace with ECM, 97%+ AFUE	$1,797 based on average contractor response between 92% no staging no ECM and 97% multi-stage with ECM.	$1,797.00
3441	NG Furnace, 95% AFUE	Based on 15 contractors' response on 78% furnace baseline subtracted from responses to cost for 95% without staging or ECM.	$1,194.00
3442	NG Furnace with ECM, 97+ AFUE, Enhanced Rewards	$2,450 based on average contractor response between 92% no staging no ECM and 97% multi-stage with ECM.	$2,450.00
3443	NG Furnace with ECM, 95+ AFUE (Existing), Enhanced Rewards	CLEAResult surveyed 15 Trade Allies to gauge IMC from 80% to 92% then used survey data from 40 Trade Allies to gauge 92% to 95% IMC. Added, this is $1,565.	$1,565.00
3444	LED, Recessed Downlight, Energy Star, SBP Package	Labor cost: p. 453, Hours p.259, Interior LED Fixtures 3010 (2 crew, 1.311 hr), Crew no. R-31, Electrician rate. RSMeans Green Building Cost Data, 2014. Material cost, market review, see costs tab.	$36.08
3487	CFL, Direct Install, 20 Watt	Workpaper	$5.00
3488	LED, Direct Install, 10 Watt	Workpaper	$12.50
3489	DHW Temperature Turn Down, Serving Multiple Dwelling Units, Direct Install, Electric	MMID 2125	$-
3490	DHW Temperature Turn Down, Serving Multiple Dwelling Units, Direct Install, NG	MMID 2125	$-
3525	LED, Direct Install, 10 Watt, HES	Workpaper	$12.50
3526	HPT8, 1x4, replacing T12 or T8, 2L, WPS Gold Plus Package	MMID 3390	$45.00
3527	T8 2L 4', recessed Indirect Fixture, HPT8 replacing 3 or 4L - T8 or T12, WPS Gold Plus Package	MMID 3336	$14.06
3528	T8 2L 4', HPT8 or RWT8, Replacing T12 1L 8', 0.78 < BF < 1.00, WPS Gold Plus Package	MMID 3122	$4.90
3529	T8 2L 4', HPT8 or RWT8, Replacing T12 1L 8', BF ≤0.78, WPS Gold Plus Package	MMID 3123	$4.90

MMID	Measure Name	Source	Incremental Cost
3530	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', 0.78 < BF < 1.00, WPS Gold Plus Package	MMID 3124	$4.90
3531	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', BF ≤0.78, WPS Gold Plus Package	MMIDs 3122-3126	$4.90
3532	T8 2L 4', HPT8 or RWT8, Replacing T12HO 1L 8', BF > 1.00, WPS Gold Plus Package	MMID 3126	$4.90
3533	T8 2L 4', HPT8, CEE, replacing 8' 1L T12HO, WPS Gold Plus Package	MMID 3125	$4.90
3534	T8 4L 4', HPT8 or RWT8, Replacing T12 2L 8', 0.78 < BF < 1.00, WPS Gold Plus Package	MMIDs 3127-3134	$9.80
3535	T8 4L 4', HPT8 or RWT8, Replacing T12 2L 8', BF ≤0.78, WPS Gold Plus Package	MMIDs 3127-3134	$9.80
3536	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', 0.78 < BF < 1.00, WPS Gold Plus Package	MMIDs 3127-3134	$9.80
3537	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', BF ≤0.78, WPS Gold Plus Package	MMIDs 3127-3134	$9.80
3538	T8 4L 4', HPT8 or RWT8, Replacing T12HO 2L 8', BF > 1.00, WPS Gold Plus Package	MMIDs 3127-3134	$9.80
3539	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', 0.78 < BF < 1.00, WPS Gold Plus Package	MMIDs 3127-3134	$9.80
3540	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', BF ≤0.78, WPS Gold Plus Package	MMIDs 3127-3134	$9.80
3541	T8 4L 4', HPT8 or RWT8, Replacing T12VHO 2L 8', BF > 1.00, WPS Gold Plus Package	MMIDs 3127-3134	$9.80
3542	T8, 2' Lamps, Replacing T12 Dual U-Tube, WPS Gold Plus Package	MMID 3241	$1.22
3543	T8, 2' Lamps, Replacing T12 Single U-Tube, WPS Gold Plus Package	MMIDs 3241-3243	$1.22
3544	T8, 2' Lamps, Replacing T8 Dual U-Tube, WPS Gold Plus Package	MMID 3243	$1.22

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MMID	Measure Name	Source	Incremental Cost
3545	T8, 2' Lamps, Replacing T8 Single U-Tube, WPS Gold Plus Package	MMID 3242	$1.22
3548	CFL, Standard Bulb, 310-749 Lumens, Retail Store Markdown	MMID 2116	$1.21
3549	CFL, Standard Bulb, 750-1049 Lumens, Retail Store Markdown	MMID 2117	$0.37
3550	CFL, Standard Bulb, 1050-1489 Lumens, Retail Store Markdown	MMID 2118	$0.38
3551	CFL, Standard Bulb, 1490-2600 Lumens, Retail Store Markdown	MMID 2119	$1.03
3552	CFL, Reflector, 15 watt, Retail Store Markdown	Workpaper	$4.00
3553	LED, Omnidirectional, 310-749 Lumens, Retail Store Markdown	Workpaper	$12.50
3554	LED, Omnidirectional, 750-1049 Lumens, Retail Store Markdown	Workpaper	$12.50
3555	LED, Omnidirectional, 1050-1489 Lumens, Retail Store Markdown	Workpaper	$12.50
3556	LED, Omnidirectional, 1490-2600 Lumens, Retail Store Markdown	Workpaper	$12.50
3557	LED, Reflector, 12 watt, Retail Store Markdown	Workpaper	$8.08
3567	LED, Direct Install, 10 Watt, with Co-pay	MMID 3488	$12.50
3569	Furnace And A/C, ECM, 95% + AFUE, ≥16 SEER, Enhanced Rewards	Trade Ally Survey	$2,238.73

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Appendix E: Measure Lookup by MMID

MMID	Measure Name	Page Number
1981	NG Furnace with ECM, 95%+ AFUE (Existing)	77
1981	NG Furnace with ECM, 95%+ AFUE (Existing)	310
1983	Hot Water Boiler, 95%+ AFUE	250
1986	Condensing Water Heater, NG, 90%+	296
1988	Water Heater, Indirect, ≥ 90% AFUE	307
1989	Water Heater, Electric, EF ≥ 0.93	304
2023	LP or Oil Furnace with ECM, 90%+ AFUE (Existing)	310
2116, 2132	CFL, Direct Install, 9 Watts	330
2117, 2133	CFL, Direct Install, 14 Watts	330
2118, 2134	CFL, Direct Install, 19 Watts	330
2119, 2135	CFL, Direct Install, 23 Watts	330
2120, 2136, 3474	Faucet Aerator, 1.5 GPM, Kitchen, NG	270
2121, 2137, 3476	Faucet Aerator, 1.0 GPM, Bathroom, NG	270
2122, 2138, 3476	Insulation Direct Install, 6-Foot Pipe, NG	286
2123, 2139, 3481	Showerhead, Direct Install, 1.5 GPM, NG	271
2125, 2141, 3472	DHW Temperature Turn Down, Direct Install, Natural Gas	280
2126, 3473	Faucet Aerator, 1.5 GPM, Kitchen, Electric	270
2127, 3475	Faucet Aerator, 1.0 GPM, Bathroom, Electric	270
2128, 3477	Insulation, Direct Install, 6-Foot Pipe, Electric	285
2129, 2145, 3480	Showerhead Direct Install, 1.5 GPM, Electric	271
2131, 2147, 3471	DHW Temperature Turn Down, Direct Install, Electric	283
2137	Faucet Aerator, 1.0 GPM, Bath, Gas	275
2139, 3029	Shower Aerators, Faucet Aerator, 1.5 GPM, Shower, NG	275
2143	Faucet Aerator, 1.0 GPM, Bath, Electric	275
2145, 3030	Shower Aerators, Faucet Aerator, 1.5 GPM, Shower, Electric	275
2151	Faucet Aerator, 0.5 GPM, Bath, Electric,	275
2192	A/C Split System, ≤ 65 MBh, SEER 15	317
2193	A/C Split System, ≤ 65 MBh, SEER 16+,	317
2194	A/C Split System, ≤ 65 MBh, SEER 14	317
2209	Boiler Plant Retrofit, Mid-Efficiency Plant, 1-5 MMBh	10
2221	Boiler Control – Outside Air Temperature Reset/Cutout Control – Prescriptive	254
2246	CFL, Reflector Flood Lamps, <= 32 Watts	337

2253	Circulation Fan, High Efficiency, Ag	5
2254	Compressed Air Condensate Drains, No Loss Drain	32
2255	Compressed Air Controller, Pressure/Flow Controller	16
2257	Compressed Air Heat Recovery, Space Heating	22
2258	Compressed Air Mist Eliminators	24
2259	Compressed Air Nozzles, Air Entraining	27
2261	Compressed Air System Leak Survey and Repair Year 1	29
2262	Compressed Air System Leak Survey and Repair Year 2	29
2263	Compressed Air System Leak Survey and Repair Year 3	29
2264	Compressed Air, Cycling Thermal Mass Air Dryers	19
2269	Cooler Evaporator Fan Control	227
2276	Delamping, T12 to T8, 4-Foot	118
2277	Delamping, T8 to T8	118
2280	Dishwater, Low Temp, Door Type, Electric	40
2281	Dishwater, High Temp, Electric Booster, Door Type, Electric	40
2282	Dishwater, High Temp, Electric Booster, Door Type, NG	40
2283	Dishwater, High Temp, Electric Booster, Multi Tank Conveyor, Electric	40
2284	Dishwater, High Temp, Electric Booster, Multi Tank Conveyor, NG	40
2285	Dishwater, High Temp, Electric Booster, Single Tank Conveyor, Electric	40
2286	Dishwater, High Temp, Electric Booster, Single Tank Conveyor, NG	40
2287	Dishwater, High Temp, Electric Booster, Under Counter, Electric	40
2288	Dishwater, High Temp, Electric Booster, Under Counter, NG	40
2289	Dishwater, High Temp, Gas Booster, Door Type, NG	40
2291	Dishwater, High Temp, Gas Booster, Singel Tank Conveyor, NG	40
2292	Dishwater, High Temp, Gas Heat, Under Counter, NG	40
2293	Dishwater, Low Temp, Door Type, NG	40
2294	Dishwater, Low Temp, Multi Tank Conveyor, Electric	40
2295	Dishwater, Low Temp, Multi Tank Conveyor, NG	40
2296	Dishwater, Low Temp, Single Tank Conveyor, Electric	40
2297	Dishwater, Low Temp, Single Tank Conveyor, NG	40
2298	Dishwater, Low Temp, Under Counter, Electric	40
2299	Dishwater, Low Temp, Under Counter, NG	40
2306	ECM Compressor Fan Motor	231
2314	Energy Recovery Ventilator	72
2321	Freezer, Chest, Glass Door, < 15 cu ft, ENERGY STAR	65
2322	Freezer, Chest, Glass Door, 15-29 cu ft, ENERGY STAR	65
2323	Freezer, Chest, Glass Door, 30-49 cu ft, ENERGY STAR	65
2324	Freezer, Chest, Glass Door, 50+ cu ft, ENERGY STAR	65
2325	Freezer, Chest, Solid Door, < 15 cu ft, ENERGY STAR	65

2326	Freezer, Chest, Solid Door, 15-29 cu ft, ENERGY STAR	65
2327	Freezer, Chest, Solid Door, 30-49 cu ft, ENERGY STAR	65
2328	Freezer, Chest, Solid Door, 50+ cu ft, ENERGY STAR	65
2329	Freezer, Vertical, Glass Door, < 15 cu ft, ENERGY STAR	65
2330	Freezer, Vertical, Glass Door, 15-29 cu ft, ENERGY STAR	65
2331	Freezer, Vertical, Glass Door, 30-49 cu ft, ENERGY STAR	65
2332	Freezer, Vertical, Glass Door, 50+ cu ft,ENERGY STAR	65
2333	Freezer, Vertical, Solid Door, < 15 cu ft, ENERGY STAR	65
2334	Freezer, Vertical, Solid Door, 15-29 cu ft, ENERGY STAR	65
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2336	Freezer, Vertical, Solid Door, 50+ cu ft, ENERGY STAR	65
2429	Insulation, Steam Fitting, Removable, NG	13
2430	Insulation, Steam Piping, NG	13
2471	Occupancy Sensor, Ceiling Mount, ≤ 500 Watts	327
2472	Occupancy Sensor, Ceiling Mount, ≥ 1,001 Watts	327
2473	Occupancy Sensor, Ceiling Mount, 501-Watts to 1,000 Watts	327
2483	Occupancy Sensor, Wall Mount, ≤ 200 Watts	327
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2486	Oven, Convection, ENERGY STAR, NG	58
2509	Reach In Refrigerated Case w/ Doors Replacing Open Multi Deck Case	233
2521	Refrigerator, Chest, Glass Door, < 15 cu ft, ENERGY STAR	61
2522	Refrigerator, Chest, Glass Door, 15-29 cu ft, ENERGY STAR	61
2523	Refrigerator, Chest, Glass Door, 30-49 cu ft, ENERGY STAR	61
2524	Refrigerator, Chest, Glass Door, 50+ cu ft, ENERGY STAR	61
2525	Refrigerator, Chest, Solid Door, < 15 cu ft, ENERGY STAR	61
2526	Refrigerator, Chest, Solid Door, 15-29 cu ft, ENERGY STAR	61
2527	Refrigerator, Chest, Solid Door, 30-49 cu ft, ENERGY STAR	61
2528	Refrigerator, Chest, Solid Door, 50+ cu ft, ENERGY STAR	61
2529	Refrigerator, Vertical, Glass Door, < 15 cu ft, ENERGY STAR	61
2530	Refrigerator, Vertical, Glass Door, 15-29 cu ft, ENERGY STAR	61
2531	Refrigerator, Vertical, Glass Door, 30-49 cu ft, ENERGY STAR	61
2532	Refrigerator, Vertical, Glass Door, 50+ cu ft, ENERGY STAR	61
2533	Refrigerator, Vertical, Solid Door, < 15 cu ft, ENERGY STAR	61
2534	Refrigerator, Vertical, Solid Door, 15-29 cu ft, ENERGY STAR	61
2535	Refrigerator, Vertical, Solid Door, 30-49 cu ft, ENERGY STAR	61
2536	Refrigerator, Vertical, Solid Door, 50+ cu ft, ENERGY STAR	61
2643	VFD, HVAC Fan	79
2644	VFD, HVAC Heating Pump	79
2647	VFD, Process Fan	223

2648	VFD, Process Pump	223
2652	Water Heater, ≥ 0.82 EF, Tankless, Residential, NG	301
2660	Waterer, Livestock, < 250 Watts	2
2666	Chiller System Tune Up, Air Cooled, ≤ 500 Tons,	97
2667	Chiller System Tune Up, Air Cooled, > 500 Tons,	97
2668	Chiller System Tune Up, Water Cooled, ≤ 500 Tons,	97
2669	Chiller System Tune Up, Water Cooled, > 500 Tons	97
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2745	Air Sealing	261
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2756	ENERGY STAR Clothes Washer , Common Area Electric Water Heater,	324
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2760	DHW Plant Replacement	293
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2895	High Bay Fluorescent Lighting, T5HO 8L ≤ 500 Watts, Replacing ≥ 1,000 Watt HID	212
2896	High Bay Fluorescent Lighting, T5HO (2) 4L ≤ 500 Watts, Replacing ≥ 1,000 Watt HID	212

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3025	Low-Flow Kitchen, Faucet Aerator, 1.5 GPM, Kitchen, Gas	275
3026	Low-Flow Kitchen, Faucet Aerator, 1.5 GPM, Kitchen, Electric	275
3027	Low-Flow Bath , Faucet Aerator, 1.5 GPM, Bath, Gas	275
3028	Low-Flow Bath , Faucet Aerator, 1.5 GPM, Bath, Electric	275
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3039	HID, Reduced Wattage, Exterior, Replacing 250 Watt HID	126
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3045	Water Heater, High Usage, ≥90% TE, NG	34
3046	Water Heater, High Usage, ≥0.82 EF, Tankless, NG	34
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3059	Air Conditioning Unit Tune Up - Coil Cleaning, <10 Tons,	90
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3061	Air Conditioning Unit Tune Up - Coil Cleaning, 10-20 Tons,	90
3062	Air Conditioning Unit Tune Up - Refrigerant Charge Correction, <10 Tons	93
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3071	HID, Reduced Wattage, Garage, Replacing 250 Watt HID	126
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3079	Induction, PSMH/CMH, or Linear Fluorescent, Parking Garage, Replacing 150-175 Watt HID, 24 Hour	220
3080	Induction, PSMH/CMH, or Linear Fluorescent, Parking Garage, Replacing 150-175 Watt HID, Dusk to Dawn	220
3081	Induction, PSMH/CMF or Linear Fluorescent, Exterior, Replacing 250-watt HID	217
3082	Induction, PSMH/CMH, or Linear Fluorescent, Parking Garage, Replacing 250 Watt HID, 24 Hour	220
3083	Induction, PSMH/CMH, or Linear Fluorescent, Parking Garage, Replacing 250 Watt HID, Dusk to Dawn	220
3084	Induction, PSMH/CMF or Linear Fluorescent, Exterior, Replacing 320-watt HID	217
3086	Induction, PSMH/CMF or Linear Fluorescent, Exterior, Replacing 400-watt HID,	217
3087	Induction, PSMH/CMF or Linear Fluorescent, Exterior, Replacing 70- watt to 100-watt HID	217
3088	Induction, PSMH/CMH, or Linear Fluorescent, Parking Garage, Replacing 70-100 Watt HID, 24 Hour	220
3089	Induction, PSMH/CMH, or Linear Fluorescent, Parking Garage, Replacing 70-100 Watt HID, Dusk to Dawn	220
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3095	LED Fixture, High Bay, <500 Watts, Replacing 1,000 Watt HID	153
3096	LED Fixture, High Bay, <800 Watts, Replacing 1,000 Watt HID	153
3097	LED Fixture, Bi-level, Stairwell and Passageway,	114
3099	LED Fixture, Replacing 150-175 Watt HID, Exterior	350
3099, 3289	LED Fixture, Exterior, Replacing 150-175 Watt HID	147
3100	LED Fixture, Replacing 150-175 Watt HID, Parking Garage, 24 Hour	352
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3108, 3304	LED Fixture, Exterior, Replacing 70-100 Watt HID	147
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3119	Oven, Combination, ENERGY STAR, NG	51
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3140	Dishwater, Low Temp, Post/Pans Type, NG	40
3158	LED Fixture, Downlights, Accent Lights and Monopoint ≤ 18 Watts, In Unit	165
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3251, 3343	Lighting Controls, Bi-level, Exterior and Parking Garage Fixtures, Dusk to Dawn	114
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3270	Steam Trap Repair, 50-125 psig, General Heating, 1/4"	86
3271	Steam Trap Repair, 50-125 psig, General Heating, 5/16"	86
3272	Steam Trap Repair, 50-125 psig, General Heating, 3/8" or Larger	86
3273	8 Watts	160
3274	12 Watts	160
3275	Boiler Plant Retrofit, Hybrid Plant, >1 MMBh	7
3277	Boiler, Hot Water, Near Condensing, ≥ 85% AFUE, >300MBh	248
3279	LED, Direct Install, 9.5 Watt	345
3280	VFD, Process Pump, 2648VF D, Constant Torque	223
3346	8 Watts, SBP Package,	160
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3394	LED Downlights ≤ 18 Watts Replacing 1 Lamp Pin-Based CFL Downlight	140
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3396	LED Fixture, Downlights ≤ 100 Watts, ≥ 4,000 Lumens, Interior	168
3397	LED Fixture, Downlights ≤ 100 Watts, ≥ 4,000 Lumens, Exterior	168
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3399	LED Fixture, Downlights ≥ 6,000 Lumens, Exterior	168
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3402	LED Lamp, ENERGY STAR, Replacing Incandescent Lamp ≤40 Watts, Exterior	150
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3415	Ice Machine, CEE Tier 2, Water Cooled, Self Contained, 0-499 lbs/day	47
3416	Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, 0-499 lbs/day	47
3417	Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, 500-999 lbs/day	47
3418	Ice Machine, CEE Tier 2, Air Cooled, Ice Making Head, ≥1,000 lbs/day	47
3419	Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, <500 lbs/day	47
3420	Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, 500-999 lbs/day	47
3421	Ice Machine, CEE Tier 2, Water Cooled, Ice Making Head, ≥1,000 lbs/day	47
3422	Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, 0-499 lbs/day	47
3423	Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, 500-999 lbs/day	47
3424	Ice Machine, CEE Tier 2, Air Cooled, Remote Condensing, ≥1,000 lbs/day	47
3425	LED, 8-Foot Fixture, Replacing T12 or T8, 1L	177
3426	SBP A La Carte	177

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3427	SBP Package	177
3428	LED, 8-Foot Fixture, Replacing T12 or T8, 2L	177
3429	SBP A La Carte	177
3431	LED, 8-Foot Fixture, Replacing T12HO or T8HO, 1L	177
3432	SBP A La Carte	177
3433	SBP Package	177
3434	LED, 8-Foot Fixture, Replacing T12HO or T8HO, 2L	177
3435	SBP A La Carte	177
3436	SBP Package	177
3439	LED, Direct Install, With Co-pay, 13.5 Watt	358
3440	NG Furnace with ECM, 97%+ AFUE	310
3441	NG Furnace, 95% AFUE	310
3442	NG Furnace with ECM, 97+ AFUE, Enhanced Rewards	310
3443	NG Furnace with ECM, 95+ AFUE (Existing)	310
3461	LED, Recessed Downlight, Replacing Incandescent, ENERGY STAR, In Unit	182
3462	LED, Recessed Downlight, Replacing Incandescent, ENERGY STAR, Common Area	182
3463	LED, Recessed Downlight, Replacing CFL, ENERGY STAR, In Unit	182
3464	LED, Recessed Downlight, Replacing CFL, ENERGY STAR, Common Area	182
3487	CFL, Direct Install, 20 Watt	333
3488	LED, Direct Install, 10 Watt	356
3494	Variable Speed ECM Pump, Domestic Hot Water Recirculation, < 100 Watts Max Input	101
3495	Variable Speed ECM Pump, Domestic Hot Water Recirculation, 100 - 500 Watts Max Input	101
3496	Variable Speed ECM Pump, Domestic Hot Water Recirculation, > 500 Watts Max Input	101
3497	Variable Speed ECM Pump, Heating Water Circulation , < 100 Watts Max Input	101
3498	Variable Speed ECM Pump, Heating Water Circulation , 100 - 500 Watts Max Input	101
3499	Variable Speed ECM Pump, Heating Water Circulation , > 500 Watts Max Input	101
3500	Variable Speed ECM Pump, Cooling Water Circulation , < 100 Watts Max Input	101
3501	Variable Speed ECM Pump, Cooling Water Circulation , 100 - 500 Watts Max Input	101
3502	Variable Speed ECM Pump, Cooling Water Circulation , > 500 Watts Max Input	101
3503	Variable Speed ECM Pump, Water Loop Heat Pump Circulation , < 100 Watts Max Input	101

3504	Variable Speed ECM Pump, Water Loop Heat Pump Circulation , 100 - 500 Watts Max Input	101
3505	Variable Speed ECM Pump, Water Loop Heat Pump Circulation , > 500 Watts Max Input	101
3506	Faucet Aerator, 1.0 GPM, Kitchen,Electric	275
3507	Faucet Aerator, 1.0 GPM, Kitchen,Gas	275
3508	Faucet Aerator, 0.5 GPM, Bath, Gas	275
3509	Faucet Aerator, 0.5 GPM, Kitchen, Electric	275
3510	Faucet Aerator, 0.5 GPM, Kitchen, Gas	275
3511	LED Replacement of 8-Foot T8 Lamps w/Integral or External Driver	189
3512	LED Replacement of 4-Foot T8 Lamps Using Existing Ballast	185
3512	LED Replacement of 8-Foot T8 Lamps Using Existing Ballast	192
3517	Steam Trap Repair, 126-225 psig, General Heating, 1/4"	86
3518	Steam Trap Repair, 126-225 psig, General Heating, 3/8" or Larger	86
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3520	Steam Trap Repair, 126-225 psig, General Heating, 7/32" or Smaller	86
3521	Steam Trap Repair, >225 psig, General Heating, 1/4"	86
3522	Steam Trap Repair, >225 psig, General Heating, 3/8" or Larger	86
3523	Steam Trap Repair, >225 psig, General Heating, 5/16"	86
3524	Steam Trap Repair, >225 psig, General Heating, 7/32" or Smaller	86
3548	CFL, Standard Bulb, 310-749 Lumens, Retail Store Markdown	342
3549	CFL, Standard Bulb, 750-1,049 Lumens, Retail Store Markdown	342
3550	CFL, Standard Bulb, 1,050-1,489 Lumens, Retail Store Markdown	342
3551	CFL, Standard Bulb, 1,490-2,600 Lumens, Retail Store Markdown	342
3552	CFL, Reflector, 15 Watt, Retail Store Markdown	339
3553	LED, Omnidirectional, Retail Store Markdown, 310-749 Lumens	347
3554	LED, Omnidirectional, Retail Store Markdown, 750-1,049 Lumens	347
3556	LED, Omnidirectional, Retail Store Markdown, 1,050-1,489 Lumens	347
3557	LED, Omnidirectional, Retail Store Markdown, 1,490-2,600 Lumens	347
3557	LED, Reflector, 12 Watt, Retail Store Markdown	360
3558	Insulation, Attic, R-19 to R-38	265
3559	Boiler, 95%+ AFUE, With DHW, NG	358
3560	Occupancy Sensor, Fixture Mount, > 60 Watts	324
3561	Occupancy Sensor, Fixture Mount, ≤ 60 Watts	324
3569	Furnace and A/C, ECM, 95%+ AFUE, ≥ 16 SEER, Enhanced Rewards	317
3570	Insulation and Air Sealing, Attic, R-11 to R-38	262
TBD	> 12 Watts	160
TBD	> 12 Watts, SBP Package	160
TBD	> 16 Watt	160
TBD	> 16W, SBP Package	160

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TBD	T8 LED < 20 Watts, 3L, Replacing 3L or 4L T12/T8	204
TBD	T8 LED < 20 Watts, 2L, Replacing 3L or 4L T12/T8	204