IESO Measures and Assumptions List Technical Supplement

June 2025

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Powering Tomorrow.

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1. Introduction

The Independent Electricity System Operator (IESO) have delivered Demand Side Management (DSM) programs through a series of multi-year framework since 2007. DSM programs are designed to cost-effectively meet the needs of Ontario's electricity system by focusing on provincial energy and peak demand reductions, as well as address local reliability concerns.

Recognizing the benefits that Demand Side Management (DSM) brings to the province, the IESO created Measures and Assumptions Lists (MAL)[1] that contain a list of DSM measures with their associated energy and peak demand savings and other technical input assumptions for different end-use applications in the residential, commercial and institutional and industrial sectors. It is being used for a variety of reasons from program planning and design to program evaluations.

This MAL Technical Supplement is created to substantiate the calculation of energy and peak demand savings for each measure using prescribed input assumptions and algorithms. It provides the methodology and equations used in calculating the savings as well as other technical input assumptions such as the end use load profile and effective useful life.

2. The 2025 MAL Technical Supplement

The 2025 MAL Technical Supplement contains technical information on deemed energy and demand savings for DSM measures offered by the IESO. The annual energy and summer peak demand savings represent potential gross level savings for an average Ontario consumer. These potential savings do not account for adjustment factors such as free ridership, spillover or rebound effect.

Annual energy savings in most of the measures are presented as the difference of the base measure annual consumption and efficient measure annual consumption. Where there is sufficient information, annual consumption is estimated as a function of the wattage rating and the number of operating hours. Summer peak demand savings, on the other hand, require an assumed end use load profile.

[1] IESO Measures and Assumptions Lists
https://ieso.ca/Sector-Participants/Energy-Efficiency/Evaluation-Measurement-and-Verification

Information presented in this Technical Supplement is derived and gathered from various sources ranging from previous evaluation studies involving engineering calculations to in situ (in its original place) metering studies. It may also be based on studies undertaken in different jurisdictions outside Ontario but contain input assumptions that have been found to be valid for Ontario.

2.1 Demand Side Management (DSM) Measures

A DSM measure is an action or set of actions undertaken in a DSM program which aims to encourage consumers to change their level and pattern of electricity usage. It may include energy efficiency, load management, demand response and the use of distributed energy resources.

In the past, most DSM programs were implemented to provide cost-effective energy and capacity resources to help defer the need for building new generating facilities, power purchases, and transmission and distribution capacity additions. However, due to changing times, DSM is now strategically considered to address customer needs. DSM refers to energy and load-shape modifying activities undertaken in response to administered programs. It does not refer to energy and load-shape changes arising from the normal operation of the marketplace or from government-mandated energy-efficiency standards.

DSM measures bring significant potential energy and peak demand savings for DSM programs offered in the province. It is, therefore, important to be transparent and to substantiate these savings as they serve as the basis for the design, implementation, and evaluation of DSM programs. Depending on various factors such as project size, ease of implementation or level of incentives, the estimation of savings may be approached in a prescriptive or quasi-prescriptive manner.

2.1.1 Prescriptive Measures

A prescriptive measure uses defined or fixed input assumptions embedded into the energy and demand savings equations. These input assumptions can include default efficiencies for a type of equipment specified or annual operating hours for the type of building selected. It represents how a typical DSM measure may provide resource savings based on typical or blended averages. For example, changing old T-12 lights in a garage at home with T-8 lights may be thought of as a prescriptive measure in estimating the resource savings. In this scenario, an average number of hours used by the lights in the garage may be stipulated to be the same for all residential units in estimating the resource savings in the province. This is acceptable since the measure will only be looking at one simple type of light swap. The estimated savings will likely not differ too much from the actual savings. Creating a prescriptive measure for this is an efficient and low-cost way to forecast the savings and the incentive level.

2.1.2 Quasi-Prescriptive Measures

In a non-residential scenario where program participants opt to complete fluorescent lighting retrofits that involve multiple retrofits (e.g. changing lights used in public space retail advertisement; retrofitting lights in storage areas or stock rooms; or changing lights in the underground parking garage of a mall), a quasi-prescriptive lighting measure may be considered. Instead of simply assigning a prescriptive measure to represent all T-8 retrofits in a particular building, the Program may use a quasi-prescriptive approach in estimating resource savings.

A quasi-prescriptive measure may have varying resource savings estimates based on the technology, type of equipment or the context in which they are used. It contains key, measure-specific inputs to estimate energy and peak demand savings for each program participant. It provides a methodology that allows estimating resource savings for various scenarios rather than relying on a fixed savings value for all scenarios. A quasi-prescriptive approach will allow different parameters or variables to be assumed to estimate different levels of resource savings for different retrofits in different business segments.

Using the same prescriptive lighting example, a quasi-prescriptive measure would allow multiple variations of replacing T-12 fixtures stipulating different key input parameters such as the number of 8′ lamps or 4′ lamps, whether using standard or high performance T8 fixtures or the number of operating hours in a stock room versus the number of hours for an underground parking garage.

2.2 MAL Technical Supplement Substantiation

This MAL Technical Supplement contains substantiation sheets for each prescriptive and quasi-prescriptive measures. The substantiation sheets are used to document the references and rationale for each measure’s input assumptions. Each substantiation sheet consists of the following information:

Base and Efficient Equipment Descriptions – describe the existing equipment to be replaced (base case) and high efficiency equipment that will replace it (energy efficient case); units of the equipment or technologies (e.g. single unit, package of 3, string of lights) as well as the different sizes, capacities, types and efficiency levels available in the market and applications for the measure are specified.

Codes, Standards, and Regulations – list the applicable codes, standards, and/or regulations that govern the performance (i.e. energy consumption) of the base case and/or energy efficient case equipment.

Resource Savings – describe all measure input assumptions and algorithm for the calculation of estimation of energy and demand savings including the end use load profile and effective useful life. References and sources of information, where available, are provided for the input assumptions.

Measure Assumptions – provide all the input assumptions for the base and efficient equipment including the description of all variables and constants used in the calculation of energy and demand savings; where available, references and sources of information are provided.

Energy and Demand Savings – provide the algorithm for calculating the annual energy, connected demand and summer peak demand savings; includes the algorithm results for prescriptive measures; where available, references and sources of information are provided.

End Use Load Profile - describes when the potential energy savings will occur over the period of a year for the specific measure or end-use; used in estimating peak demand savings from annual energy savings; created using 8760[2] hourly load shapes sourced from IESO Resource Planning. Refer to Appendix B for the end-use load profiles for different end-uses.

Effective Useful Life (EUL) - savings persistence of measures is based on the EUL of the technology. It is defined as an estimate of the median number of years that the measure installed will still be in place and effectively operable.

Revision History – documents the number of revisions done to the substantiation sheet by listing the number of revision, actions taken and the month/year when action was implemented.

Appendices – includes additional information on incremental costs and end use load profiles.

Appendix A (Incremental Costs) – lists all the assumed incremental costs for each measure; indicates the price differential between the energy efficient measure and baseline measure over the measure's lifetime. It is to be noted that incremental costs may differ depending on how programs are delivered (e.g. direct install vs retrofit).

Appendix B (End Use Load Profiles) – lists all end use load profiles assumed for all measures; describes when the potential energy savings will occur over the period of a year for the specific measure or end-use.

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[2] Number of hours in a year

3. Free Ridership and Other Adjustment Factors

Free ridership rates and other net-to-gross adjustment factors are not included in this Technical Supplement. Adjustment factors are a function of program design, delivery, and measure type and should be determined and maintained on a regular basis through program evaluation research.

4. Interactive Effects

Due to the advancement of technology, energy efficient equipment consumes less energy while producing the same amount of useful work or the same level of needed service. Consequently, energy efficient equipment also dissipates less waste heat into its surroundings and depending on the season and weather, the reduced waste heat may have a positive impact (reduced cooling load) and/or negative impact (increased heating load) on the energy savings.

For example, during the summer or warm weather, energy efficient lighting, which dissipates less heat, would reduce the cooling load of the cooling system thereby increasing energy savings. The reverse scenario will occur during the winter or cold weather, where the heating load will increase and the energy consumption will increase for the heating system. These impacts of energy efficient equipment on energy use are commonly referred to as interactive effects or cross effects.

When considering the overall net savings of an energy conservation measure, it is worthwhile to consider the interactive effects of the measure on space heating, space cooling or refrigeration systems. Interactive effects generate different impact levels on energy savings for different scenarios. Their impacts may range from a savings gain of 0.4 to 10% and a savings penalty of 30-36%.

Though accounting for the interactive effects will lead to more precise and realistic estimates of energy savings, the current measures in the prescriptive list do not account for interactive effects. It is inappropriate to assign a prescriptive or quasi-prescriptive value to account for interactive effects involved in each measure since there are many variables that must be considered.

5. Submission Process for New Measures

The IESO has adopted an open, transparent and flexible approach for reviewing and maintaining its Measures and Assumptions Lists. Through this approach, it is hoped that the IESO can harness the creativity and knowledge of local utility distribution companies (LDCs), manufacturers, academics and others interested in contributing to Ontario’s Measures and Assumptions Lists. This approach enables any stakeholder to submit new measures, measure revisions or other measure ideas to the IESO. Submissions of new measures or any information are welcome from any individual or group of individuals (e.g., company, organization, association) to the IESO for consideration by sending an email to evaluations@ieso.ca

Commercial & Industrial Measures (Prescriptive)

Creep Heat Controller

Measure Description

Energy Efficient Equipment Description

A minimum of ten 175W creep heat lamps with connected power supply, controller, and modulator to reduce lamp wattage during animal growth cycles. Minimum eligibility requires the controller to control at least five lamps.

Base Equipment Description

Ten 175W heat lamps that operate at full power while in use

Code, Standards and Regulations

No codes, standards and regulations exist for this measure.

Resource Savings Assumptions

Measure Assumptions

kW_{base} - base measure lamp wattage; assume ten 175W lamps[1]

Hours – assume 6,900 hours

Assume 20% energy savings[2]

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[1] A full controller setup includes a power supply, controller, and modulator. Each power supply and controller can interface with up to 12 modulators and each modulator can control 1,925W (or ten 175W lamps).

[2] Harmon, Jay D; Xin, Hongwei; Peterson, Dana Farm Energy: Conserving energy by using localized heating in swine housing, April 2012 https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1021&context=extension_ag_pubs

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{base}$ = 175W x 10 x 6900 hours x 1kW/1000W

Annual Energy Consumption $(kWh/yr)_{base}$ = 12,075 kWh

Annual Energy Consumption $(kWh/yr)_{conservation}$ = Annual Energy Consumption $(kWh/yr)_{base}$ x 0.8

Annual Energy Consumption $(kWh/yr)_{conservation}$ = 12,705 x 0.8 = 9,660 kWh

Annual Energy Savings (kWh/yr) = 12,705 – 9,660 = 2,415 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Demand Savings (kW) = 2,415/6900 = 0.35kW

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

ΔkWpeak = 2,415 x 0.01142% = 0.276 kW

End Use Load Profile

PSP-Business-Commercial-Creep_Heat_Controller

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01142%	0.01142%	0.01142%	0.01142%

Effective Useful Life (EUL)

Measure	EUL (years)
Creep Heat Controller	15

Revision History

Revision #	Description/Comment	Date Revised
1	Full measure review	July 2021
2	Updated formatting	Dec. 2023
3	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

Creep Heat Pad

Single and Double

Measure Description

Energy Efficient Equipment Description

Creep heat pads installed in place of heat lamps to keep young animals warm during early stages of life. A single creep heat pad assumed dimensions are assumed at 13.5″ x 48″ with double creep heat pads at 27″ x 48″

Base Equipment Description

One (single creep heat pad) or two (double creep heat pads) infrared heat lamps rated at 175W per lamp.

Code, Standards and Regulations

No codes, standards and regulations exist for this measure

Resource Savings Assumptions

Measure Assumptions

Base wattage = 175W

Efficiency $\text{wattage}_{\text{single}}$ = 85W

Efficiency $\text{wattage}_{\text{double}}$ = 169W

No. of hours = 6900 hours

Energy and Demand Savings

Energy Savings

For single creep heat pad

Annual Energy Consumption $(\text{kWh/yr})_{\text{base}}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{base}$ = 0.175kW x 6900 hours = 1,207.5 kWh/yr

Annual Energy Consumption $(kWh/yr)_{conservation}$ = 0.085kW x 6900 hours = 586.5 kWh/yr

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{conservation}$

Annual Energy Savings (kWh/yr) = 1,207.5 – 586.5 = 621 kWh/yr

For double creep heat pad

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{base}$ = (0.175kW x 2) x 6900 hours = 2,415 kWh/yr

Annual Energy Consumption $(kWh/yr)_{conservation}$ = 0.169kW x 6900 hours = 1,166.1 kWh/yr

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{conservation}$

Annual Energy Savings (kWh/yr) = 2,415 – 1,166.1 = 1,248.9 kWh/yr

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

For single creep heat pad

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Demand Savings (kW) = 0.175 – 0.085 = 0.09kW

For double creep heat pad

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Demand Savings (kW) = (0.175 x 2) – 0.169 = 0.181kW

Summer Peak Demand Savings

Summer peak demand savings ΔkWpeak are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

For single creep heat pad

ΔkWpeak = 1248.9 kWh * 0.00373% kW/kWh= 0.023 kW

For double creep heat pad

ΔkWpeak = 621.0 kWh * 0.00373% kW/kWh = 0.047 kW

End Use Load Profile

EM&V-Commercial-Creep_Heat_Pad

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.00373%	0.01526%	0.01526%	0.01526%

Effective Useful Life (EUL)

Measure	EUL (years)
Creep Heat Pad	10

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the OPA Measures and Assumptions List as a quasi-prescriptive measure	Sep. 2010
1	Included in the OPA Measures and Assumptions List as a prescriptive measure	Jul. 2014
2	Full measure review by Nexant	Aug. 2020
3	Updated formatting	Nov. 2023
4	Updated EM&V peak definition and summer Peak Demand Savings	Jan. 2025

Dairy Plate Cooler

Measure Description

Energy Efficient Equipment Description

The installation and use of a plate cooler to pre-cool milk prior to the milk entering a refrigerated cooling system.

Base Equipment Description

Dairy milk cooling system where milk is not pre-cooled and goes directly into a refrigerated cooling system.

Code, Standards and Regulations

No codes, standards and regulations are applicable for this measure.

Resource Savings Assumptions

Measure Assumptions[1]

Lbs Milk - estimated daily pounds of milk produced by the dairy farm that needs to be cooled through use of a milk pre-cooler; assume 68 lbs per cow per day

Cows - average number of milking cows on an Ontario dairy farm; assume 83 cows[2]

$C_{p,milk}$ – specific heat of milk; assume 0.94 Btu/(lb-°F)

Days – number of milking days of a typical dairy; assume 365 days

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[1] Wisconsin Focus on Energy 2023 Technical Reference Manual, Jan. 03, 2023 https://focusonenergy.com/evaluation-reports/2023-wisconsin-focus-on-energy-technical-reference-manual

[2] Canadian Dairy Information Centre, Dairy Farming in Canada https://agriculture.canada.ca/en/sector/animal-industry/canadian-dairy-information-centre

ΔT_{milk} - temperature difference between warm milk incoming into the plate cooler and the cooled milk leaving the plate cooler; assume 31°F

$EER_{compressor}$ - annual energy efficiency ratio of compressor 8.0 Btu/watt-hr

Hours = 2,920

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = (Lbs Milk x Cows x $C_{p,milk}$ x Days x ΔT) / (EER x 1000 W/kW)

Annual Energy Savings (kWh/yr) = (68 x 83 x 0.94 x 365 x 31) / (8 x 1000)

Annual Energy Savings (kWh/yr) = 7,503 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Average Demand Savings

Demand Savings (kW) = Annual Energy Savings (kWh/yr) / Hours

Demand Savings (kW) = 7,503 / 2920 = 2.57 kW

Summer Peak Demand Savings

No summer peak demand savings

End Use Load Profile

PSP-Industrial-Agriculture-Process_Cooling

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.00000%	0.00000%	0.00000%	0.00000%

Effective Useful Life (EUL)

Measure	EUL (years)
Dairy Plate Cooler	15[3]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures and Assumptions List	May 2016
1	Full Measure Review	Aug. 2020
2	Updated reference and formatting	Dec. 2023
3	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[3] Wisconsin Focus on Energy 2023 Technical Reference Manual, Jan. 03, 2023
https://focusonenergy.com/evaluation-reports/2023-wisconsin-focus-on-energy-technical-reference-manual

Dual & Natural Exhaust Ventilation System

Measure Description

Energy Efficient Equipment Description

Dual exhaust ventilation system. This system consists of operating exhaust fans to modulate exhaust air flow in cold months while no mechanical fans are to be operated for the rest of the year (natural ventilation)

Natural exhaust ventilation system. This system does not involve the use of mechanical exhaust fans. All ventilation is to be provided by chimneys and sidewall openings with curtains or sidewall insulated panels.

Base Equipment Description

Fans with minimum efficiency providing the required minimum ventilation requirement

Code, Standards and Regulations

ASAE EP566 December 2001 – Guidelines for Selection of Energy Efficient Agricultural Ventilation Fans.[1]

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[1] Guidelines for Selection of Energy Efficient Agricultural Ventilation Fans, ASAE Standards 2002,8760 (accessed September 2023)

https://elibrary.asabe.org/pdfviewer.aspx?GUID=897E7E60-6859-4A38-A9E1-FB949784ED19.

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 1 – Base kW Demand[2] and Number of Operating Hours for Ventilation

Usage Group	Quantity	Base kW	Base Hours
Chicken broilers	Fans: 340W/1000 birds	0.340	3000
Dairy-tie stall, outside in summer	50% in barn; 50% on pasture	0.035	5043
Dairy-tie stall, year round housing	Fans: 35W/cow	0.035	6548
Egg layers	Fans: 400W/1000 birds	0.400	5475
Greenhouse - Flowers	Fans: 1260W/1000 sq. meters	1.260	8760
Swine - Breeding & Gestation	Fans: 17W/sow	0.017	5864
Swine - Growing & Finishing	Fans: 5W/swine	0.005	8760
Turkeys	Fans: 1130W/1000 birds	1.130	6971

Quantity of animals or greenhouse area (B) in usage group (e.g. 1000 birds, 1000 m^2)

Energy Efficient Measure Demand Assumptions

Dual exhaust ventilation system assumes turning off the fan during summer and allowing natural ventilation. Assume efficient measure wattage and no. of baseline hours of operation is reduced by 44.7%.[3]

Table 2 – Efficient measure kW and Operating Hours

Usage Group	Eff kW	Eff Hours
Chicken broilers	0.152	1,341
Dairy-tie stall, outside in summer	0.016	2,254
Dairy-tie stall, year round housing	0.016	2,927
Egg layers	0.179	2,447
Greenhouse - Flowers	0.563	3,916
Swine - Breeding & Gestation	0.008	2,621
Swine - Growing & Finishing	0.002	3,916
Turkeys	0.505	3,116

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[2] Summit Blue Consulting, LLC (2009). Impact & Process Evaluation: Cross-Cutting Commercial & Institutional Retrofit Incentive Programs, an Evaluation Report prepared for the Ontario Power Authority. December 3, 2009.

https://www.ieso.ca/en/Sector-Participants/Energy-Efficiency/Evaluation-Measurement-and-Verification

[3] Navigant Consulting, Inc. Prescriptive Commercial Measures Review Phase 2: Prescriptive Commercial Non-Lighting Measure Characterization, May 2016.

Energy and Demand Savings

Energy Savings

Annual Energy Consumption (kWh/yr)base = Base Measure Wattage x Operating Hours

Annual Energy Consumption (kWh/yr)conservation = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption (kWh/yr)base - Annual Energy Consumption (kWh/yr)conservation

Table 3 – Annual Energy Savings (kWh/yr)

Usage Group	Annual Energy Consumption$_{base}$ (kWh)	Annual Energy Consumption$_{conservation}$ (kWh)	Annual Energy Savings (kWh)
Chicken broilers	1,020.00	203.81	816.19
Dairy-tie stall, outside in summer	176.52	35.27	141.25
Dairy-tie stall, year round housing	229.18	45.79	183.39
Egg layers	2,190.00	437.58	1,752.42
Greenhouse - Flowers	11,037.60	2,205.41	8,832.19
Swine - Breeding & Gestation	99.69	19.92	79.77
Swine - Growing & Finishing	43.80	8.75	35.05
Turkeys	7,876.76	1,573.85	6,302.92

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 4 – Connected Demand Savings (kW)

Usage Group	Wattage$_{base}$ (kW)	Wattage$_{conservation}$ (kW)	Connected Demand Savings (kW)
Chicken broilers	0.340	0.152	0.188
Dairy-tie stall, outside in summer	0.035	0.016	0.019
Dairy-tie stall, year round housing	0.035	0.016	0.019
Egg layers	0.400	0.179	0.221
Greenhouse - Flowers	1.260	0.563	0.697
Swine - Breeding & Gestation	0.017	0.008	0.009
Swine - Growing & Finishing	0.005	0.002	0.003
Turkeys	1.130	0.505	0.625

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 5 – Summer Peak Demand Savings (kW)

Usage Group	**Summer Peak Demand Savings (kW)**
Chicken broilers	0.118
Dairy-tie stall, outside in summer	0.000[4]
Dairy-tie stall, year round housing	0.001[4]
Egg layers	0.252
Greenhouse - Flowers	1.272
Swine - Breeding & Gestation	0.011
Swine - Growing & Finishing	0.005
Turkeys	0.908

End Use Load Profile

EM&V-Commercial-Dual_&_Natural_Ventilation_Fans_All_year

EM&V-Commercial-Dual_&_Natural_Ventilation_Fans_Winter_Only

EM&V Peak Definition

EM&V-Commercial-Dual_&_Natural_Ventilation_Fans_All_year

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.01440%	0.00879%	0.01440%	0.01440%

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[4] End Use Load Profile used: EM&V-Commercial-Dual_&_Natural_Ventilation_Fans_Winter_Only

EM&V-Commercial-Dual_&_Natural_Ventilation_Fans_Winter_Only

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.00033%	0.01731%	0.02835%	0.02835%

Effective Useful Life (EUL)

Measure	EUL (years)
Dual and Natural Exhaust Ventilation System	15

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Sep. 2010
1	Full measure review and update	Oct. 2020
2	Updated references and formatting	Nov. 2023
3	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

ENERGY STAR® Dairy Water Heater

Measure Description

Energy Efficient Equipment Description

ENERGY STAR® electric water heater with an energy factor of 2 or greater

Base Equipment Description

Standard electric water heater meeting International Energy Conservation Code (IECC) 2009 for efficiency ratings (For an electric water heater ≥ 20 gallons and ≤ 120 gallons, the energy factor (EF) is equal to 0.97 - 0.00132 x Rated Storage Volume in Gallons)[1]

Code, Standards and Regulations

The Natural Resources Canada mandates consumer water heaters manufactured and distributed in commerce, must meet the energy efficiency standards (CAN/CSA-C191-04). Energy performance standards for household electric waters are based on the rated storage in litres and the maximum allowable standby loss.

Table 1 - Energy Performance Standard for Household Electric Water Heaters[2]

Product Class	Inlet Type	Maximum Allowable Stanby Loss (W)
V_r of ≥50 to ≤270 L (11 to 59 imperial gallons)	Bottom inlet*	$\leq 40 + (0.20V_r)$
V_r of >270 to ≤454 L (60 to 100 imperial gallons)	Bottom inlet*	$\leq (0.472V_r) - 33.5$
V_r of ≥50 to ≤270 L (11 to 59 imperial gallons)	Top inlet	$\leq 35 + (0.20V_r)$
V_r of >270 to ≤454 L (60 to 100 imperial gallons)	Top inlet	$\leq (0.472V_r) - 38.5$

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[1] International Energy Conservation Code, IECC 2018

[2] https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/electric-water-heaters/6951

Where: V_r = rated nominal storage capacity in litres and W = watts

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions[3]

Eff_{base} = baseline water heater efficiency, 0.9

WU = average water use in gallons per cow per year; assume 2.75 gallons per cow per day per year; assume 1,004 gallons per year

T_{hot} = 170 °F

T_{cold} = 103 °F

No of milking cows = assume 83 for an Ontario dairy farm

Notes:

- Use a factor of 8.3 lb/gal factor in the annual energy savings calculation as the specific weight of water.
- Use a factor of 1 Btu/(lb·°F) factor in the annual energy savings calculation as the specific heat of water.
- The baseline efficiency is based on the U.S. DOE Federal Standards for efficiency rating for an 80 gallon tank.
- Preheated refrigeration heat recovery output water is around a conservative 120°F and average well water temperature is 52.3°F and a 75/25 split of those two temperatures is assumed to determine a mixed deemed average of approximately 103°F incoming water heater temperature.

Energy Efficient Measure Assumptions

$Eff_{Conservation}$ = conservation water heater efficiency, 2.0

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[3] Wisconsin Focus on Energy 2023 Technical Reference Manual, Jan. 03, 2023 https://focusonenergy.com/evaluation-reports/2023-wisconsin-focus-on-energy-technical-reference-manual

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = [(1/Eff_{base}) – (1/$Eff_{conservation}$) x WU x No. of cows x Specific heat of water x specific weight of water x (T_{hot} – T_{cold})] / 3412 Btu/kWh

Annual Energy savings (kWh/yr) = [(1/0.90) – (1/2) x 1004 x 83 x 1 x 8.3 x (170 – 103) /3413

Annual Energy savings (kWh/yr) = 8,297.52

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Average Demand Savings (kW) = Annual Energy Savings (kWh/yr) / 8760

Average Demand Savings (kW) = 0.947 kW

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

ΔkWpeak = 8,297.52 x 0.01142%

ΔkWpeak = 0.947 kW

End Use Load Profile

PSP-Industrial-Agriculture-Other

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01142%	0.01142%	0.01142%	0.01142%

Effective Useful Life (EUL)

Measure	EUL (years)
Agriculture Electric Water Heaters	15[4]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	May 2016
1	Updated references and formatting	Nov. 2023
2	Updated EM&V peak definition, Peak Demand Savings and formatting	Jan. 2025

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[4] 2023 Wisconsin Focus on Energy Technical Reference Manual
https://focusonenergy.com/evaluation-reports/2023-wisconsin-focus-on-energy-technical-reference-manual

Engine Block Heater Timer

Measure Description

Energy Efficient Equipment Description

Engine block heater operated by an outdoor plug-in timer that turns on the heater only when the outdoor temperature is below -3.8 °C (25 °F)

Base Equipment Description

Engine block heater that is manually plugged in by the farmer to facilitate equipment start-up at a later time

Code, Standards and Regulations

No codes, standards and regulations exist for this measure.

Resource Savings Assumptions

Measure Assumptions[1]

Base heater wattage (W) = 1,500W

In Service Rate (ISR) = 78.39%

Parasitic Load = 5.46 kWh

Note: Engine block heaters typically range in connected load from 200W to 2,000W. Average sized engine block heater is 1500W.

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Assumed Hours of Operation

Use Season = number of days in the winter season in which the engine block heater is used; assume 83 days[2]

% Days =percentage of days in the Use Season in which the operator actually uses the engine block heater); assume 84.23%

$\text{Hours}_{\text{base}}$ =daily operating hours for the base case; assume 10.66 hours

$\text{Hours}_{\text{eff}}$ =daily operating hours for the efficient case; assume 2.9 hours

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = [ISR x Use Season x %Days x ($\text{Hours}_{\text{base}}$ – $\text{Hours}_{\text{eff}}$) x $\text{kW}_{\text{heater}}$] – Parasitic Load

Annual Energy Savings (kWh/yr) = [0.7839 x 83 x 0.8435 x (10.66 – 2.9) x 1.5] – 5.46

Annual Energy Savings (kWh/yr) = 632.4 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There is no connected demand savings since block heater wattages do not change.

Summer Peak Demand Savings

Summer peak demand savings $\Delta \text{kW}_{\text{peak}}$ are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

As engine block heaters are not used in the summer season or during the summer peak coincident period, the coincidence factor, and subsequent peak demand savings, is zero.

End Use Load Profile

EM&V-Residential-Car_Block_Heater_South_Ontario

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[2] Canada Environment and Climate Change, weather and meteorological BIN data from 2010 for London, Ontario, Canada, for the days that exhibited temperature below 25°F, http://climate.weather.gc.ca/ http://climate.weather.gc.ca/

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.00000%	0.01621%	0.36691%	0.36691%

Effective Useful Life (EUL)

Measure	EUL (years)
Engine Block Heater Timer	3[3]

Revision History

Revision #	Description/Comment	Date Revised
0	New agribusiness measure substantiation	May 2016
1	Updated references and formatting	Nov. 2023
2	Updated EM&V peak definition, Peak Demand Savings and references	Jan. 2025

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[3] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

High Efficiency Ventilation Exhaust Fans

Measure Description

Energy Efficient Equipment Description

High efficiency ventilation and exhaust fans installed in barns and other agricultural applications

Base Equipment Description

Standard efficiency ventilation and exhaust fans installed in barns and other agricultural applications

Code, Standards and Regulations

No code, standards and regulations exist for this measure

Resource Savings Assumptions

Measure Assumptions[1]

CFM – cubic feet per minute of air movement

Hours – operating hours per year of the fan; assume 4,313 hours

Eff_{std} – efficiency of the standard efficiency fan at a static pressure of 0.1 inches water

Eff_{high} - efficiency of the high efficiency fan at a static pressure of 0.1 inches water

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[1] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, February 2021, Section 4.1.3 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

Table 1 – Default values for standard and high efficiency ventilation fans for dairy and swine facilities

Fan Size (in)	High Efficiency (cfm/W @ 0.1” water)	Standard Efficiency (cfm/W @0.1” water)	CFM
≥18” to < 24”	12.4	9.2	3,600
≥24” to < 36”	15.3	11.2	6,274
≥36” to < 48”	19.2	15.0	10,837
≥48”	22.7	17.8	22,626

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = [(1/Eff$_{std}$) – (1/Eff$_{high}$) x CFM x Hours x kW/1000W]

Table 2 – Annual Energy Savings (kWh/yr)

Fan Size (in)	Energy Savings (kWh)
≥18” to < 24”	435.5
≥24” to < 36”	647.4
≥36” to < 48”	681.6
≥48”	1,183.4

Connected Demand Savings

Demand Savings (kW) = [(1/Eff$_{std}$) – (1/Eff$_{high}$) x CFM x kW/1000W]

Table 3 – Connected Demand Savings (kW)

Fan Size (in)	kW Savings (kW)
≥18” to < 24”	0.101
≥24” to < 36”	0.150
≥36” to < 48”	0.158
≥48”	0.274

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$$

Table 4 – Summer Peak Demand Savings (kW)

Fan Size (in)	Peak Demand Savings (kW)
≥18” to < 24”	0.127
≥24” to < 36”	0.188
≥36” to < 48”	0.198
≥48”	0.344

End Use Load Profile

EM&V-Commercial-HE_Ventilation_Exhaust_Fans

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.02911%	0.00000%	0.00000%	0.00000%

Effective Useful Life (EUL)

Measure	EUL (years)
High Efficiency Ventilation Exhaust Fan	15[2]

Revision History

Revision #	Description/Comment	Date Revised
1	Full measure review	Aug. 2020

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[2] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, February 2021, Section 4.1.3. https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

2	Updated references and formatting	Nov. 2023
3	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

High Temperature Cutout Thermostat

Measure Description

Energy Efficient Equipment Description

High temperature cutout thermostats are applied to creep heat lamps to turn off lamp power when ambient temperature exceeds 75° F

Base Equipment Description

Creep heat lamps without control

Code, Standards and Regulations

No codes, standards and regulations exist for this measure.

Resource Savings Assumptions

Measure Assumptions

Lamp wattage (W_{lamp}) = 175W

Quantity (Qty) = 9[1]

$Hours_{base}$ = 6,900 hours

$Hours_{off}$ = 632[2]

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = W_{lamp} x Qty x $Hours_{off}$

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[1] Most controllers have a current maximum of 16A, which is enough to control 9 lamps at 175W each.

[2] Average number of typical weather hours at or above 75°F in Toronto (525 hours) and Windsor (740 hours).

Annual Energy Savings (kWh/yr) = [175W x 9 x 632] x kW/1000W = 995.4 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There are no connected demand savings for this measure

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

ΔkWpeak = 995.4 kWh x 0.05464%= 0.544 kW

End Use Load Profile

PSP-Business-Commercial-HT_Cutout_Thermostat

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.05464%	0.00000%	0.08197%	0.00000%

Effective Useful Life (EUL)

The effective useful life of a high temperature cutout thermostat is assumed to be 10 years.

Revision History

Revision #	Description/Comment	Date Revised
0	Full measure substantiation	Aug. 2020
1	Updated formatting	Nov. 2023
2	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

High Volume Low Speed Fans (HVLS)

Measure Description

Energy Efficient Equipment Description

High volume low speed fan installed in barns and other agricultural applications

Base Equipment Description

Standard efficiency box ventilation fans installed in barns and other agricultural applications

Code, Standards and Regulations

No applicable code, standards and regulations

Resource Savings Assumptions

Measure Assumptions

Table 1 – Default Values for Conventional and HVLS Fan Wattages[1]

Fan Diameter (ft)	Efficient Wattage (W)	Baseline Wattage (W)
≥ 10 ft to <11 ft, 1 HP	424	2,506
≥ 11 ft to <19 ft, 1.5 HP	659	3,898
≥ 19 ft to ≤24 ft, 2 HP	940	5,555

Annual hours per year[2] = 2,124 hours

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[1] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, February 2021; 3.2.13 Circulation Fan: High-Volume Low-Speed
https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

[2] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, February 2021; 4.1.5 High Volume Low Speed (used City of Erie)
https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = (Baseline Wattage – Efficient Wattage) x Hours

x kW/1000

Table 2 – Annual Energy Savings (kWh/yr)

Fan Diameter (ft)	Annual Energy Savings (kWh)
≥ 10 ft to <11 ft, 1 HP	4,422.2
≥ 11 ft to <19 ft, 1.5 HP	6,879.6
≥ 19 ft to ≤24 ft, 2 HP	9,802.3

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = (Baseline Wattage – Efficient Wattage) x kW/1000

Table 3 – Connected Demand Savings (kW)

Fan Diameter (ft)	Connected Demand Savings (kW)
≥ 10 ft to <11 ft, 1 HP	2.08
≥ 11 ft to <19 ft, 1.5 HP	3.24
≥ 19 ft to ≤24 ft, 2 HP	4.62

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 4 – Summer Peak Demand Savings (kW)

Fan Diameter (ft)	Summer Peak Demand Savings (kW)
≥ 10 ft to <11 ft, 1 HP	1.493
≥ 11 ft to <19 ft, 1.5 HP	2.322
≥ 19 ft to ≤24 ft, 2 HP	3.309

End Use Load Profile

EM&V-Commercial-HVLS_No_Summer_Operation

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.03376%	0.00000%	0.00000%	0.00000%

Effective Useful Life (EUL)

Measure	EUL (years)
HVLS	15[3]

Revision History

Revision #	Description/Comment	Date Revised
1	Full measure review	Aug. 2020
2	Updated references and formatting	Nov. 2023
3	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[3] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, February 2021; 4.1.5 High Volume Low Speed (used City of Erie)
https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

Low Energy Livestock Waterer

Measure Description

Energy Efficient Equipment Description

Low energy livestock waterer for agricultural applications

Base Equipment Description

Standard efficiency livestock waterer for agricultural applications

Code, Standards and Regulations

No code, standards and regulations exist for this measure

Resource Savings Assumptions

Measure Assumptions[1]

W_{base} – power consumption of baseline equipment; assume 1,100 W

W_{eff} – power consumption of baseline equipment; assume 250 W

HOU – average annual run hours of heater; annual operation is used at a conservative estimate of number of hours below 0°C; assume 2,804 hours

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = (W_{base} – W_{eff}) x Hours x kW/1000W

Annual Energy Savings (kWh/yr) = [(1,100 – 250) x 2,804]/1000 = 2,383 kWh/yr

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[1] Wisconsin Focus on Energy 2023 Technical Reference Manual, Jan. 03, 2023 https://focusonenergy.com/evaluation-reports/2023-wisconsin-focus-on-energy-technical-reference-manual

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = (W_{base} – W_{eff}) x kW/1000W

Demand Savings (kW) = (1,100 – 250) /1000 = 0.85 kW

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

End Use Load Profile

PSP-Business-Commercial-Livestock_Waterer

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.00000%	0.00000%	0.00000%	0.00000%

Effective Useful Life (EUL)

Measure	**EUL (years)**
Low Energy Livestock Waterer	10[2]

Revision History

Revision #	**Description/Comment**	**Date Revised**
1	Full measure review	Aug. 2020
2	Updated references and formatting	Nov. 2023

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[2] Wisconsin Focus on Energy 2023 Technical Reference Manual, Jan. 03, 2023 https://focusonenergy.com/evaluation-reports/2023-wisconsin-focus-on-energy-technical-reference-manual

Revision #	Description/Comment	Date Revised
3	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

Milk Scroll Compressor

Measure Description

Energy Efficient Equipment Description

Scroll compressor for dairy bulk tank milk cooling

Base Equipment Description

Reciprocating compressor for dairy bulk tank milk cooling

Code, Standards and Regulations

ANSI/ASHRAE Standard 15-2019 – Safety Standard for Refrigeration Systems specifies the safe design, construction, installation, and operation of refrigeration systems. Applies to the design, construction, test, installation, operation, and inspection of mechanical and absorption refrigeration systems including heat pump systems used in stationary applications, to modifications including replacement of parts or components if they are not identical in function and capacity, and to substitutions of refrigerant having a different number designation.[1]

Resource Savings Assumptions

Measure Assumptions[2]

C_p – specific heat value of milk; assume 0.93 Btu/lb-°F

lbs_{milk} – weight of milk per day; assume milk density of 8.7 lbs/gallon and an average milk production per cow per day of 6 gallons = 52.2 lbs/day

ΔT – refrigeration system cooling milk from 98°F to 38°F = 60°F

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[1] American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Standard, Research & Technology https://www.ashrae.org/technical-resources/standards-and-guidelines/titles-purposes-and-scopes#15

[2] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, Feb. 2021 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

EER_{base} – baseline compressor efficiency; assume 5.85

EER_{eff} – dairy scroll compressor efficiency; assume 10.6

Days = milking days per year of a typical dairy; assume 365 days

Cows = average number of cows milked per day in Ontario; assume 83 cows[3]

Hours = annual milking hours; assume 8 hours per day, 365 days per year, 2,920 hours

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = $[(1/EER_{base}) – (1/EER_{eff})] \times C_p \times \Delta T \times lbs_{milk} \times Days \times Cows \times kW/1000W$

Annual Energy Savings (kWh/yr) = $[(1/5.85) – (1/10.6)] \times 0.93 \times 60 \times 52.2 \times 365 \times 83$

Annual Energy Savings (kWh/yr) = 6,759,390 x kW/1000W = 6,759 kWh/yr

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Annual Energy Savings / Hours

Demand Savings (kW) = 6,759/2,920 = 2.314 kW

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

End Use Load Profile

PSP-Industrial-Agriculture-Other

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[3] Canadian Dairy Information Centre, Dairy Farming in Canada https://agriculture.canada.ca/en/sector/animal-industry/canadian-dairy-information-centre

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01142%	0.01142%	0.01142%	0.01142%

Effective Useful Life (EUL)

Measure	EUL (years)
Milk Scroll Compressor	15[4]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	May 2016
1	Full Measure review	Oct. 2020
2	Updated references and formatting	Nov. 2023
3	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[4] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, February 2021 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

Photocell and Timer for Lighting Control

Measure Description

Energy Efficient Equipment Description

Installation of lighting controls that contain both a timer (to set on/off schedules) and a photocell (to reduce daytime lamp usage). Facilities must include enough ambient light to allow for the lighting system to turn off in the daytime.

Base Equipment Description

Lighting system without any controls

Code, Standards and Regulations

No codes, standards and regulations exist for this measure.

Resource Savings Assumptions

Measure Assumptions

$\text{Lamps}_{\text{base}}$ = 48W T8HO

No. of lamps per fixture = 6

Fixtures per sensor = 4

Ballast Factor=1.0

$\text{Hours}_{\text{base}}$ =365 days ×17 hours/day[1] = 6,205 hours

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[1] Long day lighting (LDL) is a common dairy industry practice that exposes the cows to lighting for 16-18 hours per day to increase milk production. For this analysis daily hours of use will apply the average of 17 hours.

$\text{Hours}_{\text{photocell}} = 3{,}729$[2]

Energy and Demand Savings

Energy Savings

$\text{Annual Energy Savings (kWh/yr)} = \text{kW}_{\text{base}} \times \text{Hours}_{\text{photocell}}$

Annual Energy Savings (kWh/yr) = 1.152 kW x 3729 hours = 4,295.8 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There is no connected demand savings.

Summer Peak Demand Savings

Summer peak demand savings $\Delta \text{kW}_{\text{peak}}$ are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

ΔkWpeak = 4,295.8 kWh x 0.01110% = 0.477 kW

End Use Load Profile

EM&V-Commercial-HVAC_Fans_Pumps

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01110%	0.01110%	0.01142%	0.01142%

Effective Useful Life (EUL)

Measure	EUL (years)
Photocell and timer for lighting control	8[3]

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[2] Toronto hours between sunrise and sunset is 4,458.75, and this value assumes a reduction of 730 hours due to the photocell only operating 1 hour after sunrise and 1 hour before sunset.

[3] Wisconsin Focus on Energy 2023 Technical Reference Manual. Jan. 03, 2023 https://focusonenergy.com/evaluation-reports/2023-wisconsin-focus-on-energy-technical-reference-manual

Revision History

Revision #	Description/Comment	Date Revised
0	Full measure review	Aug. 2020
1	Updated references and formatting	Nov. 2023
2	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

Solar Hot Water Collector

Dairy Farms

Measure Description

Energy Efficient Equipment Description

Solar hot water pre-heater including solar collector panels, supplemental storage, antifreeze protection, pumps and controls system. The solar water heater will be assumed to be installed as a pre-heating system to a conventional electrical water heater. Hot water heaters with solar powered electric resistive elements are also eligible. The measure is substantiated for dairy farm use only.

Base Equipment Description

Conventional electric hot water heater with no collector panels

Code, Standards and Regulations

CSA 378-87 is the standard applied to individual thermal solar collectors. CAN/CSA F383-08 is the installation code for solar collector systems. All systems must include collectors certified under CSA 387-87, and the installation must meet the standards described in CSA F383-08.[1]

ENERGY STAR rated solar water heating systems must have a minimum Solar Uniform Energy Factor of ≥ 3.0 for electrical water heating back-up applications and ≥ 1.8 for gas water heating back-up applications.[2]

Resource Savings Assumptions

Measure Assumptions

Base water heater - electric

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[1] CSA standards for Solar Thermal Collector Systems, CANSIA. https://www.csagroup.org/store/product/CAN-CSA-378-87/ (accessed Nov. 2023)

[2] ENERGY STAR Criteria for Solar Energy Factor https://www.energystar.gov/products/water_heaters/residential_water_heaters_key_product_criteria

Solar thermal panels size - assume 80 ft^2 based on 1.5 gallon capacity per ft^2

Size of hot water tank (HW) – 120 gallons

Uniform Energy Factor $(UEF)_{base}$ – 0.90[3]

Uniform Energy Factor $(UEF)_{eff}$ – 2.62[3]

Temperature difference (ΔT) - 170°F - 42°F = 128°F

No. of days (Days) – 365 days

Energy to Demand Factor (ETDF) – assume 0.00008047[3]

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = $[(1/UEF_{base}) – (1/UEF_{eff})]$ x HW x days x BTU/gal-°F x ΔT x 1/BTU/kWh

Annual Energy Savings (kWh/yr) = [(1/0.9) – (1/2.62)] x 120 x 365 x 8.3 x 128 x 1/3,412

Annual Energy Savings (kWh/yr) = 9,948 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

No demand connected savings for this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

ΔkWpeak = 9,948 x 0.01110% = 1.104 kW

End Use Load Profile

EM&V-Commercial-HVAC_Fans_Pumps

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[3] Pennsylvania PUC Technical Reference Manual Vol. 2 – Residential Measures, February 2021 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01110%	0.01110%	0.01142%	0.01142%

Effective Useful Life (EUL)

Measure	EUL (years)
Solar hot water collector	15[4]

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Sep. 2020
1	Updated measures assumptions.	July 2013
2	Updated measure assumptions.	April 2017
3	Full measure review	Aug. 2020
4	Updated references and formatting	Nov. 2023
5	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[4] Pennsylvania PUC Technical Reference Manual Vol. 2 – Residential Measures, February 2021
https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

Compressed Air Low Pressure Drop Filter

Measure Description

Energy Efficient Equipment Description

The efficient condition is a low pressure drop filter with pressure drop not exceeding 1 psid when new and 3 psid at end-of-life.

Low pressure drop filters remove solids and aerosols from compressed air systems with a longer life and lower pressure drop than standard coalescing filters, resulting in the ability to lower a compressed air systems pressure setpoints. This reduces the compressor work required resulting in energy savings.[1]

Base Equipment Description

The baseline condition is a standard coalescing filter with a pressure drop greater than the efficient case equipment.

Code, Standards and Regulations

ISO 12500:2007-Part 1 to 3, Filters for Compressed Air – Test Methods. There is no known regulations pertaining to energy efficiency of compressed air filters.

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Base measure pressure drop defined by existing conditions. If existing psid is unknown, assume a pressure drop improvement of 5 psid between baseline and efficient case.

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Energy Efficient Measure Assumptions

Efficient measure assumed to have pressure drop of no more than 1 psid when new and 3 psid at end-of-life. In other words, filter pressure drop should not increase by more than 2 psid over equipment lifetime.

Assumed Hours of Operation

Annual compressor hours. Assume 1976 hours for a single shift facility, 3952 for 2-shift, 5928 for 3-shift, and 8320 for continuous operation. Assume 5,700 average if hours of operation are unknown[2]

Energy and Demand Savings

Energy Savings[3]

Annual Energy Savings (kWh/yr) = (HP/Eff) x 0.746kW/hp x LF x Hours x ΔP x SF/100

where: HP – compressor nominal horsepower

Eff – compressor motor efficiency, if unknown, assume 90%

LF – typical compressor load factor, assume 75%

ΔP – reduction in pressure differential across filter (in psid), if unknown, assume 5 psid

SF – savings factor; 1% reduction in power per 2 psi reduction in system pressure is equal to 0.5% reduction per 1 psi

Table 1 – Annual Energy Savings (kWh/yr)

Compressor Horsepower Ratings	Energy Savings (kWh)
0 to <30 HP	1,771.75
≥30 to <50 HP	3,543.50
≥50 to <70 HP	5,315.25
≥70 to <90 HP	7,087.00
≥90 to <110 HP	8,858.75

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[3] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Version 4.1, Jan. 31, 2024 https://mn.gov/commerce-stat/trm/releases/4.1.pdf

Connected Demand Savings

No connected demand savings - installed compressor power remains unchanged

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$

Table 2 – Summer Peak Demand Savings (kW)

Compressor Horsepower Ratings	Summer Peak Demand Savings (kW)
0 to <30 HP	0.192
≥30 to <50 HP	0.384
≥50 to <70 HP	0.575
≥70 to <90 HP	0.767
≥90 to <110 HP	0.959

End Use Load Profile

PSP-Industrial-Miscellaneous_Industrial-Compressed_Air

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01082%	0.01066%	0.01230%	0.01131%

Effective Useful Life (EUL)

Illinois TRM assumes 10 years[4] and Minnesota TRM assumes 5 years[5]. Assumed 7 years for Ontario as mid-range estimate.

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[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[5] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Version 4.1, Jan. 31, 2024 https://mn.gov/commerce-stat/trm/releases/4.1.pdf

Revision History

Revision #	Description/Comment	Date Revised
0	New Measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Updated references and formatting	Nov. 2023
2	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

Compressed Air Primary Air Receiver Tank

Measure Description

Energy Efficient Equipment Description

Compressed air primary air receiver tanks with amount of incremental storage to make 3-5 US gallons per cfm primary air receiver capacity

Base Equipment Description

Primary storage of at least 1 US gallon per cfm of fixed speed compressor capacity

Code, Standards and Regulations

None

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Assume a baseline storage ratio of 1 gal/cfm

Energy Efficient Measure Assumptions

Assume efficient case storage of 3-5 gal/cfm

Assumed Hours of Operation

Assume 1,976 hours for a single shift facility, 3,952 for 2-shift, 5,928 for 3-shift, and 8,320 for continuous operation. Assume 5,700 average if hours of operation are unknown.[1]

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = 0.9 x $hp_{compressor}$ x Hours x (CF_b – CF_e)

where: $hp_{compressor}$ = compressor motor nominal hp

0.9 = compressor motor nominal hp to full load kW conversion factor

Hours = compressor total hours of operation depending on shift

CF = compressor factor

Table 1 – Annual Energy Savings (kWh/yr)

Baseline Compressor	Compressor Factor (≤40 hp)	Compressor Factor (50 - 200 hp)
Load/No-Load w/ 1 gallon/cfm	0.909	0.887
Load/No-Load w/ 3 gallon/cfm	0.831	0.811
Load/No-Load w/ 4 gallon/cfm	0.812	0.792
Load/No-Load w/ 5 gallon/cfm	0.806	0.786

Assume 80% safety factor[2] for 50-200 hp compressors.

Table 1 – Annual Energy Savings (kWh/yr)

Category	Primary Air Receiver Tank	Average Compressor HP	Annual Energy Savings (kWh)
Compressor: < 40 hp	0 to <15 HP (0 to <240 USG)	10	4,757
Compressor: < 40 hp	≥15 to <25 HP (≥240 to <400 USG)	20	9,513
Compressor: < 40 hp	≥25 to <35 HP (≥400 to <660 USG)	30	14,270
Compressor: < 40 hp	≥35 to <45 HP (≥660 to <1060 USG)	40	19,027
Compressor: 50-200 hp	≥45 to <55 HP (≥800 to <1060 USG)	50	18,600
Compressor: 50-200 hp	≥55 to <125 HP (≥1060 to <2220 USG)	100	37,200
Compressor: 50-200 hp	≥125 to <175 HP (≥2200 to <3150 USG)	150	55,800
Compressor: 50-200 hp	≥175 to <225 HP (≥3150 to <4050 USG)	200	74,400

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

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[2] Recommended by Posterity during their review in December 2020.

Connected Demand Savings

No connected demand savings since installed compressor power remains unchanged.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 2 – Summer Peak Demand Savings (kW)

Category	**Primary Air Receiver Tank**	**Average Compressor HP**	**Annual Peak Demand Savings (kW)**
Compressor: < 40 hp	0 to <15 HP (0 to <240 USG)	10	0.515
Compressor: < 40 hp	≥15 to <25 HP (≥240 to <400 USG)	20	1.030
Compressor: < 40 hp	≥25 to <35 HP (≥400 to <660 USG)	30	1.545
Compressor: < 40 hp	≥35 to <45 HP (≥660 to <1060 USG)	40	2.059
Compressor: 50-200 hp	≥45 to <55 HP (≥800 to <1060 USG)	50	2.013
Compressor: 50-200 hp	≥55 to <125 HP (≥1060 to <2220 USG)	100	4.026
Compressor: 50-200 hp	≥125 to <175 HP (≥2200 to <3150 USG)	150	6.040
Compressor: 50-200 hp	≥175 to <225 HP (≥3150 to <4050 USG)	200	8.053

End Use Load Profile

PSP-Industrial-Miscellaneous_Industrial-Compressed_Air

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.01082%	0.01066%	0.01230%	0.01131%

Effective Useful Life (EUL)

Illinois Technical Reference Manual[3] assumes 10 years, while Minnesota Technical Reference Manual[4] assumes 20 years. Assume 15 years for Ontario as mid-range estimate.

Revision History

Revision #	Description/Comment	Date Revised
0	New Measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Updated formatting	Nov. 2023
2	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[4] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Version 4.1, Jan. 31, 2024 https://mn.gov/commerce-stat/trm/releases/4.1.pdf

VSD & VD Air Compressor

Measure Description

Energy Efficient Equipment Description

This measure relates to the installation of an air compressor with a variable frequency drive, load/no load controls or variable displacement control. Baseline compressors choke off the inlet air to modulate the compressor output, which is not efficient. The baseline equipment is either an oil-flooded compressor ≤ 200 hp with inlet modulating with blowdown or load/no-load controls. Variable displacement savings is assumed to be 80% of the VSD Compressor.

Base Equipment Description

Efficient compressors use a variable speed drive on the motor to match output to the load. Savings are calculated using representative baseline and efficient demand numbers for compressor capacities according to the facility’s load shape, and the number of hours the compressor runs at that capacity. Demand curves are as per DOE data for a Variable Speed compressor versus a Modulating compressor. This measure applies only to an individual compressor ≤ 200 hp. Only one compressor per compressed air distribution system is eligible. This measure was developed to be applicable to the following program types: Retrofit. If applied to other program types, the measure savings should be verified. The high efficiency equipment is a compressor ≤ 200 hp with variable speed control.

Code, Standards and Regulations

No known regulations pertaining to energy efficiency of compressed air dryers.

Resource Savings Assumptions

Measure Assumptions[1]

$hp_{compressor}$ – compressor motor nominal hp

0.9 – compressor motor nominal hp to full load kW conversion factor

HOURS – compressor total hours of operation; assume 5,702 hours

CF_b – baseline compressor factor; assume 0.890 for ≤ 40 hp and 0.863 for 50-200 hp

CF_e – efficient compressor factor; assume 0.705 for ≤ 40 hp and 0.658 for 50-200 hp

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = 0.9 x $hp_{compressor}$ x HOURS x (CF_b – CF_e)

Table 1 – Annual Energy Savings (kWh/yr)

Compressor hp	Variable Speed Drive	Variable Displacement
10	9,493.83	7,595.06
15	14,240.75	11,392.60
20	18,987.66	15,190.13
25	23,734.58	18,987.66
30	28,481.49	22,785.19
40	37,975.32	30,380.26
50	59,528.88	47,623.10
60	71,434.66	57,147.72
75	89,293.32	71,434.66
100	119,057.76	95,246.21
125	148,822.20	119,057.76
150	178,586.64	142,869.31
200	238,115.52	190,492.42

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Annual Energy Savings (kWh/yr) / HOURS

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Table 2 – Average Demand Savings (kW)

Compressor hp	Variable Speed Drive	Variable Displacement
10	1.67	1.33
15	2.50	2.00
20	3.33	2.66
25	4.16	3.33
30	5.00	4.00
40	6.66	5.33
50	10.44	8.35
60	12.53	10.02
75	15.66	12.53
100	20.88	16.70
125	26.10	20.88
150	31.32	25.06
200	41.76	33.41

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 3 – Summer Peak Demand Savings (kW)

Compressor hp	Variable Speed Drive	Variable Displacement
10	1.03	0.82
15	1.54	1.23
20	2.06	1.64
25	2.57	2.06
30	3.08	2.47
40	4.11	3.29
50	6.44	5.15
60	7.73	6.19
75	9.67	7.73
100	12.89	10.31
125	16.11	12.89
150	19.33	15.46
200	25.77	20.62

End Use Load Profile

PSP-Industrial-Miscellaneous_Industrial-Compressed_Air

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01082%	0.01066%	0.01230%	0.01131%

Effective Useful Life (EUL)

Measure	EUL (years)
VSD/VD Air Compressor	13[2]

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Sep. 2020
1	Updated references and formatting	Dec. 2023
2	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Cycling or Thermal Mass Refrigerated Dryer

Measure Description

Energy Efficient Equipment Description

Cycling or thermal mass refrigerated dryer

Base Equipment Description

Non-cycling refrigerated dryer

Code, Standards and Regulations

No known regulations pertaining to energy efficiency of compressed air dryers

Resource Savings Assumptions

Measure Assumptions[1]

Base Measure Assumptions

$EC50_{base}$ - baseline energy consumption ratio of dryer at 50% inlet load capacity compared to fully loaded conditions assumed to be 0.843.

Energy Efficient Measure Assumptions

$EC50_{efficient}$ - energy consumption ratio of dryer at 50% inlet load capacity compared to fully loaded conditions assumed to be 0.729 for thermal mass dryer.

P_s - Assume full flow specific power of dryer to be 0.007 kW/cfm for baseline and efficient dryer

CFM – rated capacity of refrigerated dryer

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Assumed Hours of Operation

Compressed air system pressurized hours (H) is assumed to be 3,920 hours[2]

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = P_s x ($EC50_{base} – EC50_{efficient}$) x H x CFM

Table 1 – Annual Energy Savings (kWh/yr)

Cycling or Thermal Mass Dryer CFM	Annual Energy Savings (kWh)
0 to <200 CFM	994.84
≥200 to <400 CFM	2,487.10
≥400 to <750 CFM	4,974.20

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Connected demand savings is assumed to be zero.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 2 – Summer Peak Demand Savings (kW)

Cycling or Thermal Mass Dryer CFM	Summer Peak Demand Savings (kW)
0 to <200 CFM	0.108
≥200 to <400 CFM	0.269
≥400 to <750 CFM	0.538

End Use Load Profile

PSP-Industrial-Miscellaneous_Industrial-Compressed_Air

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[2] 16 hours per day, 5 days per week, 49 weeks per year

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01082%	0.01066%	0.01230%	0.01131%

Effective Useful Life (EUL)

Measure	EUL (years)
Cycling or Thermal Mass Dryer	13[3]

Revision History

Revision #	Description/Comment	Date Revised
0	New Measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Updated formatting	Nov. 2023
2	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Engineered Nozzles

Measure Description

Energy Efficient Equipment Description

Engineered nozzles to replace open blowing pipe or locally fabricated nozzles

Base Equipment Description

Crimped pipe or locally fabricated nozzle to blow compressed air to clean machine or cutting tool

Code, Standards and Regulations

No codes, standards and regulations exist for this measure

Resource Savings Assumptions

Measure Assumptions

Flow rates of air leakes at different pressures for a range of orifice diameters. For well rounded nozzles, values are multiplied by 0.97 and by 0.61 for sharp orifices.

Table 1 – Air Leakage (cfm) through Orifice Diameters[1]

Pressure (psig)	Orifice Diameter 1/64"	Orifice Diameter 1/32"	Orifice Diameter 1/16"	Orifice Diameter 1/8"	Orifice Diameter 1/4"	Orifice Diameter 3/8"
30	0.13	0.51	2.09	8.33	33.36	75.01
40	0.17	0.67	2.75	10.97	43.91	98.74
50	0.21	0.84	3.39	13.53	54.18	121.84
60	0.25	1.00	4.01	16.03	64.15	144.30
70	0.29	1.16	4.66	18.62	74.40	167.80
80	0.32	1.26	5.24	20.76	83.10	187.20
90	0.36	1.46	5.72	23.10	92.00	206.60
100	0.40	1.55	6.31	25.22	100.90	227.00
125	0.48	1.94	7.66	30.65	122.20	275.50

Pressure is assumed 80 psig for regulated open blowing pipes and 30 psig for efficient nozzles or air assisted nozzles

Assume average compressor size is 62 hp, 575V and 85% power factor; assume compressor output factor (cfm/hp) = 4.5[2]

Compressor adjustment factor 1.10[3]

Percent of time that open blowing occurs = 5%[4]

Assumed Hours of Operation

Assume 16 hours per day, 5 days per week and 49 weeks per year which is calculated as 3,920 hours/year

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Average Demand Savings x Annual Operating Hours

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[1] Energy Tips – Compressed Air
https://www.energy.gov/sites/prod/files/2014/05/f16/compressed_air3.pdf

[2] Compressed Air Energy Efficiency
https://www.cedengineering.ca/userfiles/M06-013%20-%20Compressed%20Air%20Energy%20Efficiency.pdf

[3] Adjustment for part load efficiency, pressure loss across filters, dryers and nominal power to operate dryer

[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20. 2024
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Table 2 - Annual Energy Savings (kWh)

Orifice Diameter (inches)	Annual Energy Savings (kWh)
1/16	109.37
1/8	431.20
1/4	1,724.80
3/8	3,880.80

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

The average demand savings is calculated from the air savings and using a compressor index value of kW/100 cfm

Open blowing flow rate = Air leakage at 80 psig (cfm) x 0.97

Efficient nozzle flow rate = Air leakage at 30 psig (cfm) x 0.97

Table 3 - Air Savings with Nozzle

Orifice Diameter (inches)	Open Blowing Flow Rate (cfm)	Efficient Nozzle Flow Rate (cfm)	Air Savings (cfm)
1/16	5.24	2.09	3.06
1/8	20.76	8.33	12.06
1/4	83.10	33.36	48.25
3/8	187.20	75.01	108.82

Compressor Index (kW/100 cfm) = [Maximum compressor power (kW) / Maximum compressor output] x Adjustment factor x 100

Compressor Index (kW/100 cfm) = [(62 hp x 0.746 kW/hp) / (62 hp x 4.5 cfm/hp)] x 1.10 x 100

Compressor Index = 18.24 kW/100 cfm

Table 4 - Average Demand Savings (kW) for 5% of Time with Open Blowing

Orifice Diameter (inches)	Equivalent Demand Savings (kW)	Average Demand Savings (kW)
1/16	0.56	0.03
1/8	2.20	0.11
1/4	8.80	0.44
3/8	19.84	0.99

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 5 – Summer Peak Demand Savings (kW)

Orifice Diameter (inches)	Summer Peak Demand Savings (kW)
1/16	0.012
1/8	0.047
1/4	0.187
3/8	0.420

End Use Load Profile

PSP-Industrial-Miscellaneous_Industrial-Compressed_Air

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01082%	0.01066%	0.01230%	0.01131%

Effective Useful Life (EUL)

Measure	EUL (years)
Engineered Nozzles	15[5]

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[5] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 30, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Revision History

Revision #	Description/Comment	Date Revised
1	Engineered Nozzle to Replace Open Blowing Pipe or Locally Fabricated Nozzles – 1/4″ Nominal Diameter	Jan. 2019
2	Full measure review by Nexant	Aug. 2020
3	Updated references and formatting	Nov. 2023
4	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

Regenerative Dryer with Dewpoint Control

Measure Description

Energy Efficient Equipment Description

Heatless, externally-heated, or blower purge Regenerative Dryer with Dewpoint Controlled Regeneration.

Regenerative dryers consist of two towers containing a desiccant material through which compressed air is circulated, in order to reduce condensation that can adversely affect compressed air equipment. Air is alternatively circulated through one tower until the desiccant is saturated, while moisture is removed from the second tower during the desiccant "regeneration" process. Depending on the system configuration, desiccant dryers used a combination of purge air and heating to regenerate the towers. Dewpoint controls adjust the amount of air and energy that is required to regenerate the desiccant towers by monitoring the moisture removal load on the system and adjusting regeneration cycles to match the load.

Base Equipment Description

Regenerative Dryer with Timer Controlled Regeneration.

Baseline regenerative dryer systems alternate towers on a fixed schedule, regardless of the actual moisture removal load at each regeneration interval.

Code, Standards and Regulations

ISO 7183:2007, Compressed air dryers – Specifications and testing. No known regulations pertaining to energy efficiency of compressed air dryers.

Resource Savings

Measure Assumptions[1]

CFM_{dryer} – flowrate of dryer in cubic feet per minute (CFM)

PF – purge flow of desiccant dryer (%)

Table 1 – Purge Flow of Dessicant Dryer

Compressor Type	Purge Flow (PF)
Heatless	15%
Externally-heated	7.5%
Blower Purge	2%

kWcompressor – power reduction per reduced air demand depending on the type of compressor control (kW/CFM)

Table 2 – Power Reduction for Different Compressor Control Types

Air Compressor Type	ΔkW/CFM
Reciprocating – On/off Control	0.18
Reciprocating – Load/Unload	0.14
Screw – Load/Unload	0.15
Screw – Variable Displacement	0.15
Screw - VFD	0.18

kWheater – average power of heater per CFM of dryer (kW/CFM); assume 0.007 kW/CFM for heated models, 0.013 kW/CFM for blower purge models

kW_{blower} – average power of blower per CFM of dryer (kW/CFM); assume 0 kW/CFM for heated models, 0.003 kW/CFM for blower purge models

Hours – annual operating hours; assume weighted average of 5,700 hours

PRF – purge reduction factor, 50% for heatless desiccant dryers, 60% for externally-heated or heated blower purge dryers

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = CFM_{dryer} x [(PF x kW_{comp}) + kW_{heater} + kW_{blower}] x Hours x PRF

Table 3 – Annual kWh Savings < 200 CFM Dryer

Air Compressor Control Type	∆kW/CFM	Heatless	Externally Heated	Blower Purge
Reciprocating – On/off Control	0.18	7,695.00	7,011.00	6,703.20
Reciprocating – Load/Unload	0.14	5,985.00	5,985.00	6,429.60
Screw – Load/Unload	0.15	6,412.50	6,241.50	6,498.00
Screw – Variable Displacement	0.15	6,412.50	6,241.50	6,498.00
Screw - VFD	0.18	7,695.00	7,011.00	6,703.20
			Average	**6,634.80**

Table 4 – Annual kWh Savings for ≥200 to <400 CFM Dryer

Air Compressor Control Type	∆kW/CFM	Heatless	Externally Heated	Blower Purge
Reciprocating – On/off Control	0.18	19,237.50	17,527.50	16,758.00
Reciprocating – Load/Unload	0.14	14,962.50	14,962.50	16,074.00
Screw – Load/Unload	0.15	16,031.25	15,603.75	16,245.00
Screw – Variable Displacement	0.15	16,031.25	15,603.75	16,245.00
Screw - VFD	0.18	19,237.50	17,527.50	16,758.00
			Average	**16,587.00**

Table 5 – Annual kWh Savings for ≥400 to 750 CFM Dryer

Air Compressor Control Type	∆kW/CFM	Heatless	Externally Heated	Blower Purge
Reciprocating – On/off Control	0.18	38,475.00	35,055.00	33,516.00
Reciprocating – Load/Unload	0.14	29,925.00	29,925.00	32,148.00
Screw – Load/Unload	0.15	32,062.50	31,207.50	32,490.00
Screw – Variable Displacement	0.15	32,062.50	31,207.50	32,490.00
Screw - VFD	0.18	38,475.00	35,055.00	33,516.00
			Average	**33,174.00**

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

No connected demand savings – installed compressor power remains unchanged

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$

Table 6 – Summer Peak Demand Savings (kW)

CFM Dryer	Summer Peak Demand Savings (kW)
< 200 CFM	0.718
≥200 to <400 CFM	1.795
≥400 to <750 CFM	3.591

End Use Load Profile

PSP-Industrial-Miscellaneous_Industrial-Compressed_Air

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01082%	0.01066%	0.01230%	0.01131%

Effective Useful Life (EUL)

Illinois TRM[2] defines this measure as a controls retrofit and assumes a 5-year EUL, equivalent to one-third of the assumed remaining life on the existing desiccant air dryer. The Wisconsin TRM[3] assumes 15-year EUL, which is the same EUL as the desiccant dryer itself.

In scenarios where existing desiccant dryers are retrofit with dewpoint controls, assume an EUL of 5 years. In scenarios where new desiccant dryers are being installed (with the baseline equipment being timer-controlled dryers), assume an EUL of 15 years.

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[3] Wisconsin Focus on Energy 2024 Technical Reference Manual, Jan. 07, 2024 https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

Revision History

Revision #	Description/Comment	Date Revised
0	New Measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Updated references and formatting	Nov. 2023
2	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

Zero Air Loss Drains

Measure Description

Energy Efficient Equipment Description

Zero air loss drains

Base Equipment Description

The base case assumes that moisture drains under the control of timers will be replaced by zero loss drains. Internal float operated drain valves are not eligible.

Code, Standards and Regulations

Not applicable.

Resource Savings Assumptions

Measure Assumptions

See below.

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Connected Demand Savings x Annual Operating Hours

Assuming operating hours of 3,920 hours/yr[1], annual energy savings (kWh/yr) are calculated as follows:

1/8” Drain, Demand Savings = 0.0298 kW x 3,920 hrs/yr = 117 kWh/yr

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[1] (16 hrs/day) x (5 days/wk) x 49 wks/yr) = 3,920 hrs/yr

1/4” Drain, Demand Savings = 0.119 kW x 3,920 hrs/yr = 466 kWh/yr

3/8” Drain, Demand Savings = 0.268 kW x 3,920 hrs/yr = 1,051 kWh/yr

1/2” Drain, Demand Savings = 0.476 kW x 3,920 hrs/yr = 1,866 kWh/yr

Blended Zero Loss Drain kW Savings = 1,206 kWh/yr

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

The following table presents the flow rates of air leakages at different pressures for a range of orifice diameters, as referenced from the United States Department of Energy Compressed Air Challenge from 2013[2]

Table 1 - Air Leakage (cfm) through Orifice Table

Pressure (psig)	**Orifice Diameter 1/64”**	**Orifice Diameter 1/32”**	**Orifice Diameter 1/16”**	**Orifice Diameter 1/8”**	**Orifice Diameter 1/4”**	**Orifice Diameter 3/8”**
70	0.29	1.16	4.66	18.62	74.40	167.80
80	0.32	1.26	5.24	20.76	83.10	187.20
90	0.36	1.46	5.72	23.10	92.00	206.60
100	0.40	1.55	6.31	25.22	100.90	227.00
125	0.48	1.94	7.66	30.65	122.20	275.50

For nozzles, values are multiplied by 0.97 for well-rounded orifices and by 0.61 for sharp orifices.

The pressure is assumed to be 100 psig for zero loss air drains. Assuming well-rounded orifices, the following diameters were calculated:

1/8” Drain Flow Rate = 25.22 cfm x 0.97 = 24.5 cfm

1/4" Drain Flow Rate = 100.90 cfm x 0.97 = 97.9 cfm

3/8” Drain Flow Rate = 227.00 cfm x 0.97 = 220.2 cfm

1/2" Drain Flow Rate = 403.5 cfm x 0.97 = 391.4 cfm

The 1/2" Drain air leakage rate was determined by extrapolation of the values provided in the Compressed Air Challenge table. The values up to 3/8” were plotted and a trend line derived.

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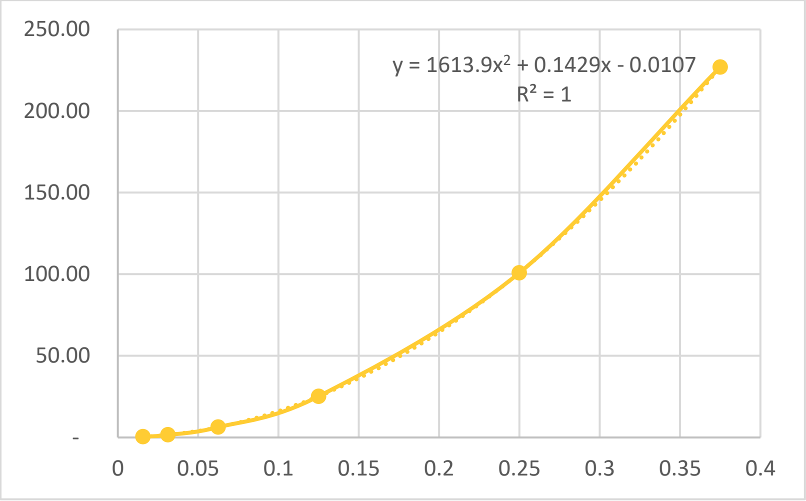
[2] Energy Tips – Compressed Air
https://www.energy.gov/sites/prod/files/2014/05/f16/compressed_air3.pdf



The equation of y = 1613.9x2 + 0.1492x – 0.0107 was used to determine the air leakage rate for ½” drains, where x equals the size of the drain.

To convert air savings to equivalent demand savings, a Compressor Index value (kW/100 cfm) was calculated as follows:

Average Compressor Size = assume 62 hp

Maximum Compressor Power = 62 hp x 0.746 kW/hp = 46.25 kW

Compressor Output Factor (cfm per hp) = assume 4.54[3]

Compressor Maximum Output = 62 hp x 4.5 cfm/hp = 279 cfm

Adjustment Factor = assume 1.105[4]

Compressor Index = [(46.25 kW) / (279 cfm)] x 1.10 x 100 = 18.23 kW/100 cfm

This Compressor Index or specific power value is consistent across all sizes of compressors as the ratio of compressor hp to cfm is constant.

Using this calculated Compressor Index, the Drain Flow Rates above can be converted to Equivalent kW Demand:

1/8” Drain Equivalent Demand = 24.5 cfm x 18.23 kW/100 cfm = 4.47 kW

1/4" Drain Equivalent Demand = 97.9 cfm x 18.23 kW/100 cfm = 17.85 kW

3/8” Drain Equivalent Demand = 220.2 cfm x 18.23 kW/100 cfm = 40.14 kW

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[3] CED Engineering Compressed Air Efficiency, Compressed Air Best Practices: The Relationship Between Pressure and Flow in a Compressed Air System https://www.cedengineering.ca/userfiles/M06-013%20-%20Compressed%20Air%20Energy%20Efficiency.pdf

[4] Adjustment for part load efficiency, pressure loss across filters, dryers and nominal power to operate dryer.

1/2″ Drain Equivalent Demand = 391.4 cfm x 18.23 kW/100 cfm = 71.35 kW

For all drains, it is assumed that there are typically 6 timed drain actuations per hour. Based on input from the Compressed Air Working Group and ESource inputs, it is assumed that the compressed air is blown down for 4 seconds per drain cycle. Using these assumptions, the fraction of operating time for the zero loss drains can be calculated as follows:

Fraction of Drain Operation Per Hour = (4 s/cycle x 6 cycles/hr) / 3,600 s/hr = 0.00667

Therefore, the demand savings for the drains are calculated as:

1/8″ Drain, Demand Savings = 4.47 kW x 0.00667 = 0.0298 kW

1/4″ Drain, Demand Savings = 17.85 kW x 0.00667 = 0.119 kW

3/8″ Drain, Demand Savings = 40.14 kW x 0.00667 = 0.268 kW

1/2″ Drain, Demand Savings = 71.35 kW x 0.00667 = 0.476 kW

Each drain size was then assigned a weighting based on forecasted uptake, and the weightings were used to create a blended zero air loss drain measure, assuming the following weighted average.

1/8″ Drain, Forecasted Weighting = 0.167

1/4″ Drain, Forecasted Weighting = 0.167

3/8″ Drain, Forecasted Weighting = 0.167

1/2″ Drain, Forecasted Weighting = 0.500

Calculating for a blended zero air loss drain connected demand savings:

1/8″ Drain, Weighted kW Savings = 0.167 x 0.0298 kW = 0.005 kW

1/4″ Drain, Weighted kW Savings = 0.167 x 0.119 kW = 0.020 kW

3/8″ Drain, Weighted kW Savings = 0.167 x 0.268 kW = 0.045 kW

1/2″ Drain, Weighted kW Savings = 0.500 x 0.476 kW = 0.238 kW

Blended Zero Loss Drain kW Savings = 0.308 kW

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

ΔkWpeak = 1,206 kWh/yr x 0.01082% = 0.131 kW

End Use Load Profile

PSP-Industrial-Miscellaneous_Industrial-Compressed_Air

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.01082%	0.01066%	0.01230%	0.01131%

Effective Useful Life (EUL)

Measure	**EUL (years)**
Zero Air Loss Drains	10[5]

Revision History

Revision #	**Description/Comment**	**Date Revised**
0	Zero Loss Air Drains	Sep. 2018
1	Full measure review	Aug. 2020
2	Updated references and formatting	Nov. 2023
3	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[5] Jurisdictional scan of similar measures in Illinois, Massachusetts, Minnesota, Missouri, New York, Pennsylvania and Vermont revealed a range of EULs from 5 to 15 years.

Demand Control Kitchen Ventilation

Measure Description

Energy Efficient Equipment Description

Automated, variable/demand flow, commercial kitchen ventilation, less than 15,000 cfm capacity.

Base Equipment Description

Constant volume commercial kitchen ventilation, less than 15,000 cfm exhaust.

Code, Standards and Regulations

No codes, standards and regulations exist for this measure.

Resource Savings Assumptions

Measure Assumptions[1]

System Capacity – the rated capacity of the kitchen exhaust hood (CFM); the midpoint of each exhaust capacity category was used to determine the baseline input fan power

FP_{base} – the average total, (exhaust hood and make up air) fan power for the baseline condition in kW calculated as follows:

$$FP_{base} = (0.73010 \times \text{System Capacity}) - 0.78175$$

FP_{eff} – the average total, (exhaust hood and make up air) fan power for the efficient case in kW

$$FP_{eff} = FP_{base} \times (1\text{-}\%\text{ Flow Reduction})^{3}$$

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[1] Natural Gas Demand Side Management Technical Resource Manual Version 6.0, December 16, 2021. https://www.oeb.ca/sites/default/files/OEB-Natural-Gas-DSM-Technical-Resource-Manual-V6.0-20211216.pdf

% Flow Reduction - the average % reduction in the exhaust flow rate resulting from the DCV installation (% of baseline flow); assume 25.1%

Annual Hours - the annual operating hours of the system assumed to be 16 hrs/day, 5840 hrs/yr

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = $(FP_{base} – FP_{eff})$ x Annual Hours

Table 1 – Annual Energy Savings (kWh/yr)

Exhaust Fan Capacity (CFM)	Assumed Capacity (CFM)	FP_{base}	FP_{eff}	Annual Energy Savings (kWh/yr)
Up to 5,000 CFM	3,000	1.41	0.59	4,774.39
5,0001-10,000 CFM	7,500	4.69	1.97	15,880.77
10,001-15000 CFM	12,500	8.34	3.50	28,240.01

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There are no connected demand savings for this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 2 – Summer Peak Demand Savings (kW)

Exhaust Fan Capacity (CFM)	Assumed Capacity (CFM)	Summer Peak Demand Savings (kW)
Up to 5,000 CFM	3,000	0.595
5,0001-10,000 CFM	7,500	1.980
10,001-15000 CFM	12,500	3.520

End Use Load Profile

PSP-Business-Commercial-Cooking

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01247%	0.01019%	0.01916%	0.01284%

Effective Useful Life (EUL)

Measure	EUL (years)
Demand Control Kitchen Ventilation	15[2]

Revision History

Revision #	Description/Comment	Date Revised
0	Substantiation sheet created	Sep. 2019
1	Updated references and formatting	Nov. 2023
2	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[2] Natural Gas Demand Side Management Technical Resource Manual Version 6.0, December 16, 2021. https://www.oeb.ca/sites/default/files/OEB-Natural-Gas-DSM-Technical-Resource-Manual-V6.0-20211216.pdf

Demand Control Ventilation

Enclosed Parking Garages

Measure Description

Energy Efficient Equipment Description

Ventilation systems that detect contamination levels (via CO sensors) and adjust airflow to maintain acceptable levels of air contamination. Modulating airflow saves fan energy, but can also save heating energy, if the garage is heated.

Base Equipment Description

Garages that operate ventilation fans continuously to ensure contaminant levels are maintained at acceptable levels.

Code, Standards and Regulations

Ontario Building Code 2012 Section 6.2.2.3 (1) – Ventilation of Storage and Repair Garages[1] states that:

Except as provided in Sentences (4) and (6), an enclosed storage garage shall have a mechanical ventilation system designed to,

(a) limit the concentration of carbon monoxide to not more than 100 parts per million of air when measured between 900 mm and 1,800 mm from the floor, where the majority of the vehicles stored are powered by gasoline fuelled engines,

(b) limit the concentration of nitrogen dioxide to not more than 3 parts per million parts of air when installed in accordance with manufacturer's instructions, where the majority of the vehicles stored are powered by diesel fuelled engines, or

(c) provide, during operating hours, a continuous supply of outdoor air at a rate of not less than 3.9 L/s for each square metre of floor area.

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[1] O. Reg. 332/12: Building Code https://www.ontario.ca/laws/regulation/120332

Resource Savings Assumptions

Measure Assumptions[2]

HP – motor horsepower

LF – motor load factor, assume 0.70

UF – motor usage factor, assume 1.00

t – annual operating hours, typically 8760

SF – annual reduction in operating hours, assume 33%

C_1 = 0.746 kW/HP

η_{motor} – motor efficiency, assume 91%

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = (HP x LF x UF x C_1 x t x SF) / η_{motor}

Table 1 – Annual Energy Savings (kWh/yr)

Motor Horsepower	Assumed Horsepower	Annual Energy Savings (kWh/yr)
≥2 to ≤ 5 HP	5	8,294.37
>5 to ≤ 10 HP	10	16,588.74
>10 to ≤ 25 HP	25	41,471.86
>25 to ≤ 50 HP	50	82,943.72
>50 to ≤ 75 HP	75	124,415.58
>75 to ≤ 100 HP	100	165,887.45

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

No connected demand savings – installed motor horsepower remains constant.

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[2] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Version 4.1, Jan. 31, 2024, C/I HVAC – Parking Garage Exhaust Fan CO Control and Heating https://mn.gov/commerce-stat/trm/releases/4.1.pdf

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$$

Table 2 – Summer Peak Demand Savings (kW)

Motor Horsepower	Summer Peak Demand Savings (kW)
≥2 to ≤ 5 HP	0.947
>5 to ≤ 10 HP	1.894
>10 to ≤ 25 HP	4.734
>25 to ≤ 50 HP	9.468
>50 to ≤ 75 HP	14.203
>75 to ≤ 100 HP	18.937

End Use Load Profile

PSP-Consumer-Residential-Ventilation_And_Circulation

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01142%	0.01142%	0.01142%	0.01142%

Effective Useful Life (EUL)

Wisconsin TRM[3] assumes 5 years. Minnesota TRM[4] assumes 15 years. Illinois TRM[5] assumes 10 years. Assumed 10 years for Ontario as mid-range estimate.

Measure	EUL (years)
Demand Control Kitchen Ventilation – Parking Garages	10

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[3] Wisconsin Focus on Energy 2020 Technical Reference Manual https://s3.us-east-1.amazonaws.com/focusonenergy/staging/Focus_on_Energy_2020_TRM.pdf

[4] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Version 4.1, Jan. 31, 2024 https://mn.gov/commerce-stat/trm/releases/4.1.pdf

[5] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Revision History

Revision #	Description/Comment	Date Revised
0	New Measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Updated references and formatting	Nov. 2023
2	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

Demand Control Ventilation

Interior Conditioned Spaces

Measure Description

Energy Efficient Equipment Description

Add CO_2 sensors to existing HVAC systems to detect contaminants associated with high occupancy (via CO_2 sensors) and adjust airflow to maintain acceptable levels of indoor air quality. Modulating airflow saves fan energy, but can also save heating and cooling energy from reduced outdoor air conditioning loads.

Note that the "Advanced Rooftop Controls" measure also includes the addition of DCV to an existing HVAC system, but is restricted to cases where VFDs are also retrofitted onto existing single-speed supply fans.

Base Equipment Description

Ventilation systems that operate on a static outdoor air schedule, based on standard ASHRAE 62.1 ventilation rates

Code, Standards and Regulations

ASHRAE 62.1-2010 – Ventilation for Acceptable Indoor Air Quality (referenced in Table 1.3.1.2 of the Ontario Building Code).[1]

Ontario Building Code Section 6.2.2.1 (2) – "Except in storage garages and repair garages covered by Article 6.2.2.3., the rates at which outdoor air is supplied in buildings by ventilation systems shall be not less than the rates required by ANSI/ASHRAE 62.1, "Ventilation for Acceptable Indoor Air Quality."[2]

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[1] ASHRAE 62.1-2010 – Ventilation for Acceptable Indoor Air Quality

[2] Ontario O.Reg. 509-18: Energy and Water Efficiency - Appliances and Products Ontario Building Code 2012 – O.Reg. 332/12 (current as of May 11, 2020).

Resource Savings Assumptions

Measure Assumptions

Table 1 – Energy Savings Factor (kWh/1000 ft^2)[3]

Building Type	**$ESF_{cooling}$ [kWh/1,000 sq-ft]**	**$ESF_{heating}$ [kWh/1,000 sq-ft]**
Office - Low-rise (1 to 3 Stories)	248	850
Office - Mid-rise (4 to 11 Stories)	235	556
Office - High-rise (12+ Stories)	245	733
Religious Building	277	5,478
Restaurant	280	3,956
Retail - Department Store	340	1,378
Retail - Strip Mall	205	878
Convenience Store	328	675
Elementary School	178	2,372
High School	172	2,314
College/ University	223	4,569
Healthcare Clinic	195	1,611
Lodging (Hotel/Motel)	315	733
Manufacturing	262	617
Special Assembly/Auditorium	232	6,417
Other	249	2,197

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = (SF/1000) x $ESF_{cooling}$

where: SF – Total square footage for the conditioned space impacted by the measure

ESF – Energy savings factor for cooling (kWh/1000 ft^2)

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[3] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Version 6.1 (Effective January 31, 2019) using Buffalo state https://dps.ny.gov/system/files/documents/2022/11/technical-resource-manual-version-6.1-filed-january-31-2019-effective-january-31-2019.pdf

Table 2 – Annual Energy Savings (kWh/yr)

Building Type	**>50,000 to ≤100,000 ft²**	**>100,000 to ≤250,000 ft²**	**>250,000 to ≤500,000 ft²**	**>500,000 to ≤750,000 ft²**	**>750,000 to ≤1M ft²**
Office - Low-rise (1 to 3 Stories)	18,600	43,400	93,000	155,000	217,000
Office - Mid-rise (4 to 11 Stories)	17,625	41,125	88,125	146,875	205,625
Office - High-rise (12+ Stories)	18,375	42,875	91,875	153,125	214,375
Religious Building	20,775	48,475	103,875	173,125	242,375
Restaurant	21,000	49,000	105,000	175,000	245,000
Retail - Department Store	25,500	59,500	127,500	212,500	297,500
Retail - Strip Mall	15,375	35,875	76,875	128,125	179,375
Convenience Store	24,600	57,400	123,000	205,000	287,000
Elementary School	13,350	31,150	66,750	111,250	155,750
High School	12,900	30,100	64,500	107,500	150,500
College/ University	16,725	39,025	83,625	139,375	195,125
Healthcare Clinic	14,625	34,125	73,125	121,875	170,625
Lodging (Hotel/Motel)	23,625	55,125	118,125	196,875	275,625
Manufacturing	19,650	45,850	98,250	163,750	229,250
Special Assembly/Auditorium	17,400	40,600	87,000	145,000	203,000
Other	18,675	43,575	93,375	155,625	217,875
Average	18,675	43,575	93,375	155,625	217,875

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

No connected demand savings for this measure

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 3 – Summer Peak Demand Savings (kW)

Exhaust Fan Capacity (ft^2)	**Annual Energy Savings (kWh/yr)**	**Summer Peak Demand Savings (kW)**
>50,000 to ≤100,000	18,675	0.009
>100,000 to ≤250,000	43,575	0.021
>250,000 to ≤500,000	93,375	0.045
>500,000 to ≤750,000	155,625	0.076
>750,000 to ≤1M	217,875	0.106

End Use Load Profile

PSP-Business-Other_Commercial_Buildings-CE_Space_Heating

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.00005%	0.01363%	0.00025%	0.02587%

Effective Useful Life (EUL)

Measure	**EUL (years)**
Demand Control Ventilation	10[4]

Revision History

Revision #	**Description/Comment**	**Date Revised**
0	New Measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Updated references and formatting; changed end-use load profile to align with summer peak demand savings = 0	Nov. 2023

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[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

2	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

Beverage Vending Machine Controls Occupancy Sensors

Measure Description

Energy Efficient Equipment Description

Beverage vending machine occupancy sensor controls

Base Equipment Description

Standard beverage vending machine without controls

Code, Standards and Regulations

Measure covers the installation of occupancy controls to existing beverage vending machines. Natural Resources Canada provides standards for new refrigerated vending machines, but these are not applicable to a retrofit controls measure.

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Watts_{base} = 400W

Note: This measure does not apply to ENERGY STAR® beverage vending machines

Energy Efficient Measure Assumptions

Average consumption for standard beverage vending machines with controls.

Energy Savings Factor (ESF) = 46%[1]

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[1] 2021 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 9.0, Sep. 25, 2020 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Assumed Hours of Operation

Annual hours of operation = 8766 hours

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(\text{kWh/yr})_{base}$ x ESF

Annual Energy Savings (kWh/yr) = (400W x 8766hrs) x 1000W/kW x 0.46

Annual Energy Savings (kWh/yr) = 1,612.9 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There is no connected demand savings for this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

ΔkWpeak =1,612.9 kWh x 0.01220% = 0.197 kW

End Use Load Profile

PSP-Business-Commercial-Other_Plug_Loads

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01220%	0.01220%	0.01255%	0.01243%

Effective Useful Life (EUL)

Measure	EUL (years)
Beverage Vending Machine Occupancy Sensor Controls	5[2]

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	May 2016
1	Updated savings assumptions	Mar. 2017
2	Full measure review and update	Oct. 2020
3	Updated formatting	Nov. 2023
4	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[2] 2021 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 9.0
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Circulator Pumps with ECM

Measure Description

Energy Efficient Equipment Description

Domestic hot water and space heating/cooling circulator pumps with electronically commutated motor (ECM)

Base Equipment Description

Domestic hot water and space heating/cooling circulator pumps with permanent split capacitor (PSC) motor

Code, Standards and Regulations

No code, standard and regulation exists for this measure

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 1 – Base Measure Wattages (kW)[1]

Pump Capacity	Base Wattages (kW)
<100 W (<0.134HP)	0.28
≥100<500 W (≥0.134<0.67HP)	1.39
≥500<750 W (≥0.67<1HP)	3.89
≥750<1490 W (≥1<2HP)	4.88
≥1490<2237 W (≥2<3HP)	9.75
2237 W (3HP)	14.63

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[1] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Jan. 31, 2023, ECM Circulators, https://mn.gov/commerce-stat/trm/releases/4.0.pdf

Energy Efficient Measure Demand Assumptions

Table 2 – Efficient Measure Wattages (kW)[2,3]

ECM Circulators	Wattages (kW)
<100 W (<0.134HP)	0.05
≥100<500 W (≥0.134<0.67HP)	0.25
≥500<750 W (≥0.67<1HP)	0.70
≥750<1490 W (≥1<2HP)	0.88
≥1490<2237 W (≥2<3HP)	1.76
2237 W (3HP)	2.63

Assumed Hours of Operation

Table 3 - Lighting hours based on Facility Types[2]

Facility Type	Annual Operating Hours
DHW Circulator[4]	2190
Heating Hot Water Circulator	2582
Chilled Water Circulator	1191

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{conservation}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{conservation}$

Table 4 – Annual Energy Savings (kWh/yr)

ECM Circulators	DHW Circulator	Heating Hot Water Circulator	Chilled Water Circulator
<100 W (<0.134HP)	504	594	274
≥100<500 W (≥0.134<0.67HP)	2,497	2,943	1,358
≥500<750 W (≥0.67<1HP)	6,986	8,237	3,799
≥750<1490 W (≥1<2HP)	8,760	10,328	4,764

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[2] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Jan. 31, 2023, ECM Circulators, https://mn.gov/commerce-stat/trm/releases/4.0.pdf

[3] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, February 2021. https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

[4] Commercial and residential domestic hot water.

≥1490<2237 W (≥2<3HP)	17,498	20,630	9,516
2237 W (3HP)	26,280	30,984	14,292

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 5 – Connected Demand Savings (kW)

ECM Circulators	Connected Demand Savings (kW)
<100 W (<0.134HP)	0.23
≥100<500 W (≥0.134<0.67HP)	1.14
≥500<750 W (≥0.67<1HP)	3.19
≥750<1490 W (≥1<2HP)	4.00
≥1490<2237 W (≥2<3HP)	7.99
2237 W (3HP)	12.00

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 6 – Summer Peak Demand Savings (kW)

ECM Circulators	DHW Circulator	Heating Hot Water Circulator	Chilled Water Circulator
<100 W (<0.134HP)	0.062	0.032	0.140
≥100<500 W (≥0.134<0.67HP)	0.305	0.160	0.694
≥500<750 W (≥0.67<1HP)	0.855	0.449	1.943
≥750<1490 W (≥1<2HP)	1.071	0.563	2.436
≥1490<2237 W (≥2<3HP)	2.140	1.125	4.866
2237 W (3HP)	3.214	1.689	7.308

End Use Load Profile

PSP-Business-Commercial-Domestic_Hot_Water

PSP-Consumer-Residential-Domestic_Hot_Water

PSP-Business-Commercial-Cooling_Chillers

PSP-Business-Commercial-Forced_Air_Central_Heating

EM&V Peak Definition

Table 7 – EM&V Peak Values

End Use Load Profile	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
PSP-Business-Commercial-Domestic_Hot_Water	0.01223%	0.01535%	0.01452%	0.01728%
PSP-Consumer-Residential-Domestic_Hot_Water	0.01033%	0.01592%	0.01099%	0.01603%
PSP-Business-Commercial-Cooling_Chillers	0.05114%	0.00000%	0.09330%	0.00000%
PSP-Business-Commercial-Forced_Air_Central_Heating	0.00545%	0.02037%	0.01233%	0.03490%

Effective Useful Life (EUL)

Measure	EUL (years)
Circulator Pump with ECM	15[5]

Revision History

Revision #	Description/Comment	Date Revised
0	Substantiation sheet created	Oct. 2021
1	Updated references and formatting	Nov. 2023
2	Updated EM&V peak definition & Peak Demand Savings	Jan. 2025

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[5] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Jan. 31, 2023 https://mn.gov/commerce-stat/trm/releases/4.0.pdf

Premium Efficiency Motors

Totally Enclosed Fan-Cooled (TEFC) & Open Drip Proof (ODP)

Measure Description

Energy Efficient Equipment Description

Premium efficiency motors (1-300 hp)

Base Equipment Description

Premium standard electric motors for constant speed and uniformly loaded motors

Code, Standards and Regulations

All motors are required to meet the regulatory requirements if their manufacturing process is completed on or after June 1, 2016. Products that meet the regulatory definition of a motor must meet or exceed the efficiencies outlined in Table 12-12 of NEMA MG-1-2014. Also aligned with O.Reg.509/18 Schedule 6 Motors, Pumps, and Transformers and with efficiency levels provided US DOE 10 Code of Federal Regulation Part 431, Subpart B, 431.25, Table 1 (Subtype 1)[1]

Resource Savings Assumptions

Measure Assumptions

Base Measure Demand Assumptions

Minimum nominal efficiency standard at 100% of nominal full load (Premium - most stringent level)[2]

Motor is assumed to be partially loaded and running at a base load factor (LF_{base})

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[1] O. Reg. 509/18: Energy and Water Efficiency – Appliances and Products https://www.ontario.ca/laws/regulation/180509#BK19

[2] Efficiency NEMA 12-12 https://config.baldor.com/Help/MAC/Efficiency_Help.pdf (accessed Dec. 2023)

Energy Efficient Measure Demand Assumptions

Motor efficiency is assumed to be 1% better than the base measure motor efficiency

Base efficiency motor is replaced by premium efficiency motor of same nameplate power rating (hp)

Assumed Hours of Operation

Equivalent Full Load Hours (EFLH) = 4,000 hrs/yr for both base and efficient measures

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base}$ = [PR x LF x EFLH x 0.746 kW/hp] / η_{base}

Annual Energy Consumption $(kWh/yr)_{efficient}$ = [PR x LF x EFLH x 0.746 kW/hp] / $\eta_{efficient}$

where: PR – motor nameplate power rating (hp)

LF – load factor; assume 76% for fans and 79% for pumps

EFLH – equivalent full load hours

η – motor efficiency, %

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{efficient}$

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Table 1 – Annual Energy Savings for Premium Efficiency ODP Motors (kWh/yr)[3]

Motor Power Rating (hp)	**2-Pole (3600 rpm) η_{base}**	**2-Pole (3600 rpm) η_{eff}**	**2-Pole (3600 rpm) Energy Savings (kWh/ yr)**	**4-Pole (1800 rpm) η_{base}**	**4-Pole (1800 rpm) η_{eff}**	**4-Pole (1800 rpm) Energy Savings (kWh/ yr)**	**6-Pole (1200 rpm) η_{base}**	**6-Pole (1200 rpm) η_{eff}**	**6-Pole (1200 rpm) Energy Savings (kWh/ yr)**
1	77.0%	78.0%	38	85.5%	86.5%	31	82.5%	83.5%	33
1.5	84.0%	85.0%	48	86.5%	87.5%	45	86.5%	87.5%	45
2	85.5%	86.5%	61	86.5%	87.5%	60	87.5%	88.5%	59

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[3] Not exactly equal with values in CDMIS/MAL; see Appendix for CDMIS/MAL values

3	85.5%	86.5%	92	89.5%	90.5%	84	88.5%	89.5%	86
5	86.5%	87.5%	150	89.5%	90.5%	140	89.5%	90.5%	140
7.5	88.5%	89.5%	215	91.0%	92.0%	203	90.2%	91.2%	207
10	89.5%	90.5%	280	91.7%	92.7%	267	91.7%	92.7%	267
15	90.2%	91.2%	414	93.0%	94.0%	389	91.7%	92.7%	400
20	91.0%	92.0%	542	93.0%	94.0%	519	92.4%	93.4%	526
25	91.7%	92.7%	667	93.6%	94.6%	640	93.0%	94.0%	649
30	91.7%	92.7%	800	94.1%	95.1%	760	93.6%	94.6%	768
40	92.4%	93.4%	1,051	94.1%	95.1%	1,014	94.1%	95.1%	1,014
50	93.0%	94.0%	1,297	94.5%	95.5%	1,256	94.1%	95.1%	1,267
60	93.6%	94.6%	1,537	95.0%	96.0%	1,492	94.5%	95.5%	1,508
75	93.6%	94.6%	1,921	95.0%	96.0%	1,865	94.5%	95.5%	1,885
100	93.6%	94.6%	2,561	95.4%	96.4%	2,466	95.0%	96.0%	2,487
125	94.1%	95.1%	3,168	95.4%	96.4%	3,082	95.0%	96.0%	3,108
150	94.1%	95.1%	3,801	95.8%	96.8%	3,668	95.4%	96.4%	3,699
200	95.0%	96.0%	4,973	95.8%	96.8%	4,891	95.4%	96.4%	4,932
250	95.0%	96.0%	6,218	95.8%	96.8%	6,114	95.4%	96.4%	6,165
300	95.4%	96.4%	7,398	95.8%	96.8%	7,337	95.4%	96.4%	7,398

Table 2 - Annual Energy Savings for Premium Efficiency TEFC Motors (kWh/yr)[4]

Motor Power Rating (hp)	**2-Pole (3600 rpm)** **η_{base}**	**2-Pole (3600 rpm)** **η_{eff}**	**2-Pole (3600 rpm) Energy Savings (kWh/ yr)**	**4-Pole (1800 rpm)** **η_{base}**	**4-Pole (1800 rpm)** **η_{eff}**	**4-Pole (1800 rpm) Energy Savings (kWh/ yr)**	**4-Pole (1800 rpm)** **η_{base}**	**4-Pole (1800 rpm)** **η_{eff}**	**4-Pole (1800 rpm) Energy Savings (kWh/ yr)**
1	77.0%	78.0%	38	85.5%	86.5%	31	82.5%	83.5%	33
1.5	84.0%	85.0%	48	86.5%	87.5%	45	87.5%	88.5%	44

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[4] Not exactly equal with values in CDMIS/MAL; see Appendix for CDMIS/MAL values

2	85.5%	86.5%	61	86.5%	87.5%	60	88.5%	89.5%	57
3	86.5%	87.5%	90	89.5%	90.5%	84	89.5%	90.5%	84
5	88.5%	89.5%	143	89.5%	90.5%	140	89.5%	90.5%	140
7.5	89.5%	90.5%	210	91.7%	92.7%	200	91.0%	92.0%	203
10	90.2%	91.2%	276	91.7%	92.7%	267	91.0%	92.0%	271
15	91.0%	92.0%	406	92.4%	93.4%	394	91.7%	92.7%	400
20	91.0%	92.0%	542	93.0%	94.0%	519	91.7%	92.7%	534
25	91.7%	92.7%	667	93.6%	94.6%	640	93.0%	94.0%	649
30	91.7%	92.7%	800	93.6%	94.6%	768	93.0%	94.0%	778
40	92.4%	93.4%	1,051	94.1%	95.1%	1,014	94.1%	95.1%	1,014
50	93.0%	94.0%	1,297	94.5%	95.5%	1,256	94.1%	95.1%	1,267
60	93.6%	94.6%	1,537	95.0%	96.0%	1,492	94.5%	95.5%	1,508
75	93.6%	94.6%	1,921	95.4%	96.4%	1,849	94.5%	95.5%	1,885
100	94.1%	95.1%	2,534	95.4%	96.4%	2,466	95.0%	96.0%	2,487
125	95.0%	96.0%	3,108	95.4%	96.4%	3,082	95.0%	96.0%	3,108
150	95.0%	96.0%	3,730	95.8%	96.8%	3,668	95.8%	96.8%	3,668
200	95.4%	96.4%	4,932	96.2%	97.2%	4,851	95.8%	96.8%	4,891
250	95.8%	96.8%	6,114	96.2%	97.2%	6,063	95.8%	96.8%	6,114
300	95.8%	96.8%	7,337	96.2%	97.2%	7,276	95.8%	96.8%	7,337

Connected Demand Savings

Demand Savings (kW) = PR x LF x 0.746 kW/hp x (1/п_{base} – 1/$\text{п}_{\text{efficient}}$)

where: PR – motor nameplate power rating (hp)

LF – load factor; assume 76% for fans and 79% for pumps

EFLH – equivalent full load hours

п – motor efficiency, %

Table 3 – Connected Demand Savings for Premium Efficiency ODP and TEFC Motors (kW)[5]

Motor Power Rating (hp)	ODP 2-Pole (3600 rpm)	ODP 4-Pole (1800 rpm)	ODP 6-Pole (1200 rpm)	TEFC 2-Pole (3600 rpm)	TEFC 4-Pole (1800 rpm)	TEFC 6-Pole (1200 rpm)
1	0.0094	0.0077	0.0082	0.0094	0.0077	0.0082
1.5	0.0119	0.0112	0.0112	0.0119	0.0112	0.0110
2	0.0153	0.0150	0.0146	0.0153	0.0150	0.0143
3	0.0230	0.0210	0.0215	0.0225	0.0210	0.0210
5	0.0375	0.0350	0.0350	0.0358	0.0350	0.0350
7.5	0.0537	0.0508	0.0517	0.0525	0.0500	0.0508
10	0.0700	0.0667	0.0667	0.0689	0.0667	0.0677
15	0.1034	0.0973	0.1000	0.1016	0.0985	0.1000
20	0.1354	0.1297	0.1314	0.1354	0.1297	0.1334
25	0.1667	0.1601	0.1621	0.1667	0.1601	0.1621
30	0.2001	0.1901	0.1921	0.2001	0.1921	0.1946
40	0.2628	0.2534	0.2534	0.2628	0.2534	0.2534
50	0.3243	0.3141	0.3168	0.3243	0.3141	0.3168
60	0.3842	0.3730	0.3769	0.3842	0.3730	0.3769
75	0.4802	0.4663	0.4712	0.4802	0.4624	0.4712
100	0.6403	0.6165	0.6217	0.6336	0.6165	0.6217
125	0.7919	0.7706	0.7771	0.7771	0.7706	0.7771
150	0.9503	0.9171	0.9247	0.9325	0.9171	0.9171
200	1.2433	1.2228	1.2330	1.2330	1.2127	1.2228
250	1.5542	1.5285	1.5412	1.5285	1.5158	1.5285
300	1.8495	1.8341	1.8495	1.8341	1.8190	1.8341

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[5] Not exactly equal with values in CDMIS/MAL; see Appendix for CDMIS/MAL values

Summer Peak Demand Savings

Summer Peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 4 –Peak Demand Savings for Premium Efficiency ODP and TEFC Motors (kW)[6]

Motor Power Rating (hp)	ODP 2-Pole (3600 rpm)	ODP 4-Pole (1800 rpm)	ODP 6-Pole (1200 rpm)	TEFC 2-Pole (3600 rpm)	TEFC 4-Pole (1800 rpm)	TEFC 6-Pole (1200 rpm)
1	0.0041	0.0034	0.0036	0.0051	0.0042	0.0045
1.5	0.0052	0.0049	0.0049	0.0064	0.0061	0.0061
2	0.0067	0.0066	0.0064	0.0083	0.0081	0.0079
3	0.0101	0.0092	0.0094	0.0125	0.0114	0.0116
5	0.0164	0.0153	0.0153	0.0203	0.0189	0.0189
7.5	0.0235	0.0223	0.0227	0.0291	0.0275	0.0280
10	0.0307	0.0292	0.0292	0.0379	0.0361	0.0361
15	0.0453	0.0426	0.0438	0.0560	0.0527	0.0542
20	0.0594	0.0568	0.0576	0.0733	0.0702	0.0711
25	0.0731	0.0701	0.0710	0.0903	0.0867	0.0878
30	0.0877	0.0833	0.0842	0.1083	0.1029	0.1040
40	0.1152	0.1111	0.1111	0.1423	0.1372	0.1372
50	0.1421	0.1376	0.1388	0.1756	0.1701	0.1715
60	0.1684	0.1635	0.1652	0.2080	0.2019	0.2041
75	0.2104	0.2043	0.2065	0.2600	0.2524	0.2551
100	0.2806	0.2702	0.2724	0.3467	0.3338	0.3366
125	0.3470	0.3377	0.3405	0.4288	0.4172	0.4207
150	0.4164	0.4019	0.4052	0.5145	0.4965	0.5007

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[6] Not exactly equal with values in CDMIS/MAL; see Appendix for CDMIS/MAL values

200	0.5448	0.5358	0.5403	0.6731	0.6620	0.6675
250	0.6903	0.6787	0.6844	0.6787	0.6731	0.6787
300	0.8213	0.8145	0.8213	0.8145	0.8077	0.8145

End Use Load Profile

EM&V-Commercial-HVAC_Fans_Pumps

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.01110%	0.01110%	0.01142%	0.01142%

Effective Useful Life (EUL)

Measure	**EUL (years)**
Premium Efficiency Motors	15[7] years

Revision History

Revision #	**Description/Comment**	**Date Revised**
0	Included in the OPA Measures and Assumptions List	Oct. 2008
1	Updated measure assumptions	Jan. 2010
2	Updated measure assumptions	July 2013

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[7] State of Pennsylvania Technical Reference Manual, Volume 3: Commercial & Industrial Measures. Sep. 2024 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

3	Updated savings assumptions and costs	Apr. 2017
4	Full review	Aug. 2020
5	Added 250 and 300 HP	Nov. 2020
6	Updated references and formatting; CDMIS/MAL values not updated (see Appendix)	Dec. 2023
7	Updated references, EM&V peak definition, Peak Demand Savings and table A.3 (Appendix)	Jan. 2025

Appendix – CDMIS/MAL Savings Values For Premium Efficiency Motors

Table A.1 - Annual Energy Savings (kWh/yr)

Motor Power Rating (hp)	**ODP 2-Pole (3600 rpm)**	**ODP 4-Pole (1800 rpm)**	**ODP 6-Pole (1200 rpm)**	**TEFC 2-Pole (3600 rpm)**	**TEFC 4-Pole (1800 rpm)**	**TEFC 6-Pole (1200 rpm)**
1	37.263	30.261	32.488	46.038	37.387	40.139
1.5	47.017	44.353	44.353	58.089	54.799	54.799
2	60.521	59.138	57.801	74.774	73.065	71.414
3	90.782	82.891	84.765	112.161	102.412	104.727
5	147.845	138.152	138.152	182.662	170.687	170.687
7.5	211.912	200.490	204.042	261.817	247.705	252.094
10	276.305	263.276	263.276	341.375	325.277	325.277
15	408.084	384.008	394.914	504.188	474.442	487.916
20	534.639	512.011	518.646	660.547	632.590	640.787
25	658.190	631.878	640.014	813.193	780.685	790.737
30	789.828	750.259	758.253	975.832	926.945	936.822
40	1,037.292	1,000.345	1,000.345	1,281.575	1,235.927	1,235.927
50	1,280.027	1,239.924	1,250.432	1,581.474	1,531.926	1,544.908
60	1,516.507	1,472.368	1,487.908	1,873.644	1,819.111	1,838.311
75	1,895.633	1,840.461	1,859.885	2,342.055	2,273.889	2,297.888
100	2,527.511	2,433.519	2,453.947	3,122.740	3,006.612	3,031.852
125	3,126.079	3,041.898	3,067.434	3,862.271	3,758.265	3,789.815
150	3,751.295	3,620.016	3,650.278	4,634.725	4,472.530	4,509.918
200	4,907.895	4,826.688	4,867.037	6,063.704	5,963.373	6,013.225
250	6,218.000	6,114.000	6,165.000	6,114.000	6,063.000	6,114.000
300	7,398.000	7,337.000	7,398.000	7,337.000	7,276.000	7,337.000

Table A.2 – Connected Demand Savings (kW)

Motor Power Rating (hp)	ODP 2-Pole (3600 rpm)	ODP 4-Pole (1800 rpm)	ODP 6-Pole (1200 rpm)	TEFC 2-Pole (3600 rpm)	TEFC 4-Pole (1800 rpm)	TEFC 6-Pole (1200 rpm)
1	0.0093	0.0076	0.0081	0.0093	0.0076	0.0081
1.5	0.0118	0.0111	0.0111	0.0118	0.0111	0.0111
2	0.0151	0.0148	0.0145	0.0151	0.0148	0.0145
3	0.0227	0.0207	0.0212	0.0227	0.0207	0.0212
5	0.0370	0.0345	0.0345	0.0370	0.0345	0.0345
7.5	0.0530	0.0501	0.0510	0.0530	0.0501	0.0510
10	0.0691	0.0658	0.0658	0.0691	0.0658	0.0658
15	0.1020	0.0960	0.0987	0.1020	0.0960	0.0987
20	0.1337	0.1280	0.1297	0.1337	0.1280	0.1297
25	0.1646	0.1580	0.1600	0.1646	0.1580	0.1600
30	0.1975	0.1876	0.1896	0.1975	0.1876	0.1896
40	0.2593	0.2501	0.2501	0.2593	0.2501	0.2501
50	0.3200	0.3100	0.3126	0.3200	0.3100	0.3126
60	0.3791	0.3681	0.3720	0.3791	0.3681	0.3720
75	0.4739	0.4601	0.4650	0.4739	0.4601	0.4650
100	0.6319	0.6084	0.6135	0.6319	0.6084	0.6135
125	0.7815	0.7605	0.7669	0.7815	0.7605	0.7669
150	0.9378	0.9050	0.9126	0.9378	0.9050	0.9126
200	1.2270	1.2067	1.2168	1.2270	1.2067	1.2168
250	1.5442	1.5285	1.5412	1.5285	1.5158	1.5285
300	1.8495	1.8341	1.8495	1.8341	1.8190	1.8341

Table A.3 – Summer Peak Demand Savings (kW)

Motor Power Rating (hp)	ODP 2-Pole (3600 rpm)	ODP 4-Pole (1800 rpm)	ODP 6-Pole (1200 rpm)	TEFC 2-Pole (3600 rpm)	TEFC 4-Pole (1800 rpm)	TEFC 6-Pole (1200 rpm)
1	0.0041	0.0034	0.0036	0.0051	0.0042	0.0045
1.5	0.0052	0.0049	0.0049	0.0064	0.0061	0.0061
2	0.0067	0.0066	0.0064	0.0083	0.0081	0.0079
3	0.0101	0.0092	0.0094	0.0125	0.0114	0.0116
5	0.0164	0.0153	0.0153	0.0203	0.0189	0.0189
7.5	0.0235	0.0223	0.0227	0.0291	0.0275	0.0280
10	0.0307	0.0292	0.0292	0.0379	0.0361	0.0361
15	0.0453	0.0426	0.0438	0.0560	0.0527	0.0542
20	0.0594	0.0568	0.0576	0.0733	0.0702	0.0711
25	0.0731	0.0701	0.0710	0.0903	0.0867	0.0878
30	0.0877	0.0833	0.0842	0.1083	0.1029	0.1040
40	0.1152	0.1111	0.1111	0.1423	0.1372	0.1372
50	0.1421	0.1376	0.1388	0.1756	0.1701	0.1715
60	0.1684	0.1635	0.1652	0.2080	0.2019	0.2041
75	0.2104	0.2043	0.2065	0.2600	0.2524	0.2551
100	0.2806	0.2702	0.2724	0.3467	0.3338	0.3366
125	0.3470	0.3377	0.3405	0.4288	0.4172	0.4207
150	0.4164	0.4019	0.4052	0.5145	0.4965	0.5007
200	0.5448	0.5358	0.5403	0.6731	0.6620	0.6675
250	0.6903	0.6787	0.6844	0.6787	0.6731	0.6787
300	0.8213	0.8145	0.8213	0.8145	0.8077	0.8145

Variable Frequency Drive

Measure Description

Energy Efficient Equipment Description

Variable frequency drive installed for 1-100 hp motors

Base Equipment Description

Electric motors with no variable frequency drive

Code, Standards and Regulations

There are currently no standards specified for variable frequency drives. However, Natural Resources Canada does specify that successful application and maintenance of VFD drives requires an understanding of their impact on the motor and electrical distribution system. The application of VFDs to induction motors can cause effects which must be considered for successful operation.

The Ontario Building Code requires adherence to the standards of ASHRAE 90.1-2016 which includes certain provisions requiring fans and pumps to be able to modulate flows. This can be accomplished through dampers, modulating valves or VFD (among other options).

Resource Savings Assumptions

Measure Assumptions[1]

Electric motor at 78% load factor (average of 76% for fan motor and 79% for pump motor)

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[1] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, Feb. 2021 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

Estimated run hours (RHRS) = 4,000 hours

Motor Efficiency (η) = assume NEMA premium efficiency for ODP 4 pole 1,800 rpm motor

Energy Savings Factor $= \sum_{n=0\%}^{n=100\%} Baseline\ Control\ Power\ Ratio\ (PLR) x\ \%Flow\ Ratio$

Table 1 – Default Load Profiles for HVAC Fans and Pumps

HVAC Flow Ratio	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
HVAC Fan	0%	0%	0%	0%	0%	10%	20%	30%	20%	15%	5%
HVAC Pump	0%	0%	0%	5%	10%	20%	30%	20%	10%	5%	0%

Table 2 – Supply/Return and Cooling Tower Fan Power Part Load Ratios

Fan Flow Ratio	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Constant Volume	1	1	1	1	1	1	1	1	1	1	1
Two-Speed	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	1
Air Foil/Backward Incline	0.56	0.53	0.53	0.57	0.64	0.72	0.8	0.89	0.96	1.02	1.05
Air Foil/Backward Incline with Inlet Guide Vanes	0.47	0.53	0.56	0.57	0.59	0.6	0.62	0.67	0.74	0.85	1
Forward Curved	0.2	0.22	0.26	0.3	0.37	0.45	0.54	0.65	0.77	0.91	1.06
Forward Curved with Inlet Guide Vanes	0.2	0.21	0.22	0.23	0.26	0.31	0.39	0.49	0.63	0.81	1.04
Variable Frequency Drive	0.05	0.05	0.05	0.08	0.13	0.2	0.3	0.43	0.6	0.8	1.03

Table 3 – HVAC Pump Power Part Load Ratios

Pump Flow Ratio	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Constant Volume	1	1	1	1	1	1	1	1	1	1	1
Throttle Valve	0.55	0.61	0.67	0.73	0.78	0.82	0.87	0.9	0.94	0.97	1
Variable Frequency Drive	0.27	0.19	0.14	0.13	0.15	0.21	0.3	0.43	0.6	0.79	1.03

Table 4 – Average Energy Savings Factor

Baseline Control	**Baseline Power Ratio**	**VFD Power Ratio**	**Savings Factor**
Fan - Constant Volume	100%	50%	70%
Fan - Two-Speed	95%	50%	50%
Fan - Air Foil/Backward Incline	90%	50%	48%
Fan - Air Foil/Backward Incline with Inlet Guide Vanes	71%	50%	40%

Fan - Air foil, back incline w. inlet guide vanes	69%	50%	33%
Fan - Forward Curved	56%	50%	24%
Fan - Forward Curved with Inlet Guide Vanes	50%	50%	23%
Fan – Variable Frequency Drive	95%	50%	0%
Pump – Constant Volume	100%	34%	66%
Pump – Throttle Valve	86%	34%	52%
Pump – Variable Frequency Drive	34%	34%	0%
Average Savings (ESF)			37%

Energy and Demand Savings

Energy Savings

$$\text{Annual Energy Savings (kWh/yr)} = 0.746 \text{ x HP x } (\text{LF}/\eta_{\text{motor}}) \text{ x RHRS x ESF}$$

Table 5 – Annual Energy Savings (kWh/yr)[2]

Motor/Pump Horsepower	Motor/Pump Power (kW)	Motor/Pump Efficiency	Energy Savings (kWh)
1	0.75	85.50%	1,007
1.5	1.12	86.50%	1,493
2	1.49	86.50%	1,991
3	2.24	89.50%	2,887
5	3.73	89.50%	4,811
7.5	5.60	91.00%	7,098
10	7.46	91.70%	9,391
15	11.19	93.00%	13,890
20	14.92	93.00%	18,520
25	18.65	93.60%	23,002
30	22.38	94.10%	27,455
40	29.84	94.10%	36,607
50	37.30	94.50%	45,565
60	44.76	95.00%	54,390
75	55.95	95.00%	67,988
100	74.60	95.40%	90,271
125	93.25	95.40%	112,840
150	111.90	95.80%	134,840
200	149.20	95.80%	179,790

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[2] Calculations may not be exact due to rounding errors

250[3]	186.50	95.58%	225,250
300[4]	223.80	95.58%	270,300

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = 0.746 x HP x (LF/η_{motor}) x RHRS

Table 6 – Annual Connected Demand Savings (kW)

Motor/Pump Horsepower	Motor/Pump Power (kW)	Connected Demand Savings (kW)	Peak Demand Savings (kW)
1	0.75	0.25	0.112
1.5	1.12	0.37	0.166
2	1.49	0.50	0.221
3	2.24	0.72	0.320
5	3.73	1.20	0.534
7.5	5.60	1.77	0.788
10	7.46	2.35	1.043
15	11.19	3.47	1.542
20	14.92	4.63	2.056
25	18.65	5.75	2.554
30	22.38	6.86	3.048
40	29.84	9.15	4.064
50	37.30	11.39	5.058
60	44.76	13.60	6.038
75	55.95	17.00	7.547
100	74.60	22.57	10.021
125	93.25	28.21	12.527
150	111.90	33.71	14.969
200	149.20	44.95	19.959
250	186.50	56.20	25.005
300	223.80	67.42	30.007

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below. See table 6 for Peak Demand Savings

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[3] Back calculated motor efficiency for 250 and 300 hp. The actual efficiency is 95.8%

[4] Back calculated motor efficiency for 250 and 300 hp. The actual efficiency is 95.8%

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

End Use Load Profile

EM&V-Commercial-HVAC_Fans_Pumps

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01110%	0.01110%	0.01142%	0.01142%

Effective Useful Life (EUL)

Measure	EUL (years)
Variable Frequency Drive	15[5]

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the OPA Measures and Assumptions List	July 2013
1	Updated measure assumptions	Apr. 2017
2	Reviewed by Nexant full measure review	Aug. 2020
3	Updated references and aligned with CDMIS/MAL	Dec. 2023
	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

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[5] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, Sep. 2024 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

Horticultural Inter-Lighting

Measure Description

Energy Efficient Equipment Description

This measure is an LED inter-lighting fixture installed within the canopy to illuminate a vertical growing surface. The fixture must be listed on the Design Light Consortium's (DLC) Horticultural Lighting Program and Qualified Products List[1]

Base Equipment Description

Fluorescent T8's installed within the canopy at the same distance away from the vertical growing surface as the EE measure

Code, Standards and Regulations

Fixtures must meet the DLC's Testing and Reporting Requirements for LED-based Horticultural Lighting (effective date: 31March 2023).[2]

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Based on three inter-lighting projects that are still in the pre-project phase, the following baseline demand assumptions are made:

All three projects are installing LED inter-lighting where none previously existed.

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[1] Design Lighting Consortium (DLC) Horticultural Lighting

[2] https://www.designlights.org/our-work/horticultural-lighting/ Design Lights Consortium, "Technical Requirements for LED-based Horticultural Lighting," 30 November 2022. https://www.designlights.org/wp-content/uploads/2023/03/DLC_HORT-Technical-Requirements-V3-0_03312023.pdf

Baseline measure was assumed to be fluorescent T8 inter-lighting since it can be installed within the canopy without overheating the plant. Philips TL-D 80 58 W that has a PPF of 70 umol/s per lamp.

Both EE and Baseline measures are installed 20cm away from the vertical growing surface at a height of 1.5m with a max plant height of 1.8m (within the canopy).

Design PPFD at vertical growing surface averaged 57 umol/s/m^2.

The baseline design required on average 10 lamps per one EE fixture to produce the same light level at the growing surface.

Assume Baseline Connected Power = 586.26 W

Energy Efficient Measure Assumptions

Assume Efficient Measure Connected Power = 95.86 kW[3]

Assumed Annual Hours of Operation of the

Horticultural inter-lighting led grow light fixture - Cucumbers = 2,784 hrs

Horticultural inter-lighting led grow light fixture - Tomatoes = 2,848 hrs

Horticultural inter-lighting led grow light fixture - Peppers = 3,339 hrs

Horticultural inter-lighting led grow light fixture - Others = 5,326.83 hrs

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = (Base Measure Wattage - Conservation Measure Wattage) x Operating Hours

Annual Energy Savings $(\text{kWh/yr})_{\text{cucumbers}}$ = (0.586 kW -0.0958 kW) x 2,784 hrs

= 1365.27 kWh

Annual Energy Savings $(\text{kWh/yr})_{\text{tomatoes}}$ = (0.586 kW -0.0958 kW) x 2,848 hrs

= 1396.66 kWh

Annual Energy Savings $(\text{kWh/yr})_{\text{peppers}}$ = (0.586 kW -0.0958 kW) x 3,339 hrs

= 1637.45 kWh

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[3] Average connected demand per efficient measure from the three projects.

$$\text{Annual Energy Savings (kWh/yr)}_{\text{others}} = (0.586\text{ kW} - 0.0958\text{ kW}) \times 5{,}327\text{ hrs}$$

$$= 2612.36\text{ kWh}$$

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Demand Savings (kW) = 0.586 – 0.0958 = 0.49 kW

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

$\Delta \text{kWpeak}_{\text{cucumbers}}$ = 1,365.27 x 0.00056% = 0.008 kW

$\Delta \text{kWpeak}_{\text{tomatoes}}$ = 1,396.66 x 0.00056% = 0.008 kW

$\Delta \text{kWpeak}_{\text{peppers}}$ = 1,637.45 x 0.00056% = 0.009 kW

$\Delta \text{kWpeak}_{\text{others}}$ = 2,612.36 x 0.00056% = 0.015 kW

End Use Load Profile

CUSTOM-Business-Other_Commercial_Buildings-CUSTOM-Industrial-Agriculture-Horticultural Lighting - Veg

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.00056%	0.00085%	0.00129%	0.00418%

Effective Useful Life (EUL)

Baseline Measure Life (hours) = 20,000 hours[4]

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[4] Sonepar BlueWay, IESO Presriptive Lighting Review - Survey Results and Pricing Summary, 2020.

Efficient Measure Life (hours) = 50,000 hours[5]

Effective Useful Life (years) = Measure Life (hrs) / EFLH (hrs/yr)

Equivalent Full Load Hours (EFLH)others = 5,327/yr

Baseline EULothers = 20,000/5,327 = 3.75 years

Efficient Measure EULothers = 50,000/5,327 = 9.39 years

Equivalent Full Load Hours (EFLH)cucumbers = 2,784/yr

Baseline EULcucumbers = 20,000/2,784 = 7.18 years

Efficient Measure EULcucumbers = 50,000/2,784 = 17.96 years

Equivalent Full Load Hours (EFLH)tomatoes = 2,848/yr

Baseline EULtomatoes = 20,000/2,848 = 7.02 years

Efficient Measure EULtomatoes = 50,000/2,848 = 17.56 years

Equivalent Full Load Hours (EFLH)peppers = 3,339/yr

Baseline EULpeppers = 20,000/3,339 = 5.99 years

Efficient Measure EULpeppers = 50,000/3,339 = 14.97 years

Revision History

Revision #	Description/Comment	Date Revised
0	Horticultural Inter-lighting LED Grow Lights	Oct. 2020
1	Updated formatting	Nov. 2023
2	Updated EM&V peak definition, Peak Demand Savings; added annual operating hours, Energy Savings and EUL values for cucumbers, tomatoes and peppers	Jan. 2025

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[5] IESO, IESO HPNC + Retrofit Business Case Horticulture 09Aug2018, 2018.

Horticultural LED Grow Lights

Cannabis Greenhouses

Measure Description

Energy Efficient Equipment Description

The measure is an LED fixture installed in a cannabis greenhouse. The fixture must be listed on the Design Light Consortium's (DLC) Horticultural Lighting Program and Qualified Products List[1]

Base Equipment Description

Depending on the cannabis growth phase, the following are the base equipment:

- Flower phase baseline: double ended high pressure sodium
- Vegetative phase baseline: single ended metal halide
- Clone phase baseline: T5HO, standard fixture

Code, Standards and Regulations

Fixtures must meet DLC's Technical Requirements for LED-based Horticultural Lighting version 3 (effective date: 31March 2023).[2]

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[1] Design Lighting Consortium (DLC) Horticultural Lighting
https://www.designlights.org/our-work/horticultural-lighting/

[2] Design Lights Consortium, "Technical Requirements for LED-based Horticultural Lighting," 30 November 2022.
https://www.designlights.org/wp-content/uploads/2023/03/DLC_HORT-Technical-Requirements-V3-0_03312023.pdf

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions:

Baseline energy use is calculated by weighting the energy use of fixtures at each growth phase by how much canopy area that growth phase occupies:

Baseline Energy Use (kWh/yr)= (Baseline Energy Use$_{\text{Flower Phase}}$ x Canopy Area$_{\text{Flower Phase}}$) + (Baseline Energy Use$_{\text{Vegetative Phase}}$ x Canopy Area$_{\text{Vegetative Phase}}$) + (Baseline Energy Use$_{\text{Clone Phase}}$ x Canopy Area$_{\text{Clone Phase}}$)

Baseline energy use for individual phases is calculated as follows:

Baseline Energy Use$_{\text{Phase X}}$ (kWh/yr) = (Required PPFD$_{\text{Phase X}}$ x Associated Fixture Area x Equivalent Full Load Hours) / (LED Efficacy x 1000W/kW)

Where the required parameters are provided in the table below:

Table 1 – Parameters used in the Estimation of Energy and Demand Savings.[3]

Growth Phase	Parameter	Value	Source
Flower Phase	Associated Fixture Area (ft^2)	20	[2]
Flower Phase	Required photosynthetic photon flux density (PPFD) (μmol/s/ft^2)	56	[2]
Flower Phase	Baseline Efficacy (μmol/J)	1.7	[2]
Flower Phase	Canopy Area	65%	[2]
Flower Phase	Equivalent Full Load Hours	2,800	Hydro One data for IESO Greenhouse Study.
Flower Phase	Baseline Fixture Wattage (W)	656	Calculated Using Variables Above
Vegetable Phase	Associated Fixture Area (ft^2)	24	[2]

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[3] Report on Cannabis Greenhouse and Warehouses: Energy Management Best Practices https://www.ieso.ca/en/Sector-Participants/IESO-News/2021/08/Report-on-Cannabis-Greenhouse-and-Warehouses-Energy-Management-Best-Practices

Vegetable Phase	Required photosynthetic photon flux density (PPFD) (μmol/s/ft^2)	56	[2]
Vegetable Phase	Baseline Efficacy (μmol/J)	1.02	[2]
Vegetable Phase	Canopy Area	33%	[2]
Vegetable Phase	Equivalent Full Load Hours	2,800	Hydro One data for IESO Greenhouse Study.
Vegetable Phase	Baseline Fixture Wattage (W)	1,312	Calculated Using Variables Above
Clone Phase	Associated Fixture Area (ft^2)	10	[2]
Clone Phase	Required photosynthetic photon flux density (PPFD) (μmol/s/ft^2)	19	[2]
Clone Phase	Baseline Efficacy (μmol/J)	0.55	[2]
Clone Phase	Canopy Area	2%	[2]
Clone Phase	Equivalent Full Load Hours	2,800	Hydro One data for IESO Greenhouse Study.
Clone Phase	Baseline Fixture Wattage (W)	338	Calculated Using Variables Above

Table 2 – Baseline Energy Use (kWh/yr)

Phase	Baseline Fixture Wattage (W)	Equivalent Full Load Hours (hrs)	Canopy Area (%)	Baseline Energy Use (kWh/yr)
Flower	656	2,800	65	1,194
Vegetative	1,312	2,800	33	1,212
Clone	338	2,800	2	19
Total				**2,425**

Efficient Measure Energy Assumptions:

Efficient measure energy use was calculated using the same algorithm as baseline energy use, but an efficacy of 2.4 μmol/J was used for all three growth phases. This is the average efficacy of DLC qualified horticultural LED fixtures.[4]

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[4] Design Lights Consortium, "Horticultural Lighting Program and Qualified Products List," [Online]. Available: https://www.designlights.org/horticultural-lighting/

Table 3 – Efficient Energy Use (kWh/yr)

Phase	Efficient Fixture Wattage (W)	Equivalent Full Load Hours (hrs)	Canopy Area (%)	Efficient Energy Use (kWh/yr)
Flower	465	2,800	65	846
Vegetative	558	2,800	33	515
Clone	77	2,800	2	4
Total				**1,366**

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Baseline Energy Use (kWh/yr) – Efficient Energy Use (kWh/yr)

Annual Energy Savings (kWh/yr) = 2,425 – 1,365 = 1,060 kWh/yr

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings$_{\text{Phase X}}$ (kW) = (Base Measure Wattage – Efficient Measure Wattage)$_{\text{Phase X}}$ – Canopy Area$_{\text{Phase X}}$

Table 4 – Connected Demand Savings (kW)

Phase	Baseline Fixture Wattage (W)	Efficient Fixture Wattage (W)	Canopy Area (%)	Connected Demand Savings (W)
Flower	656	465	65	124
Vegetative	1,312	558	33	249
Clone	338	77	2	5
Total				**378**

Summer Peak Demand Savings

Summer peak demand savings ΔkW$_{\text{peak}}$ are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

ΔkWpeak = 1,060 x 0.00127% = 0.013 kW

End Use Load Profile

CUSTOM-Business-Other_Commercial_Buildings-CUSTOM-Industrial-Agriculture-Horticultural Lighting - Cannabis

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.00127%	0.01522%	0.00167%	0.02407%

Effective Useful Life (EUL)

Baseline Measure Life (hours) = 12,000 hours[5]

Efficient Measure Life (hours) = 50,000 hours[6]

Equivalent Full Load Hours (EFLH) = 2,800 hours/yr

Effective Useful Life (years) = Measure Life (hrs) / EFLH (hrs/yr)

Baseline EUL = 12,000/2,800 = 4 years

Efficient Measure EUL = 50,000/2,800 = 18 years

Revision History

Revision #	Description/Comment	Date Revised
0	Horticultural LED Grow Lights – Cannabis Greenhouses	July 2020
1	Updated formatting	Nov. 2023
2	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[5] Sonepar BlueWay, IESO Presriptive Lighting Review - Survey Results and Pricing Summary, 2020.

[6] IESO, IESO HPNC + Retrofit Business Case Horticulture 09Aug2018, 2018.

Horticultural LED Grow Lights

Cannabis Warehouses

Measure Description

Energy Efficient Equipment Description

The measure is an LED fixture installed in a cannabis warehouse (indoor grow). The fixture must be listed on the Design Light Consortium's (DLC) Horticultural Lighting Program and Qualified Products List[1]

Base Equipment Description

Depending on the cannabis growth phase, the following are the base equipment:

- Flower phase baseline: double ended high pressure sodium
- Vegetative phase baseline: single ended metal halide
- Clone phase baseline: T5HO, standard fixture

Code, Standards and Regulations

Fixtures must meet DLC's Technical Requirements for LED-based Horticultural Lighting version 3 (effective date: 31March 2023).[2]

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[1] Design Lighting Consortium (DLC) Horticultural Lighting https://www.designlights.org/our-work/horticultural-lighting/

[2] Design Lights Consortium, "Technical Requirements for LED-based Horticultural Lighting," 30 November 2022 https://www.designlights.org/wp-content/uploads/2023/03/DLC_HORT-Technical-Requirements-V3-0_03312023.pdf

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions:

Baseline energy use is calculated by weighting the energy use of fixtures at each growth phase by how much canopy area that growth phase occupies:

Baseline Energy Use (kWh/yr)= (Baseline Energy Use$_{\text{Flower Phase}}$ x Canopy Area$_{\text{Flower Phase}}$) + (Baseline Energy Use$_{\text{Vegetative Phase}}$ x Canopy Area$_{\text{Vegetative Phase}}$) + (Baseline Energy Use$_{\text{Clone Phase}}$ x Canopy Area$_{\text{Clone Phase}}$)

Baseline energy use for individual phases is calculated as follows:

Baseline Energy Use$_{\text{Phase X}}$ (kWh/yr) = (Required PPFD$_{\text{Phase X}}$ x Associated Fixture Area x Equivalent Full Load Hours) / (LED Efficacy x 1000W/kW)

Where the required parameters are provided in the table below:

Table 1 – Parameters used in the Estimation of Energy and Demand Savings.[3]

Growth Phase	Parameter	Value	Source
Flower Phase	Associated Fixture Area (ft^2)	20	[2]
Flower Phase	Required photosynthetic photon flux density (PPFD) (μmol/s/ft^2)	56	[2]
Flower Phase	Baseline Efficacy (μmol/J)	1.7	[2]
Flower Phase	Canopy Area	83%	[2]
Flower Phase	Equivalent Full Load Hours	5,800	Hydro One data for IESO Greenhouse Study.
Flower Phase	Baseline Fixture Wattage (W)	656	Calculated Using Variables Above
Vegetable Phase	Associated Fixture Area (ft^2)	24	[2]

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[3] Report on Cannabis Greenhouse and Warehouses: Energy Management Best Practices https://www.ieso.ca/en/Sector-Participants/IESO-News/2021/08/Report-on-Cannabis-Greenhouse-and-Warehouses-Energy-Management-Best-Practices

Vegetable Phase	Required photosynthetic photon flux density (PPFD) (µmol/s/ft^2)	56	[2]
Vegetable Phase	Baseline Efficacy (µmol/J)	1.02	[2]
Vegetable Phase	Canopy Area	15%	[2]
Vegetable Phase	Equivalent Full Load Hours	5,800	Hydro One data for IESO Greenhouse Study.
Vegetable Phase	Baseline Fixture Wattage (W)	1,312	Calculated Using Variables Above
Clone Phase	Associated Fixture Area (ft^2)	10	[2]
Clone Phase	Required photosynthetic photon flux density (PPFD) (µmol/s/ft^2)	19	[2]
Clone Phase	Baseline Efficacy (µmol/J)	0.55	[2]
Clone Phase	Canopy Area	2%	[2]
Clone Phase	Equivalent Full Load Hours	5,800	Hydro One data for IESO Greenhouse Study.
Clone Phase	Baseline Fixture Wattage (W)	338	Calculated Using Variables Above

Table 2 – Baseline Energy Use (kWh/yr)

Phase	Baseline Fixture Wattage (W)	Equivalent Full Load Hours (hrs)	Canopy Area (%)	Baseline Energy Use (kWh/yr)
Flower	656	2,800	83	3,158
Vegetative	1,312	2,800	15	1,142
Clone	338	2,800	2	39
Total				**4,339**

Efficient Measure Assumptions:

Efficient measure energy use was calculated using the same algorithm as baseline energy use, but an efficacy of 2.4 µmol/J was used for all three growth phases. This is the average efficacy of DLC qualified horticultural LED fixtures.[4]

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[4] Design Lights Consortium, "Horticultural Lighting Program and Qualified Products List," [Online]. Available: https://www.designlights.org/horticultural-lighting/

Table 3 – Efficient Energy Use (kWh/yr)

Phase	Efficient Fixture Wattage (W)	Equivalent Full Load Hours (hrs)	Canopy Area (%)	Efficient Energy Use (kWh/yr)
Flower	465	2,800	83	2,238
Vegetative	558	2,800	15	485
Clone	77	2,800	2	9
Total				**2,732**

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Baseline Energy Use (kWh/yr) – Efficient Energy Use (kWh/yr)

Annual Energy Savings (kWh/yr) = 4,339 – 2,732 = 1,607 kWh/yr

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings$_{\text{Phase X}}$ (kW) = (Base Measure Wattage – Efficient Measure Wattage)$_{\text{Phase X}}$ – Canopy Area$_{\text{Phase X}}$

Table 4 – Connected Demand Savings (kW)

Phase	Baseline Fixture Wattage (W)	Efficient Fixture Wattage (W)	Canopy Area (%)	Connected Demand Savings (kW)
Flower	656	465	83	0.159
Vegetative	1,312	558	15	0.113
Clone	338	77	2	0.005
Total				**0.277**

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

ΔkWpeak = 1,607 x 0.00127% = 0.020 kW

End Use Load Profile

CUSTOM-Business-Other_Commercial_Buildings-CUSTOM-Industrial-Agriculture-Horticultural Lighting - Cannabis

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.00127%	0.01522%	0.00167%	0.02407%

Effective Useful Life (EUL)

Baseline Measure Life (hours) = 12,000 hours[5]

Efficient Measure Life (hours) = 50,000 hours[6]

Equivalent Full Load Hours (EFLH) = 2,800 hours/yr

Effective Useful Life (years) = Measure Life (hrs) / EFLH (hrs/yr)

Baseline EUL = 12,000/2,800 = 4 years

Efficient Measure EUL = 50,000/2,800 = 8 years

Revision History

Revision #	Description/Comment	Date Revised
0	Horticultural LED Grow Lights – Cannabis Greenhouses	July 2020
1	Updated formatting	Nov. 2023
2	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[5] Sonepar BlueWay, IESO Presriptive Lighting Review - Survey Results and Pricing Summary, 2020

[6] IESO, IESO HPNC + Retrofit Business Case Horticulture 09Aug2018, 2018.

Horticultural LED Grow Lights

Vegetable Greenhouses

Measure Description

Energy Efficient Equipment Description

The measure is an LED fixture installed in a cannabis greenhouse. The fixture must be listed on the Design Light Consortium's (DLC) Horticultural Lighting Program and Qualified Products List[1]

Base Equipment Description

The baseline technology is a 1000 W High Intensity Discharge (HID) fixture

Code, Standards and Regulations

Fixtures must meet DLC's Technical Requirements for LED-based Horticultural Lighting version 3 (effective date: 31March 2023).[2]

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Baseline Connected Power = 1080 W[3]

Baseline Equivalent Full Load Hours (EFLH) = 2,400 hr/yr[4]

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[1] Design Lighting Consortium (DLC) Horticultural Lighting https://www.designlights.org/our-work/horticultural-lighting/

[2] Design Lights Consortium, "Technical Requirements for LED-based Horticultural Lighting," 30 November 2022. https://www.designlights.org/wp-content/uploads/2023/03/DLC_HORT-Technical-Requirements-V3-0_03312023.pdf

[3] 2020 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 8.0, Oct. 17, 2019 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency
Adjusted 1000W to 1080W to account for ballast factor.

[4] Equivalent Full Load Hours are estimated from Hydro One data collected for the 2019 IESO Greenhouse Study.

Energy Efficient Measure Assumptions

Measure Connected Power = 590 W

Measure EFLHs = 2,400 hr/yr

Energy and Demand Savings

Energy Savings[5]

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{base}$ = 1080W x 2,400 hrs/yr x kW/1000W

Annual Energy Consumption $(kWh/yr)_{base}$ = 2,592 kWh/yr

Annual Energy Consumption $(kWh/yr)_{conservation}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{conservation}$ = 590 W x 2,400 hrs/yr x kW/1000W

Annual Energy Consumption $(kWh/yr)_{conservation}$ = 1,416 kWh/yr

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{conservation}$

Annual Energy Savings (kWh/yr) = 2,592 – 1,416 = 1,176 kWh/yr

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Baseline Connected Power = 1080 W

Measure Connected Power= 590 W

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Demand Savings (kW) = 1080 – 590 = 0.49 W

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

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[5] For vegetables greenhouses in Ontario it is assumed that there is no electric heating penalty or waste heat factor incorporated into energy savings, since there is no cooling in vegetable greenhouses and heating is primarily natural gas. IESO Greenhouse Energy Profile Study, 2019 https://www.ieso.ca/en/Corporate-IESO/Media/News-Releases/2019/10/New-Greenhouse-Study

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

ΔkWpeak = 1,176 kWh x 0.00056% kW/kWh = 0.007 kW

End Use Load Profile

CUSTOM-Business-Other_Commercial_Buildings-CUSTOM-Industrial-Agriculture-Horticultural Lighting - Veg

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.00056%	0.00085%	0.00129%	0.00418%

Effective Useful Life (EUL)

Baseline Measure Life (hours) = 12,000 hours[6]

Efficient Measure Life (hours) = 50,000 hours[7]

Equivalent Full Load Hours (EFLH) = 2,400 hours/yr[8]

Effective Useful Life (years) = Measure Life (hrs) / EFLH (hrs/yr)

Efficient Measure EUL = 50,000/2,400 = 21 years

Revision History

Revision #	Description/Comment	Date Revised
0	Horticultural LED Grow Lights – Vegetable Greenhouses	July 2020
1	Updated formatting	Nov. 2023
2	Updated references, Energy Efficient Measure assumptions, EM&V peak definition and Peak Demand Savings	Jan. 2025

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[6] Sonepar BlueWay, IESO Presriptive Lighting Review - Survey Results and Pricing Summary, 2020.

[7] IESO, IESO HPNC + Retrofit Business Case Horticulture 09Aug2018, 2018.

[8] Equivalent Full Load Hours are estimated from Hydro One data collected for the 2019 IESO Greenhouse Study.

Energy Star® Refrigerator

Measure Description

Energy Efficient Equipment Description

ENERGY STAR® Refrigerator

Base Equipment Description

Standard new refrigerator-freezer with automatic defrost and with bottom-mounted freezer and automatic icemaker without through-the-door ice service

Code, Standards and Regulations

Both Canada’s Energy Efficiency Regulations[1] and Ontario regulation 404/12[2] state residential refrigerators or combination refrigerator-freezer having compressor-cycled automatic defrost system with a maximum capacity of 1,100 L (39 ft3) and manufactured on or after September 15, 2014 must not exceed the maximum annual energy consumption limits. The maximum energy consumption limits = Cav * AV + C, where Cav and C depend on the refrigerator type and volume and AV is the adjusted volume of the refrigerator.

Resource Savings

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = 350 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

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[1] Canada’s Energy Efficiency Standard for Refrigerators. https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6877

[2] Ontario Regulation 404/12 Energy and Water Efficiency – Appliance and Products https://www.ontario.ca/laws/regulation/120404

Connected Demand Savings

Demand Savings (kW) = 0.210 kW

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkW_{peak} = ΔkWh * Summer Peak Demand Factor

ΔkW_{peak} = 350 x 0.01191% = 0.042 kW

End Use Load Profile

PSP-Business-Restaurant-Refrigeration

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.01191%	0.01179%	0.01254%	0.01230%

Effective Useful Life (EUL)

Measure	**EUL (years)**
Energy Star® Refrigerator	17[3]

Revision History

Revision #	**Description/Comment**	**Date Revised**
0	Created in Measures & Assumptions List	Feb. 2008
1	Updated Using Great Refrigerator Roundup Program (GRRP) Reported Data	May 2008
2	Updated using 2008 GRRP Report Results	Dec. 2009

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[3] 2020 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 8.0, Volume 3: Residential Measures https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_01-01-20_v8.0_Vol_3_Res_10-17-19_Final.pdf

3	Updated energy savings, EUL and incremental costs.	July 2013
4	Updated savings assumptions	Mar. 2017
5	Full measure review	Aug. 2020
6	Updated formatting; to be fully substantiated in the next review	Jan. 2024
7	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

In-Suite Temperature Controls

Electric Space Heating and Cooling

Measure Description

Energy Efficient Equipment Description

In-suite temperature controls for electric space heating and cooling. Measure is limited to packaged HVAC systems of five, or fewer, tons as larger systems likely require more sophisticated controls to meet code requirements.

Base Equipment Description

Manual or no in-suite temperature controls

Code, Standards and Regulations

No codes, standards and regulations exist for this measure.

Resource Savings Assumptions

Measure Assumptions

Cap_{cool} = Cooling capacity, assume 36 kBtu/h

Cap_{heat} = Heating capacity, assume 32.1 kBtu/h

SEER = Seasonal energy efficiency rating, assume 13

HSPF = Heating seasonal performance factor, assume 7.7

ESF_{cool} = Energy savings factor for cooling, assume 0.08

ESF_{heat} = Energy savings factor for heating, assume 0.07

$EFLH_{cool}$ = Equivalent full load hours for cooling, assume 1,209 hours[1]

$EFLH_{heat}$ = Equivalent full load hours for heating, assume 3,034 hours[2]

Energy and Demand Savings

Energy Savings

For electrically heated facility:

Annual Energy Savings $(kWh/yr)_{ASHP}$ = $[(Cap_{cool} \times EFLH_{cool} \times ESF_{cool}) / SEER] + [(Cap_{heat} \times EFLH_{heat} \times ESF_{heat}) / HSPF]$

Annual Energy Savings $(kWh/yr)_{ASHP}$ = $[(36 \times 1209 \times 0.08) / 13] + [(32.16 \times 3{,}034 \times 0.07) / 7.7]$

Annual Energy Savings $(kWh/yr)_{ASHP}$ = 1,155 kWh

For gas-heated facility:

Annual Energy Savings $(kWh/yr)_{CAC}$ = $(Cap_{cool} \times EFLH_{cool} \times ESF_{cool}) / SEER$

Annual Energy Savings $(kWh/yr)_{CAC}$ = $(36 \times 1209 \times 0.08) / 13)$

Annual Energy Savings $(kWh/yr)_{CAC}$ = 267.8 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There is no connected demand savings attributable to this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

$\Delta kWpeak_{ASHP}$ = 1,155 X 0.02562% = 0.296 kW

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[1] Assumed low rise building with Chicago EFLH passed through a degree day adjustment (+16%) to model Ontario weather. 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 12.0, Sep. 22, 2023 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[2] Assumed low rise building with Chicago EFLH passed through a degree day adjustment (-32%) to model Ontario weather. 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 12.0, Sep. 22, 2023 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

End Use Load Profile

EM&V-Commercial-Space_Cooling_&_Heating

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.02562%	0.01372%	0.01913%	0.01913%

Effective Useful Life (EUL)

Measure	EUL (years)
In-suite temperature controls	11[3]

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Sep. 2010
1	Updated savings assumptions and cost data	Mar. 2017
2	Full measure review	Aug. 2020
3	Updated references and formatting	Nov. 2023
4	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[3] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 12.0, Sep. 22, 2023, Small Commercial Thermostats (section 4.4.48)
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

ECM for Evaporator Fans

Walk-in Refrigerators and Freezers

Measure Description

Energy Efficient Equipment Description

A brushless DC fan electronically commutated motor (ECM) installed on evaporator fans in walk-in refrigerators and freezers

Base Equipment Description

Refrigerators and freezers with shaded-pole motor (SP) or permanent split capacitor (PSC) fan motors

Code, Standards and Regulations

The US DOE requires that commercial refrigeration equipment manufactured and distributed in commerce, must meet the energy conservation standards specified in the Code of Federal Regulations 10 CFR 431.66.[1]

There are currently no Canadian regulations on minimum energy efficiency for walk-in refrigerators and freezers. However, high-efficiency options can be specified when ordering new units or when retrofitting existing units.[2]

Resource Savings Assumptions

Measure Assumptions

Motor efficiencies: η_{FL}

SP motor efficiency: $\eta_{FL} = 30\%$

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[1] Commercial Refrigeration Equipment (accessed October 2023) https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=28

[2] https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/commercial-refrigeration-self-contained/6871

PSC motor efficiency: η_{FL} = 60%

ECM Efficiency η_{FL} = 70%

Assume average SP and PSC wattages for P_{base}

Load Factor (LF) = 0.9

Coefficient of performance (COP) = assume 2.5 for refrigerator and 1.5 for freezers

Power Input (W) = [hp x 0.7457 kW/hp x 1,000 W/kW]/ η_{FL}

Freezer hours per year: 8,273 hr[3]

Refrigerator hours per year: 8,760 hr

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Power Reduction (kW) x Hours per year (H)

Table 1 – Annual Energy Savings (kWh/yr)

Refrigeration Equipment	Motor Size (HP)	Assumed Wattage[4]	Annual Energy Savings (kWh)
Freezer	≥ 1/20 hp to < 1/10 hp	46.2	652.86
Refrigerator	≥ 1/20 hp to < 1/10 hp	45.8	542.24

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Power Reduction (kW) = $(\text{Power}_{base} - \text{Power}_{eff})$ x LF x (1 + 1/COP)

Table 2 – Connected Demand Savings (kW)

Refrigeration Equipment	Motor Size (HP)	Connected Demand Savings (kW)
Freezer	≥ 1/20 hp to < 1/10 hp	0.079
Refrigerator	≥ 1/20 hp to < 1/10 hp	0.062

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[3] "A evaporator fan in a cooler runs all the time, but a freezer only runs 8273 hours per year due to defrost cycles (4 20-min defrost cycles per day)" Efficiency Maine TRM. https://www.efficiencymaine.com/docs/EMT-TRM_Commercial_Industrial_Multifamily_v2024_1.pdf

[4] Back calculated given the savings assumptions in MAL; may give different savings values due to decimals.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$$

Table 3 – Summer Peak Demand Savings (kW)

Refrigeration Equipment	Motor Size (HP)	Peak Demand Savings (kW)
Freezer	≥ 1/20 hp to < 1/10 hp	0.076
Refrigerator	≥ 1/20 hp to < 1/10 hp	0.063

End Use Load Profile

PSP-Business-Commercial-Refrigeration

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01169%	0.01128%	0.01260%	0.01165%

Effective Useful Life (EUL)

Measure	EUL (years)
ECM for Evaporator Fans	15[5]

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Oct. 2013
1	Full measure review	Aug. 2020

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[5] Wisconsin Focus on Energy 2023 Technical Reference Manual, Jan. 03, 2023
https://focusonenergy.com/evaluation-reports/2023-wisconsin-focus-on-energy-technical-reference-manual

2	Updated references and formatting; back calculated assumed motor wattage given MAL savings	Jan. 2024
3	Updated EM&V peak definition and Summer Peak Demand Savings	Jan. 2025

Advanced Rooftop Unit Controls

Measure Description

Energy Efficient Equipment Description

A traditional single-zone packaged rooftop unit (RTU) retrofitted with advanced controls that allow for the modulation of supply fan and outdoor air dampers in response to in-zone CO_2 sensor feedback (i.e. demand controlled ventilation, or DCV).

Base Equipment Description

Single-zone packaged RTU with single-speed supply fan and integrated economizer, operating on a static outdoor air delivery schedule.

Code, Standards and Regulations

ASHRAE 62.1-2010 – Ventilation for Acceptable Indoor Air Quality (referenced in Table 1.3.1.2 of the Ontario Building Code)

Ontario Building Code Section 6.2.2.1 (2)[1] – "Except in storage garages and repair garages covered by Article 6.2.2.3., the rates at which outdoor air is supplied in buildings by ventilation systems shall be not less than the rates required by ANSI/ASHRAE 62.1, "Ventilation for Acceptable Indoor Air Quality.".

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Existing RTU system that has a single-speed supply fan, an economizer, and uses a schedule-based approach to outdoor air ventilation. Schedules are set such that outdoor air ventilation is not provided to the building during unoccupied hours

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[1] Ontario Building Code 2012 – O.Reg. 332/12 (Current as of May 11, 2020).

Energy Efficient Measure Assumptions

RTU system that has a variable or multi-speed supply fan, an economizer, and uses a CO_2 sensor-based system to provide feedback on indoor air quality and allow the RTU system to modulate outdoor and supply air flow accordingly. Schedules are set such that outdoor air ventilation is not provided to the building during unoccupied hours.

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = $(Size_{cooling} \times SF_{cooling}) + (Size_{heating} \times SF_{heating})$

where: Size = cooling and heating output capacity, in tons and MBtu/hr, respectively

SF = cooling and heating savings factors, normalized to the equipment output capacity

Refer to the table below for normalized heating and cooling factors. Factors reflect a rooftop unit (RTU) with demand control ventilation (DCV) and 2-stage fan controls, which was the middle of three efficient case controls strategy modelled in Illinois2. Savings factors are taken from results shown for Rockford, IL, which has similar heating degree days to Toronto (~3,700 Celsius heating degree days) as representative of the average customer in Ontario.

Table 1 – Normalized Electric Cooling Energy Savings

Building Type	Cooling Savings (kWh/ton)	Electric Heat Savings (kWh/ton)	Electric Peak Demand Savings (kW/ton)
Assembly	145.8	893.1	0.107
Assisted Living	574.4	59.6	0.116
College	410.8	831.9	0.207
Storage	339.8	171.3	0.065
Convenience Store	918.9	464.9	0.369
Garage	479.7	47.7	0.054
Grocery	480.1	835.0	0.122
Manufacturing	773.4	47.7	0.335
Office	1,071.2	143.1	0.395
Religious	869.4	131.2	0.462
Restaurant	554.0	262.4	0.231
Large Retail	692.6	178.9	0.152
Small Retail	739.7	226.6	0.171

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[2] 2023 Illinois Statewide Technical Reference Manual for Energy Efficiency, version 11.0, Sep. 22, 2022 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Table 2 – Annual Cooling Savings (kWh) for different Cooling Capacity

Building Type	**Cooling Capacity ≥3 to <5.4 tons**	**Cooling Capacity ≥5.4 to <11.4 tons**	**Cooling Capacity ≥11.4 to <19.9 tons**	**Cooling Capacity ≥19.9 to <63.4 tons**
Assembly	394	1,225	2,282	6,065
Assisted Living	1,551	4,825	8,989	23,895
College	1,109	3,451	6,429	17,089
Storage	917	2,854	5,318	14,136
Convenience Store	2,481	7,719	14,381	38,226
Garage	1,295	4,029	7,507	19,956
Grocery	1,296	4,033	7,514	19,972
Manufacturing	2,088	6,497	12,104	32,173
Office	2,892	8,998	16,764	44,562
Religious	2,347	7,303	13,606	36,167
Restaurant	1,496	4,654	8,670	23,046
Large Retail	1,870	5,818	10,839	28,812
Small Retail	1,997	6,213	11,576	30,772
Average	**1,672**	**5,201**	**9,691**	**25,759**

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

No connected demand savings for this measure since installed compressor remains unchanged.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 2 – Annual Cooling Savings (kWh) for different Cooling Capacity

Building Type	**Cooling Capacity ≥3 to <5.4 tons**	**Cooling Capacity ≥5.4 to <11.4 tons**	**Cooling Capacity ≥11.4 to <19.9 tons**	**Cooling Capacity ≥19.9 to <63.4 tons**
Average	0.855	2.659	4.954	13.169

End Use Load Profile

EM&V-Commercial-Cooling

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.05112%	0.00000%	0.00000%	0.00000%

Effective Useful Life (EUL)

Illinois TRM[3] and Wisconsin TRM[4] assume 10 years. Missouri TRM[5] assumes assumes 15 years. Assumed an EUL of 12 years as a mid-range estimate for Ontario, in alignment with "DCV – Interior Spaces" measure.

Revision History

Revision #	Description/Comment	Date Revised
0	New Measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Updated references and format	Nov. 2023
2	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[4] Wisconsin Focus on Energy 2024 Technical Reference Manual, Jan. 07, 2024 https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

[5] Missouri Technical Resource Manual, March 31, 2017 https://dnr.mo.gov/document-search/missouri-technical-reference-manual-pub2839/pub2839

ECM for HVAC Applications

Fan Motor Replacement

Measure Description

Energy Efficient Equipment Description

Replacement of fan motor in an existing fan-powered Variable Air Volume (VAV) unit with brushless DC fan motors or electronically commutated motors (ECMs)

Base Equipment Description

Fan-powered Variable Air Volume (VAV) units powered by a single speed fractional horsepower permanent split capacitor (PSC) induction motor

Code, Standards and Regulations

NEMA Standard MG 1-2006[1] give ratings for motors at full load rating conditions. The DOE procedure for testing air conditioner SEER assumes a default air handler fan efficiency.

Resource Savings Assumptions

Measure Assumptions[2]

Motor nominal power rating = 1 hp

Average Load Factor (LF) = 90%

Effective full load hours, heat ($EFLH_{heat}$) = 2,285 hrs/yr[3]

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[1] NEMA Standards Publication MG 1-2006 Revision 1-2007
https://www.nema.org/docs/default-source/standards-document-library/mg-1-2006-rev-1-combined-revised-ed.pdf

[2] Pennsylvania PUC Technical Reference Manual Vol. 3 – Commercial and Industrial Measures, February 2021, ECM Circulating Fan measure.
https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

[3] Wisconsin Focus on Energy 2024 Technical Reference Manual, Jan. 07, 2024, ECM HVAC Fan Motors
https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

Effective full load hours, cool ($EFLH_{cool}$) = 678 hrs/yr[3]

Energy Interactive Factor (IF_{kWh}) = 26.2%

Demand Interactive Factor (IF_{kW}) = 30%

PSC Motor Efficiency, η_{PSC} = 50%

ECM Efficiency, η_{ECM} = 70%

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Annual Energy Savings $(kWh/yr)_{heat}$ + Annual Energy Savings $(kWh/yr)_{cool}$

Annual Energy Savings $(kWh/yr)_{heat}$ = Power Reduction (kW) x $EFLH_{heat}$ = 0.3837 x 2,285 = 876.7 kWh/yr

where: Power Reduction (kW) = 1 hp x 0.746 kW/hp x LF x $(1/\eta_{PSC} – 1/\eta_{ECM})$

Power Reduction (kW) = 1 hp 0.746 kW/hp x 0.9 x (1/0.5 – 1/0.7)

Power Reduction (kW) = 0.3837

Annual Energy Savings $(kWh/yr)_{cool}$ = Power Reduction (kW) x $EFLH_{cool}$ x $(1 + IF_{kWh})$ = 0.3837 x 678 x (1 + 0.262) = 328.3 kWh/yr

Annual Energy Savings (kWh/yr) = 876.7 + 328.3 = 1,205 kWh/yr

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Power Reduction (kW) = 1 hp x 0.746 kW/hp x LF x $(1/\eta_{PSC} – 1/\eta_{ECM})$

Power Reduction (kW) = 1 hp 0.746 kW/hp x 0.9 x (1/0.5 – 1/0.7)

Power Reduction (kW) = 0.3837 kW[4]

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[4] CDMIS has a different value (0.062 kW) which was not changed since connected demand is not normally used in calculating summer peak demand savings

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$

$\Delta kWpeak = 1{,}205 \times 0.05114\% = 0.616\ kW$

End Use Load Profile

PSP-Business-Other_Commercial_Buildings-Cooling_DX

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.05114%	0.00000%	0.09330%	0.00000%

Effective Useful Life (EUL)

Measure	EUL (years)
ECM for HVAC Applications	15[5]

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Oct. 2013
1	Full measure review and update	Oct. 2020
2	Updated references and formatting	Nov. 2023
3	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

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[5] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024, page 798 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

ECM for HVAC Applications

Fan Powered VAV Box

Measure Description

Energy Efficient Equipment Description

Fan-powered variable air volume (VAV) units equipped with brushless DC fan motors or electronically commutated motors (ECMs).

Base Equipment Description

Fan-powered variable air volume (VAV) units powered by a single speed fractional horsepower permanent split capacitor (PSC) induction motor.

Code, Standards and Regulations

NEMA Standard MG 1-2006[1] give ratings for motors at full load rating conditions. The DOE procedure for testing air conditioner SEER assumes a default air handler fan efficiency.

Resource Savings Assumptions

Measure Assumptions[2]

Design Air Volume (AV_{Design}) expressed in cubic feet per minute (CFM)

BSF – box size factor (Watts/CFM)

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[1] NEMA Standards Publication MG 1-2006 Revision 1-2007 https://www.nema.org/docs/default-source/standards-document-library/mg-1-2006-rev-1-combined-revised-ed.pdf

[2] Rhode Island Technical Resource Manual, National Grid, Nov. 2012 page A-9 https://www9.nationalgridus.com/non_html/eer/ri/Rhode%20Island%20TRM_PY2013_final.pdf (accessed Oct. 2013)

Table 1 – Box Size Factor for different Unit Capacities

Unit Capacity (AV_{Design})	**Box Size Factor (BSF)**
< 1000 CFM	0.32 Watts/CFM
≥ 1000 CFM	0.21 Watts/CFM

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = AV_{design} x BSF x %Flow x EFLH x kWh/1000Wh

%Flow annual = 52%

Effective full load hours (EFLH) = 3,000 hrs/year

Table 2 – Annual Energy Savings for different Unit Capacities

Unit Capacity (AV_{Design})	**Assumed Capacity**	**Annual Energy Savings (kWh)**
< 1000 CFM	1000	500
≥ 1000 CFM	1068	350

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 3 – Connected Demand Savings for different Unit Capacities

Unit Capacity (AV_{Design})	**Connected Demand Savings (kW)**
< 1000 CFM	0.180
≥ 1000 CFM	0.320

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 4 – Summer Peak Demand Savings for different Unit Capacities

Unit Capacity (AV_{Design})	Summer Peak Demand Savings (kW)
< 1000 CFM	0.256
≥ 1000 CFM	0.179

End Use Load Profile

PSP-Business-Other_Commercial_Buildings-Cooling_DX

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.05114%	0.00000%	0.09330%	0.00000%

Effective Useful Life (EUL)

Measure	EUL (years)
ECM for HVAC Applications (Fan Powered VAV Box	15[3]

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Sep. 2019
1	Full measure review and update	Oct. 2020
2	Checked on references; no reference for the connected demand savings	Nov. 2023

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, page 798 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

3	Updated references, EM&V peak definition and Peak Demand Savings	Jan. 2025

Hotel Occupancy Controls

HVAC + Lighting

Measure Description

Energy Efficient Equipment Description

The measure includes the installation of hotel occupancy sensors to control air conditioning and heating controls in hotels that operate all 12 months of the year.

The occupancy based controls must include an occupancy sensor such as (but not limited to) infrared sensors, ultrasonic sensors, door magnetic strip sensors and/or card-key sensors. The controls must be able to shutoff and/or place the HVAC equipment serving the space in an unoccupied temperature setback/setup setting.

Base Equipment Description

No occupancy controls for lighting or HVAC systems

Code, Standards and Regulations

No required codes a standards for hotel occupancy controls

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

No programmable or timed heating or lighting controls are in place.

Energy Efficient Measure Assumptions[1]

Unoccupied setback/setup to heating/cooling system offsets

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[1] Wisconsin Focus on Energy 2024 Technical Reference Manual, Jan. 07, 2024 https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

Cooling capacity (Cap_{cool}) = 9,000 Btu/h

Heating capacity (Cap_{heat}) = 8,037 Btu/h

Energy efficiency ratio (EER) = 8.98 for PTAC; 8.88 for PTHP

Coefficient of Performance (COP) = assume 2.7

Equivalent full load hours (EFLH) = 663 for cooling; 1,161 for heating

Savings Factor (% Savings) = 18.4%

Energy and Demand Savings

Energy Savings

For electrically heated facility:

Annual Energy Savings $(kWh/yr)_{PTHP}$ = { [($EFLH_{cool}$ x Cap_{cool}) / (1,000 x EER_{PTHP})] + [($EFLH_{heat}$ x Cap_{heat}) / (3,412 x COP)] } x % Savings

Annual Energy Savings $(kWh/yr)_{PTHP}$ = { [(663 x 9,000) / (1,000 x 8.88)] + [(1,161 x 8,037) / (3,412 x 2.7)] } x 0.184

Annual Energy Savings $(kWh/yr)_{PTHP}$ = 310 kWh

For gas-heated facility:

Annual Energy Savings $(kWh/yr)_{PTAC}$ = [($EFLH_{cool}$ x Cap_{cool}) / (1,000 x EER_{PTAC})] x % Savings

Annual Energy Savings $(kWh/yr)_{PTAC}$ = [(663 x 9,000) / (1,000 x 8.98)] x 0.184

Annual Energy Savings $(kWh/yr)_{PTAC}$ = 122 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There is no connected demand savings attributable to this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

$\Delta kWpeak_{PTHP}$ = 310 x 0.05114% = 0.159 kW

$\Delta kWpeak_{PTAC}$ = 122 x 0.05114% = 0.062 kW

End Use Load Profile

PSP-Business-Other_Commercial_Buildings-Cooling_DX

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.05114%	0.00000%	0.09330%	0.00000%

Effective Useful Life (EUL)

Illinois TRM assumes 15 years for Guest Room Energy Management (PTAC & PTHP). Wisconsin TRM assumes 8 years for the same measure. Assumed average of 10 years for Ontario.

Measure	EUL (years)
Hotel Occupancy Controls	10

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Oct. 2013
1	Full measure review	Aug. 2020
2	Updated formatting	Nov. 2023
3	Updated references, EM&V peak definition and Peak Demand Savings. Removed Section Listed as Other Resource Savings	Jan. 2025

Unitary Air Conditioners

Single-Package and Split System

Measure Description

Energy Efficient Equipment Description

Unitary air Assumed minimum improvement over baseline equipment ranging from 0.8 to 1.3 EER

Base Equipment Description

NRCan energy efficiency regulations for the 'Large air conditioners, heat pumps and condensing units' measure based off the Cooled by Air table.

Code, Standards and Regulations

NRCan sets energy efficiency regulations for large air conditioners, heat pumps and condensing units[1].

Regulatory definition:

Large air conditioner, a commercial or industrial unitary air conditioner with a cooling capacity of at least 19 kW (65,000 Btu/h) but less than 223 kW (760,000 Btu/h). It does not include a single package vertical air conditioner.

Large heat pump, a commercial or industrial unitary heat pump that is intended for air-conditioning and space-heating applications and that has a cooling capacity of at least 19 kW (65,000 Btu/h) but less than 223 kW (760,000 Btu/h). It does not include a single package vertical heat pump.

Large condensing unit, a commercial or industrial condensing unit that is intended for air conditioning applications and that has a cooling capacity of at least 40 kW (135,000 Btu/h) but not more than 70 kW (240,000 Btu/h).

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[1] Energy Efficiency Regulations for Large air conditioners, heat pumps and condensing units https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/large-air-conditioners-heat-pumps-and-condensing-units/6881

Compliance date:

Manufactured on or after January 1, 2018 for large air conditioners and large heat pumps and manufactured on or after December 31, 1998 for and before January 1, 2010 large condensing units.

Resource Savings Assumptions

Measure Assumptions

Table 1 – Assumed Energy Efficiency Ratio (EER/IEER) for Base and Efficient Unitary AC

Unitary Equipment Size in Tons	Unitary Equipment Size BTU per hour	Heating Type	Energy Efficiency Ratio (EER / IEER) for Assumed Base Case	Minimum Efficiency Rating (EER / IEER)
Split System ≥ 3.0 to < 5.4 tons	≥ 36,000 to < 65,000	All	13.0 SEER (Approximately 11.14 EER)	12.5 EER
Split System ≥ 3.0 to < 5.4 tons	≥ 36,000 to < 65,000	All	13.0 SEER (Approximately 11.14 EER)	12.5 EER
Single Package With Economizer ≥ 3.0 to < 5.4 tons	≥ 36,000 to < 65,000	All	13.0 SEER (Approximately 11.14 EER)	12.5 EER
Single Package With Economizer ≥ 3.0 to < 5.4 tons	≥ 36,000 to < 65,000	All	13.0 SEER (Approximately 11.14 EER)	12.5 EER
Split System ≥ 5.4 to ≤ 7.5 tons	≥ 65,000 to ≤ 90,000	Electric Resistance	11.2 / 12.9	12.2 / 14.0
Split System ≥ 5.4 to ≤ 7.5 tons ≥ 5.4 to ≤ 7.5	≥ 65,000 to ≤ 90,000	All Other	11.0 / 12.7	12.0 / 13.8
Single Package With Economizer ≥ 5.4 to ≤ 7.5 tons	≥ 65,000 to ≤ 90,000	Electric Resistance	11.2 / 12.9	12.2 / 14.0
Single Package With Economizer ≥ 5.4 to ≤ 7.5 tons	≥ 65,000 to ≤ 90,000	All Other	11.0 / 12.7	12.0 / 13.8
Split System and Single Package > 7.5 to < 11.25 tons	> 90,000 to < 135,000	Electric Resistance	11.2 / 12.9	12.2 / 14.0
Split System and Single Package > 7.5 to < 11.25 tons	> 90,000 to < 135,000	All Other	11.0 / 12.7	12.0 / 13.8
Split System and Single Package ≥ 11.25 to < 20.0 tons	≥ 135,000 to < 240,000	Electric Resistance	11.0 / 12.4	12.2 / 14.2
Split System and Single Package ≥ 11.25 to < 20.0 tons	≥ 135,000 to < 240,000	All Other	10.8 / 12.2	12.0 / 14.0
Split System and Single Package ≥ 20.0 to < 63.3 tons	≥ 240,000 to < 760,000	Electric Resistance	10.0 / 11.6	10.8 / 13.2

Split System and Single Package ≥ 20.0 to < 63.3 tons	≥ 240,000 to < 760,000	All Other	9.8 / 11.4	10.6 / 12.3
Split System and Single Package ≥ 63.3 tons	≥ 760,000	Electric Resistance	9.7 / 11.3	10.4 / 12.3
Split System and Single Package ≥ 63.3 tons	≥ 760,000	All Other	9.5 / 11.1	10.2 / 12.1

Equivalent Full Load Hours (EFLH) = 600

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base} = (Cap_{base} \times EFLH) / EER_{base}$

Annual Energy Consumption $(kWh/yr)_{eff} = (Cap_{eff} \times EFLH) / EER_{eff}$

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{eff}$

Table 2 – Annual Energy Savings (kWh/yr)

Unitary AC Size (Tons)	**Unitary AC Size (kBtu/hr)**	**Heating Type**	**Assumed Capacity (kBtu/hr)**	**Annual Energy Savings (kWh/yr)**
Single Package with Economizer ≥3.0 to < 5.4 tons	≥ 36 to < 65	All	50.5	295.9
Single Package with Economizer ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	All	77.5	352.3
Single Package with Economizer ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	Electric Resistance	77.5	340.3
Split System ≥ 3.0 to < 5.4 tons	≥ 36 to < 65	All	50.5	295.9
Split System ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	All	77.5	352.3
Split System ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	Electric Resistance	77.5	340.3
Split System/Single Package ≥ 7.5 to < 11.25 tons	≥ 90 to < 135	All	112.5	511.4

Split System/Single Package ≥ 7.5 to < 11.25 tons	≥ 90 to < 135	Electric Resistance	112.5	494.0
Split System/Single Package ≥ 11.25 to < 20 tons	≥ 135 to < 240	All	187.5	1,041.7
Split System/Single Package ≥ 11.25 to < 20 tons	≥ 135 to < 240	Electric Resistance	187.5	1,006.0
Split System/Single Package ≥ 20 to < 63 tons	≥ 240 to < 756	All	500.0	2,310.4
Split System/Single Package ≥ 20 to < 63 tons	≥ 240 to < 756	Electric Resistance	500.0	2,222.2
Split System/Single Package ≥ 63 tons	≥ 760	All	760.0	3,294.1
Split System/Single Package ≥ 63 tons	≥ 760	Electric Resistance	760.0	3,164.2

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 3 – Connected Demand Savings (kW)

Unitary AC Size (Tons)	Unitary AC Size (kBtu/hr)	Heating Type	Assumed Capacity (kBtu/hr)	Annual Demand Savings (kW/yr)
Single Package with Economizer ≥3.0 to < 5.4 tons	≥ 36 to < 65	All	50.5	0.49
Single Package with Economizer ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	All	77.5	0.59
Single Package with Economizer ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	Electric Resistance	77.5	0.57
Split System ≥ 3.0 to < 5.4 tons	≥ 36 to < 65	All	50.5	0.49
Split System ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	All	77.5	0.59
Split System ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	Electric Resistance	77.5	0.57

Split System/Single Package ≥ 7.5 to < 11.25 tons	≥ 90 to < 135	All	112.5	0.85
Split System/Single Package ≥ 7.5 to < 11.25 tons	≥ 90 to < 135	Electric Resistance	112.5	0.82
Split System/Single Package ≥ 11.25 to < 20 tons	≥ 135 to < 240	All	187.5	1.74
Split System/Single Package ≥ 11.25 to < 20 tons	≥ 135 to < 240	Electric Resistance	187.5	1.68
Split System/Single Package ≥ 20 to < 63 tons	≥ 240 to < 756	All	500.0	3.85
Split System/Single Package ≥ 20 to < 63 tons	≥ 240 to < 756	Electric Resistance	500.0	3.70
Split System/Single Package ≥ 63 tons	≥ 760	All	760.0	5.49
Split System/Single Package ≥ 63 tons	≥ 760	Electric Resistance	760.0	5.27

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 4 – Annual Summer Peak Demand Savings (kW)

Unitary AC Size (Tons)	**Unitary AC Size (kBtu/hr)**	**Heating Type**	**Assumed Capacity (kBtu/hr)**	**Annual Peak Demand Savings (kW/yr)**
Single Package with Economizer ≥3.0 to < 5.4 tons	≥ 36 to < 65	All	50.5	0.151
Single Package with Economizer ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	All	77.5	0.180
Single Package with Economizer ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	Electric Resistance	77.5	0.174
Split System ≥ 3.0 to < 5.4 tons	≥ 36 to < 65	All	50.5	0.151

Split System ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	All	77.5	0.180
Split System ≥ 5.4 to < 7.5 tons	≥ 65 to < 90	Electric Resistance	77.5	0.174
Split System/Single Package ≥ 7.5 to < 11.25 tons	≥ 90 to < 135	All	112.5	0.261
Split System/Single Package ≥ 7.5 to < 11.25 tons	≥ 90 to < 135	Electric Resistance	112.5	0.253
Split System/Single Package ≥ 11.25 to < 20 tons	≥ 135 to < 240	All	187.5	0.533
Split System/Single Package ≥ 11.25 to < 20 tons	≥ 135 to < 240	Electric Resistance	187.5	0.514
Split System/Single Package ≥ 20 to < 63 tons	≥ 240 to < 756	All	500.0	1.181
Split System/Single Package ≥ 20 to < 63 tons	≥ 240 to < 756	Electric Resistance	500.0	1.136
Split System/Single Package ≥ 63 tons	≥ 760	All	760.0	1.684
Split System/Single Package ≥ 63 tons	≥ 760	Electric Resistance	760.0	1.618

End Use Load Profile

EM&V-Commercial-Cooling

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.05112%	0.00000%	0.00000%	0.00000%

Effective Useful Life (EUL)

Measure	EUL (years)
Unitary air-conditioners	15[2]

Revision History

Revision #	Description/Comment	Date Revised
0	Created substantiation sheet for this measure	Mar. 2017
1	Full measure review	Aug. 2020
2	Updated references and formatting	Nov. 2023
3	Updated table-1 to add IEER values, references, formatting, EM&V peak definition Peak Demand Savings	Jan. 2025

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep. 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Computer Room Air Conditioner (CRAC)

Measure Description

Energy Efficient Equipment Description

A Computer Room Air-Condtioner (CRAC) more efficient than the minimum efficiency outlined for equipment manufactured before May 28th 2024 in U.S DOE 10 Code of Federal Regulations[1].

Base Equipment Description

Computer Room Air-Conditioner at minimum efficiency as described in U.S DOE 10 Code of Federal Regulations for equipment manufactured before May 28th 2024.

Code, Standards and Regulations

Ontario Regulation 509/18 prescribes minimum efficiency to match U.S DOE 10 Code of Federal Regulations.

Resource Savings Assumptions

Measure Assumptions

SCOP_base is the SCOP for base measure

SCOP_ee is the SCOP for conservation measure

EFLH_cool is a value of 8760

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[1] Ontario Regulation 509/18 Energy and Water Efficiency – Appliances and Products prescribe efficiency standards from U.S DOE 10 Code of Federal Regulations Part 431, Subpart F, 431.97

O. Reg. 509/18: ENERGY AND WATER EFFICIENCY - APPLIANCES AND PRODUCTS (ontario.ca)

eCFR :: 10 CFR 431.97 -- Energy efficiency standards and their compliance dates.

LF is load factor of 0.65[2]

Annual full load operating hours = 8760 hrs

Base Measure Assumptions

The base measure used is based on Computer-Room Air-Conditioner (CRAC) manufactured before May 28th 2024. The efficiency metric used is Sensible COP (SCOP). For units manufactured on or after May 28th 2024, the US DOE prescribes the metric Net Sensible COP (NSenCOP). However, since most equipment available on the market is manufactured before May 28th 2024 and uses the SCOP metric, the base measure is also defined as such. The base measure used in calculations is an average value of the minimum SCOP efficiency for downflow and upflow configuration.

Table 1 – CRAC Base Measure Minimum SCOP Efficiency

Equipment Type	Net Sensible Cooling Capacity	Minimum SCOP Efficiency
Air-Cooled	<65,000 Btu/h	2.15
Air-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	2.05
Air-Cooled	>=240,000 Btu/h and <760,000 Btu/h	1.85
Water-Cooled	<65,000 Btu/h	2.55
Water-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	2.45
Water-Cooled	>=240,000 Btu/h and <760,000 Btu/h	2.35
Water -Cooled with Fluid Economizer	<65,000 Btu/h	2.50
Water -Cooled with Fluid Economizer	>= 65,000 Btu/h and <240,000 Btu/h	2.40
Water -Cooled with Fluid Economizer	>=240,000 Btu/h and <760,000 Btu/h	2.30
Glycol-Cooled	<65,000 Btu/h	2.45
Glycol-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	2.10
Glycol-Cooled	>=240,000 Btu/h and <760,000 Btu/h	2.05
Glycol -Cooled with Fluid Economizer	<65,000 Btu/h	2.40
Glycol -Cooled with Fluid Economizer	>= 65,000 Btu/h and <240,000 Btu/h	2.05
Glycol -Cooled with Fluid Economizer	>=240,000 Btu/h and <760,000 Btu/h	2.00

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[2] State of Minnesota Technical Reference Manual for Energy Conservation Improvements Programs. Version 4.1. MN TRM 3.3 FINAL 2021-01-13

Energy Efficient Measure Assumptions

The U.S Department of Energy Compliance Certification Database[3] houses certification reports and compliance statements submitted by manufacturers for covered products and equipment subject to Federal conservation standards. The efficieny metric reported is Sensible COP (SCOP), which is prescribed for equipment manufactured before May 28, 2024. An average efficiency for each cooling capacity range: <65,000 Btu/h, ≥65,000 Btu/h and <240,000 Btu/h, ≥240,000 Btu/h and <760,000 Btu/h across all equipment types was calculated. It was observed that the average efficiency of equiment in CCMS database was 18.7% higher than the minumum efficiency prescribed by US DOE. Therefore, the conservation measure SCOP metric was conservatively assumed to be 15% higher than the corresponding minimum SCOP.

Table 2 – CRAC Energy Efficient Measure Minimum SCOP Efficiency

Equipment Type	**Net Sensible Cooling Capacity**	**Minimum SCOP Efficiency**
Air-Cooled	<65,000 Btu/h	2.47
Air-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	2.35
Air-Cooled	>=240,000 Btu/h and <760,000 Btu/h	2.12
Water-Cooled	<65,000 Btu/h	2.93
Water-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	2.81
Water-Cooled	>=240,000 Btu/h and <760,000 Btu/h	2.70
Water -Cooled with Fluid Economizer	<65,000 Btu/h	2.87
Water -Cooled with Fluid Economizer	>= 65,000 Btu/h and <240,000 Btu/h	2.75
Water -Cooled with Fluid Economizer	>=240,000 Btu/h and <760,000 Btu/h	2.64
Glycol-Cooled	<65,000 Btu/h	2.81
Glycol-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	2.41
Glycol-Cooled	>=240,000 Btu/h and <760,000 Btu/h	2.35
Glycol -Cooled with Fluid Economizer	<65,000 Btu/h	2.75
Glycol -Cooled with Fluid Economizer	>= 65,000 Btu/h and <240,000 Btu/h	2.35
Glycol -Cooled with Fluid Economizer	>=240,000 Btu/h and <760,000 Btu/h	2.29

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[3] U.S Department of Energy Compliance Certification Database
CCMS - Public Database (doe.gov)

Energy and Demand Savings

Annual Energy Savings (kWh)=$Btu_{\_cool,sensible}$ x (1 kW)/(1000 W) x (1 Wh)/(3.412 Btu) x (1/($SCOP_{\_base}$)-1/($SCOP_{\_conv}$)) x $EFLH_{\_cool}$ x LF

Where,

Btu_cool, sensible is Net sensible cooling capacity. The average cooling capacity value is calculated from the CCMS database for each cooling capacity range outlined in the base measure section.

Connected Demand Savings (kW)=$Btuh_{\_cool,sensible}$ x (1 kW)/(1000 W) x (1 Wh)/(3.412 Btu) x (1/($SCOP_{\_base}$) - 1/($SCOP_{\_ee}$))x CF x LF

Where,

CF is co-incident demand factor of 1[4]

Connected Demand Savings

Table 3 – Annual Energy (kWh) and Demand Savings (kW)

Equipment Type	Net Sensible Cooling Capacity	Annual Energy Savings (kWh/yr)	Connected Demand Savings (kW)
Air-Cooled	<65,000 Btu/h	3,794	0.43
Air-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	14,657	1.67
Air-Cooled	>=240,000 Btu/h and <760,000 Btu/h	36,526	4.17
Water-Cooled	<65,000 Btu/h	3,198	0.37
Water-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	12,260	1.40
Water-Cooled	>=240,000 Btu/h and <760,000 Btu/h	28,738	3.28
Water -Cooled with Fluid Economizer	<65,000 Btu/h	3,262	0.37
Water -Cooled with Fluid Economizer	>= 65,000 Btu/h and <240,000 Btu/h	12,515	1.43
Water -Cooled with Fluid Economizer	>=240,000 Btu/h and <760,000 Btu/h	29,364	3.35
Glycol-Cooled	<65,000 Btu/h	3,329	0.38
Glycol-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	14,308	1.63
Glycol-Cooled	>=240,000 Btu/h and <760,000 Btu/h	32,954	3.76
Glycol -Cooled with Fluid Economizer	<65,000 Btu/h	3,398	0.39
Glycol -Cooled with Fluid Economizer	>= 65,000 Btu/h and <240,000 Btu/h	14,657	1.67

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[4] State of Minnesota Technical Reference Manual for Energy Conservation Improvements Programs. Version 4.1. MN TRM 3.3 FINAL 2021-01-13

Glycol -Cooled with Fluid Economizer	>=240,000 Btu/h and <760,000 Btu/h	33,780	3.86

Summer Peak Demand Savings

The summer peak demand savings are the same as connected demand savings.

Table 3 – Summer Peak Demand Savings (kW)

Equipment Type	Net Sensible Cooling Capacity, Btu/h	Peak Demand Savings (kW)
Air-Cooled	<65,000 Btu/h	0.43
Air-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	1.67
Air-Cooled	>=240,000 Btu/h and <760,000 Btu/h	4.17
Water-Cooled	<65,000 Btu/h	0.37
Water-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	1.40
Water-Cooled	>=240,000 Btu/h and <760,000 Btu/h	3.28
Water -Cooled with Fluid Economizer	<65,000 Btu/h	0.37
Water -Cooled with Fluid Economizer	>= 65,000 Btu/h and <240,000 Btu/h	1.43
Water -Cooled with Fluid Economizer	>=240,000 Btu/h and <760,000 Btu/h	3.35
Glycol-Cooled	<65,000 Btu/h	0.38
Glycol-Cooled	>= 65,000 Btu/h and <240,000 Btu/h	1.63
Glycol-Cooled	>=240,000 Btu/h and <760,000 Btu/h	3.76
Glycol -Cooled with Fluid Economizer	<65,000 Btu/h	0.39
Glycol -Cooled with Fluid Economizer	>= 65,000 Btu/h and <240,000 Btu/h	1.67
Glycol -Cooled with Fluid Economizer	>=240,000 Btu/h and <760,000 Btu/h	3.86

End Use Load Profile

To be defined (custom)

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
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Effective Useful Life (EUL)

Measure	EUL (years)
CRAC	15[5]

Revision History

Revision #	Description/Comment	Date Revised
0	Substantiation sheet created by RI	Jan. 2025

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[5] State of Pennsylvania Technical Reference Manual Volume 3: Commercial and Industrial Measures, Issued May 2024 [1848580.pdf (pa.gov)](1848580.pdf (pa.gov))

Packaged Terminal Air Conditioners (PTAC) & Packaged Terminal Heat Pump (PTHP)

Measure Description

Energy Efficient Equipment Description

This measure relates to the purchase and installation of a Packaged Terminal Air Conditioner (PTAC) or Packaged Terminal Heat Pump (PTHP) that exceeds the minimum efficiency criteria from O.Reg. 509/18.

Packaged terminal air conditioner means a wall sleeve and a separate un-encased combination of heating and cooling assemblies specified by the builder and intended for mounting through the wall, and that is industrial equipment. It includes a prime source of refrigeration, separable outdoor louvers, forced ventilation, and heating availability by builder's choice of hot water, steam, or electricity.[1]

Packaged terminal heat pump means a packaged terminal air conditioner that utilizes reverse cycle refrigeration as its prime heat source, that has a supplementary heat source available, with the choice of hot water, steam, or electric resistant heat, and that is industrial equipment.[1]

Base Equipment Description

PTAC/PTHPs meeting the minimum requirements of Ontario O.Reg. 509/18, which refers to U.S. DOE 10 Code of Federal Regulations Part 431, Subpart F, §431.97.

Code, Standards and Regulations

Ontario O.Reg. 509/18, Schedule 4, Section 11[2]; applies to equipment manufactured January 1, 2017 or later; minimum efficiency aligns with U.S. DOE 10 Code of Federal Regulations Part 431, Subpart F, §431.97.

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[1] U.S. Code of Federal Regulations Title 10, Chapter II-D, Part 431.92
https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-F/section-431.92

[2] Ontario Regulation 509/18 Energy and Water Efficiency – Appliances and Products

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 1 – Baseline Measure Efficiencies[3]

Type	Category	Cooling Capacity	Minimum Efficiency
PTAC	Standard Size	< 7,000 BTU/h	EER = 11.9
PTAC	Standard Size	≥7,000 Btu/h and ≤15,000 Btu/h	EER = 14.0 - (0.3 x *Capacity*)
PTAC	Standard Size	>15,000 BTU/h	EER = 9.5
PTHP	Standard Size	< 7,000 BTU/h	EER = 11.9 COP = 3.3
PTHP	Standard Size	≥7,000 Btu/h and ≤15,000 Btu/h	EER = 14.0 - (0.3 x *Capacity*) COP = 3.7 - (0.052 x *Capacity*)
PTHP	Standard Size	>15,000 BTU/h	EER = 9.5 COP = 2.9

*Capacity within EER/COP equations refers to cooling capacity in thousands of BTU/h

Energy Efficient Measure Assumptions

Table 2 – Efficient Measure Efficiencies

Type	Category	Cooling Capacity	Minimum Efficiency
PTAC	Standard Size	< 7,000 BTU/h	EER = 12.9
PTAC	Standard Size	≥7,000 Btu/h and ≤15,000 Btu/h	EER ≥ [14.0 - (0.3 x Capacity)] x 1.06
PTAC	Standard Size	>15,000 BTU/h	EER = 10.5
PTHP	Standard Size	< 7,000 BTU/h	EER = 12.9 COP = 3.5
PTHP	Standard Size	≥7,000 Btu/h and ≤15,000 Btu/h	EER = [14.0 - (0.3 x Capacity)] x 1.06 COP = [3.7 - (0.052 x Capacity)] x 1.06
PTHP	Standard Size	>15,000 BTU/h	EER = 10.5 COP = 3.2

* Capacity within EER/COP equations refers to cooling capacity in thousands of BTU/h

https://www.canlii.org/en/on/laws/regu/o-reg-509-18/latest/o-reg-509-18.html

[3] U.S. Code of Federal Regulations Title 10, Chapter II-D, Part 431.97 Tables 7&8
https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-F/subject-group-ECFR2640f6ad978e4e6

Assumed Hours of Operation

$EFLH_{cool}$ = cooling equivalent full load hours, assume 650 hours per year[4]

$EFLH_{heat}$ = heating equivalent full load hours, assume 2,000 hours per year[5]

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Annual Energy Savings $(kWh/yr)_{cool}$ + Annual Energy Savings $(kWh/yr)_{heat}$

$$\text{Annual Energy Savings } (kWh/yr)_{cool} = \{Cap_{cool} \times [(1/EER_{base}) - (1/EER_{eff})] \times EFLH_{cool}\}$$

$$\text{Annual Energy Savings } (kWh/yr)_{heat} = (Cap_{heat}/3.412) \times [(1/COP_{base}) - (1/COP_{eff})] \times EFLH_{heat}$$

Annual Energy Savings (kWh/yr) = Annual Energy Savings $(kWh/yr)_{cool}$ + Annual Energy Savings $(kWh/yr)_{heat}$

Table 3 – Annual Energy Savings (kWh/yr)

Type	**Measure**	**Assumed Capacity, BTU/h**	**Annual Energy Savings$_{cool}$**	**Annual Energy Savings$_{heat}$**	**Total Annual Energy Savings**
PTAC	Capacity <7,000 Btu/h and EER ≥ 12.9	7,000	34.8	–	34.8
PTAC	Capacity ≥7,000 Btu/h and ≤15,000 Btu/h and EER ≥ [14.0 - (0.3 × Cap)] x 1.06	11,000	60.7	–	60.7
PTAC	Cooling Capacity >15,000 Btu/h and EER ≥ 10.5	15,000	93.3	–	93.3
PTHP	Cooling Capacity <7,000 Btu/h and EER ≥ 12.9 and COP ≥ 3.5	7,000	34.8	137.3	147.8
PTHP	Cooling Capacity ≥7,000 Btu/h and ≤15,000 Btu/h and EER ≥ [14.0 - (0.3 × Cap)] x 1.06 and COP ≥ [3.7 - (0.052 x Cap)] x 1.06	11,000	60.7	248.3	248.1
PTHP	Cooling Capacity >15,000 Btu/h and EER ≥ 10.5 and COP ≥ 3.2	15,000	93.3	376.6	368.9

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[4] The Missouri Technical Reference Manual – March 31, 2017 – page 146 https://dnr.mo.gov/document-search/missouri-technical-reference-manual-pub2839/pub2839

[5] 2020 OEB Natural Gas Technical Resource Manual, Version 4.0 – page 271

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Connected demand savings for heating is assumed to be zero.

Table 4 – Connected Demand Savings (kW)

Type	Measure	Assumed Capacity, BTU/h	Annual Demand Savings$_{cool}$
PTAC	Capacity <7,000 Btu/h and EER ≥ 12.9	7,000	0.046
PTAC	Capacity ≥7,000 Btu/h and ≤15,000 Btu/h and EER ≥ [14.0 - (0.3 × Cap)] x 1.06	11,000	0.058
PTAC	Cooling Capacity >15,000 Btu/h and EER ≥ 10.5	15,000	0.144
PTHP	Cooling Capacity <7,000 Btu/h and EER ≥ 12.9 and COP ≥ 3.5	7,000	0.046
PTHP	Cooling Capacity ≥7,000 Btu/h and ≤15,000 Btu/h and EER ≥ [14.0 - (0.3 × Cap)] x 1.06 and COP ≥ [3.7 - (0.052 x Cap)] x 1.06	11,000	0.058
PTHP	Cooling Capacity >15,000 Btu/h and EER ≥ 10.5 and COP ≥ 3.2	15,000	0.144

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 5 –Summer Peak Demand Savings (kW)

Type	Measure	Assumed Capacity, BTU/h	Peak Demand Savings
PTAC	Capacity <7,000 Btu/h and EER ≥ 12.9	7,000	0.007
PTAC	Capacity ≥7,000 Btu/h and ≤15,000 Btu/h and EER ≥ [14.0 - (0.3 × Cap)] x 1.06	11,000	0.009
PTAC	Cooling Capacity >15,000 Btu/h and EER ≥ 10.5	15,000	0.022
PTHP	Cooling Capacity <7,000 Btu/h and EER ≥ 12.9 and COP ≥ 3.5	7,000	0.023

PTHP	Cooling Capacity ≥7,000 Btu/h and ≤15,000 Btu/h and EER ≥ [14.0 - (0.3 × Cap)] x 1.06 and COP ≥ [3.7 - (0.052 x Cap)] x 1.06	11,000	0.036
PTHP	Cooling Capacity >15,000 Btu/h and EER ≥ 10.5 and COP ≥ 3.2	15,000	0.086

End Use Load Profile

PSP-Business-Commercial-Space_Cooling_&_Heating

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.02333%	0.01300%	0.06094%	0.01800%

Effective Useful Life (EUL)

New York TRM[6] and Minnesota TRM[7] assumes 15 years.

Revision History

Revision #	Description/Comment	Date Revised
0	New Measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Updated references and formatting	Dec. 2023
2	Updated Energy Efficient Case Measure efficiencies, connected demand savings, EM&V peak definition, Peak Demand Savings and references	Jan. 2025

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[6] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Version 12, Oct. 22, 2024 technical-resource-manual-version-12-filed-october-28-2024-effective-january-1-2025.pdf

[7] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Version 4.1, January 31, 2024 https://mn.gov/commerce-stat/trm/releases/4.1.pdf

Room Air Conditioners

Measure Description

Energy Efficient Equipment Description

Room air conditioners – window and split type

Base Equipment Description

Room air conditioners meeting the minimum requirements of Ontario O.Reg. 509/18, which refers to U.S. DOE 10 Code of Federal Regulations Part 430, Subpart C, §430.32 (b)[1]

Code, Standards and Regulations

Ontario O.Reg. 509/18 [1] - Schedule 4, Section 14

- Applies to equipment manufactured January 1, 2017 or later
- Minimum efficiency aligns with U.S. DOE 10 Code of Federal Regulations Part 430, Subpart C, §430.32 (b)

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[1] Ontario - O.Reg. 509/18: Energy and Water Efficiency - Appliances and Products

Resource Savings

Measure Assumptions

Table 1 – Combined Energy Efficiency Ratios[2]

Capacity (BTU/h)	**$\text{CEER}_{\text{baseline}}$ With Louvers**	**$\text{CEER}_{\text{baseline}}$ Without Louvers**	**$\text{CEER}_{\text{ENERGY STAR}}$ With Louvers**	**$\text{CEER}_{\text{ENERGY STAR}}$ Without Louvers**	**$\text{CEER}_{\text{CEE\_Advanced}}$ with or without Louvers**
< 8,000	11.0	10.0	12.1	11.0	12.7
8,000 to 10,999	10.9	9.6	12.0	10.6	12.5
11,000 to 13,999	10.9	9.5	12.0	10.5	12.5
14,000 to 19,999	10.7	9.3	11.8	10.2	12.3
20,000 to 27,999	9.4	9.4	10.3	10.3	10.8
>= 28,000	9.0	9.4	9.9	10.3	10.4

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = FLH x Capacity x (1/$\text{CEER}_{\text{base}}$ – 1/CEER_{eff})/1000

where: FLH = full load hours; assume 200 hours for Ontario

CEER = combined energy efficiency ratio; see Table 1

Table 2 – Annual Energy Savings (kWh/yr)

Capacity (BTU/h)	**$\text{CEER}_{\text{ENERGY STAR}}$ With Louvers**	**$\text{CEER}_{\text{ENERGY STAR}}$ Without Louvers**	**$\text{CEER}_{\text{CEE\_Advanced}}$ with or without Louvers**	**Average (kWh/yr)**
< 8,000 Btu/hr and CEER ≥12.1	11.6	12.7	23.4	15.9
8,000 to 13,999 Btu/hr and CEER ≥12.0	18.9	22.4	41.1	27.5
14,000 to 19,999 Btu/hr and CEER ≥11.8	29.6	32.3	65.3	42.4
20,000 to 27,999 Btu/hr and CEER ≥10.3	44.6	44.6	66.2	51.8
≥ 28,000 Btu/hr and CEER ≥9.9	56.6	52.1	70.5	59.7

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

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[2] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Connected Demand Savings

$$\text{Demand Savings (kW)} = \text{Capacity} \times (1/\text{CEER}_{base} - 1/\text{CEER}_{eff})/1000$$

Table 3 – Average Demand Savings (kW)

Capacity (BTU/h)	**$\text{CEER}_{\text{ENERGY STAR}}$ With Louvers**	**$\text{CEER}_{\text{ENERGY STAR}}$ Without Louvers**	**$\text{CEER}_{\text{CEE\_Advanced}}$ with or without Louvers**	**Average (kW)**
< 8,000 Btu/hr and CEER ≥12.1	0.058	0.064	0.117	0.079
8,000 to 13,999 Btu/hr and CEER ≥12.0	0.095	0.112	0.205	0.137
14,000 to 19,999 Btu/hr and CEER ≥11.8	0.148	0.161	0.326	0.212
20,000 to 27,999 Btu/hr and CEER ≥10.3	0.223	0.223	0.331	0.259
≥ 28,000 Btu/hr and CEER ≥9.9	0.283	0.260	0.353	0.299

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

$$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$$

Table 4 – Summer Peak Demand Savings (kW)

Capacity (BTU/h)	**$\text{CEER}_{\text{ENERGY STAR}}$ With Louvers**	**$\text{CEER}_{\text{ENERGY STAR}}$ Without Louvers**	**$\text{CEER}_{\text{CEE\_Advanced}}$ with or without Louvers**	**Average kW_{peak}**
< 8,000 Btu/hr and CEER ≥12.1	0.008	0.009	0.017	0.008
8,000 to 13,999 Btu/hr and CEER ≥12.0	0.013	0.016	0.029	0.014
14,000 to 19,999 Btu/hr and CEER ≥11.8	0.021	0.023	0.046	0.022
20,000 to 27,999 Btu/hr and CEER ≥10.3	0.031	0.031	0.047	0.026
≥ 28,000 Btu/hr and CEER ≥9.9	0.040	0.037	0.050	0.031

End Use Load Profile

EM&V-Commercial-Cooling

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.05112%	0.00000%	0.00000%	0.00000%

Effective Useful Life (EUL)

Measure	EUL (years)
Room Air Conditioner	10[3]

Revision History

Revision #	Description/Comment	Date Revised
0	New measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Updated references and formatting;	Dec. 2023
2	Updated End Use Load Profile to match CDMIS and MAL. Updated EM&V peak definition, Peak Demand Savings and references	Jan. 2025

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[3] Wisconsin Focus on Energy 2024 Technical Reference Manual, Jan. 07, 2024 https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

Unitary Air Source Heat Pump

Measure Description

Energy Efficient Equipment Description

This measure relates to the purchase and installation of a unitary air source heat pump that meets (or exceeds) the minimum requirements of the Northeast Energy Efficiency Partnerships (NEEP) Cold Climate Air-Source Heat Pump Specification (Version 3.0) (for units 65 MBH or less), or which exceed the minimum requirements of O.Reg. 509/18 (for units > 65 MBH).

Unitary Air Source Heat Pump (ASHP) Definition:[1]

One or more factory-made assemblies which normally include an indoor coil(s), compressor(s), Outdoor Coil(s), indoor fan(s), outdoor fan(s), and expansion device(s) including means to provide a heating function. When such equipment is provided in more than one assembly, the separated assemblies shall be designed to be used together, and the requirements of rating outlined in the standard are based upon the use of matched assemblies."

Base Equipment Description

ASHPs meeting the minimum requirements of Ontario O.Reg. 509/18. Note that minimum Heating Season Performance Factors in Ontario must be defined for Region V.

Code, Standards and Regulations

Ontario O.Reg. 509/18 [1] - Schedule 4, Section 5

- Applies to equipment manufactured January 1, 2019 or later

- Applies to unitary systems rated below 19 kW (65,000 BTU/h)

- Minimum efficiencies listed in Schedule 4-1.5 (iv)

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[1] AHRI Standard 210/240 - 2020 Standard for Performance Rating of Unitary AC and Air-Source Heat Pump Equipment https://www.ahrinet.org/system/files/2023-09/AHRI%20Standard%20210.240-2023%20%282020%29.pdf

Resource Savings

Measure Assumptions

Base Measure Assumptions[2]

Table 1 – Base Efficiency Ratings for Units < 19 kW (65,000 BTU/h)

Category	Subcategory	Application	Minimum SEER	Minimum HSPF**
Air-cooled, single phase	Single Package	All, except SDHV* and space constrained	14.0	7.0
Air-cooled, single phase	Single Package	Space constrained, including TTW	12.0	6.4
Air-cooled, single phase	Split System	All, except SDHV* and space constrained	14.0	7.1
Air-cooled, single phase	Split System	Space constrained, including TTW	12.0	6.4
Air-cooled, single phase	All	SDHV	12.0	6.3
Air-cooled, three phase	Split System	All	14.0	7.1
Air-cooled, three phase	Single Package	All	14.0	7.0
Air-cooled, VRF multi-split	All	All	EER 13.0	6.7

* SDHV - Small Duct High Velocity
** HSPF V - HSPF must be calculated for Region V

Table 2 - Base Efficiency Ratings for Large Unitary Heat Pumps

Category	Heating Type	Cooling Capacity	Min. EER	Min. IEER	COP at 8.3 °C inlet air	COP at -8.3 °C inlet air
Air-cooled	None or Electric	≥19 kW and <40 kW	11.0	12.2	3.3	2.25

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[2] Ontario O.Reg. 509/18: Energy and Water Efficiency - Appliances and Products
https://www.ontario.ca/laws/regulation/180509

Air-cooled	None or Electric	≥40 kW and <70 kW	10.6	11.6	3.2	2.05
Air-cooled	None or Electric	≥70 kW and <223 kW	9.5	10.6	3.2	2.05
Air-cooled	Other	≥19 kW and <40 kW	10.8	12.0	3.3	2.25
Air-cooled	Other	≥40 kW and <70 kW	10.4	11.4	3.2	2.05
Air-cooled	Other	≥70 kW and <223 kW	9.3	10.4	3.2	2.05
Air-cooled VRF multi-split	None or Electric	≥19 kW and <40 kW	11.0	N/A	3.3	N/A
Air-cooled VRF multi-split	None or Electric	≥40 kW and <70 kW	10.6	N/A	3.2	N/A
Air-cooled VRF multi-split	None or Electric	≥70 kW and <223 kW	9.5	N/A	3.2	N/A
Air-cooled VRF multi-split	Other	≥19 kW and <40 kW	10.8	N/A	3.3	N/A
Air-cooled VRF multi-split	Other	≥40 kW and <70 kW	10.4	N/A	3.2	N/A
Air-cooled VRF multi-split	Other	≥70 kW and <223 kW	9.3	N/A	3.2	N/A

VRF – Variable Refrigerant Flow

Energy and Demand Savings

Energy Savings[3,4]

For units with cooling capacity < 5.4 tons:

$$\text{Annual Energy Savings (kWh/yr)} = \text{Size} \times 12 \times [\, EFLH_{cool} \times (1/SEER_{base} - 1/SEER_{ee}) + EFLH_{heat} \times (1/HSPF_{base} - 1/HSPF_{ee}) \,]$$

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[3] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multi-Family, and Commercial/Industrial Measures, Version 7, April 15, 2019 https://dps.ny.gov/system/files/documents/2022/11/technical-resource-manual-version-7-filed-april-15-2019-effective-january-1-2020.pdf

[4] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Jan. 20, 2020 https://mn.gov/commerce-stat/trm/releases/3.1.pdf

For all other units:

Annual Energy Savings (kWh/yr) = Size x [$EFLH_{cool}$ x 12 x(1/$IEER_{base}$ – 1/$IEER_{ee}$) + $EFLH_{heat}$ x 3.52 x (1/COP_{base} – 1/COP_{ee})]

where: Size – system cooling capacity in tons

EFLH – equivalent full load hours; assume 650 cooling hours and 2,000 heating hours

SEER – seasonal energy efficiency ratio

HSPF – heating seasonal performance factor

IEER – integrated energy efficiency ratio

COP – heating coefficient of performance

Table 3 – Assumed Cooling and Heating Equipment Efficiencies

Measures	**Assumed Capacity (tons)**	**SEER/ $IEER_{base}$**	**SEER/ $IEER_{ee}$**	**HSPF/ COP_{base}**	**HSPF/ COP_{ee}**
Single Package ≥3.0 to <5.4 Tons, All Heating Type	3.2	13.1	15.0	2.0	2.4
Split System ≥3.0 to <5.4 Tons, All Heating Type	3.2	13.1	15.0	2.0	2.4
Split System/Single Package ≥5.4 to <11.25 Tons, All Other	8.3	12.2	13.5	2.8	3.1
Split System/Single Package ≥5.4 to <11.25 Tons, Electric Resistance (or None)	8.3	12.2	13.5	2.8	3.1
Split System/Single Package ≥11.25 to <20.0 Tons, All Other	15.6	11.6	12.7	2.6	2.9
Split System/Single Package ≥11.25 to <20.0 Tons, Electric Resistance	15.6	11.6	12.7	2.6	2.9
Split System/Single Package ≥20.0 to <63.3 Tons, All Other	41.7	10.6	11.7	2.6	2.9
Split System/Single Package ≥20.0 to <63.3 Tons, Electric Resistance	41.7	10.6	11.7	2.6	2.9

Table 4 – Annual Energy Savings (kWh/yr)

Measures	**Cooling Savings**	**Heating Savings**	**Total Savings**
Single Package ≥3.0 to <5.4 Tons, All Heating Type	235.11	1,879.62	2,114.73

Split System ≥3.0 to <5.4 Tons, All Heating Type	235.11	1,879.62	2,114.73
Split System/Single Package ≥5.4 to <11.25 Tons, All Other	556.90	1,920.00	2,476.90
Split System/Single Package ≥5.4 to <11.25 Tons, Electric Resistance (or None)	556.90	1,920.00	2,476.90
Split System/Single Package ≥11.25 to <20.0 Tons, All Other	1,002.17	3,809.52	4,811.69
Split System/Single Package ≥11.25 to <20.0 Tons, Electric Resistance	1,002.17	3,809.52	4,811.69
Split System/Single Package ≥20.0 to <63.3 Tons, All Other	3,176.14	10,154.67	13,330.81
Split System/Single Package ≥20.0 to <63.3 Tons, Electric Resistance	3,176.14	10,154.67	13,330.81

$$\text{Lifetime Energy Savings (kWh)} = \text{Annual Energy Savings (kWh/yr)} \times \text{EUL (yr)}$$

Connected Demand Savings

$$\text{Demand Savings (kW)} = \text{Size} \times 12\ (1/\text{SEER}_{\text{base}} - 1/\text{SEER}_{\text{ee}})$$

Table 5 – Demand Savings (kW)

Measures	Average Connected Demand Savings	Summer Peak Demand Savings
Single Package ≥3.0 to <5.4 Tons, All Heating Type	0.330	0.493
Split System ≥3.0 to <5.4 Tons, All Heating Type	0.330	0.493
Split System/Single Package ≥5.4 to <11.25 Tons, All Other	0.751	0.578
Split System/Single Package ≥5.4 to <11.25 Tons, Electric Resistance (or None)	0.751	0.578
Split System/Single Package ≥11.25 to <20.0 Tons, All Other	1.482	1.123
Split System/Single Package ≥11.25 to <20.0 Tons, Electric Resistance	1.482	1.123
Split System/Single Package ≥20.0 to <63.3 Tons, All Other	4.328	3.110
Split System/Single Package ≥20.0 to <63.3 Tons, Electric Resistance	4.328	3.110

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkW_{peak} = ΔkWh * Summer Peak Demand Factor

See Table 4.

End Use Load Profile

PSP-Business-Commercial-Space_Cooling_&_Heating

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.02333%	0.01300%	0.06094%	0.01800%

Effective Useful Life (EUL)

Measure	EUL (years)
Unitary Air Source Heat Pump	15[5]

Revision History

Revision #	Description/Comment	Date Revised
0	New Measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Updated formatting	Jan. 2024
2	Updated EM&V peak definition and Peak Demand Savings	Jan. 2025

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[5] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multi-Family, and Commercial/Industrial Measures, Version 7, April 15, 2019 https://dps.ny.gov/system/files/documents/2022/11/technical-resource-manual-version-7-filed-april-15-2019-effective-january-1-2020.pdf

Commercial & Industrial Measures (Quasi-Prescriptive)

HVAC Chiller

Air-Cooled or Water-Cooled

Measure Description

Energy Efficient Equipment Description

Air- or water-cooled chillers that exceed the minimum efficiency requirements of ASHRAE 90.1-2016 Table 6.8.1-3

Base Equipment Description

Air- or water-cooled chillers that meet the minimum efficiency requirements of ASHRAE 90.1-2016 Table 6.8.1-3

Code, Standards and Regulations

Ontario O.Reg. 509/18[1] - Schedule 4, Section 21

- Applies to water chillers manufactured January 1, 2017 or later
- Applies to vapour-compression, air-cooled chillers with a capacity of < 700 kW (200 ton), AND
- Vapour-compression reciprocating, rotary screw, scroll, or centrifugal water-cooled with a capacity < 8,800 kW (2,500 ton), AND
- Air- or water-cooled single-effect, or direct- or indirect-fired double-effect absorption water chiller.

Minimum chiller efficiencies provided in Table 6.8.1-3 of ASHRAE 90.1-2016 Energy Standard for Buildings Except Low-Rise Residential Buildings[2]

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[1] Ontario O.Reg. 509-18: Energy and Water Efficiency - Appliances and Products https://www.ontario.ca/laws/regulation/180509

[2] Energy Standard for Buildings Except Low-Rise Residential Buildings https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90.1-2016/90_1_2016_t_v_y_al_an_ao_at_aw_ay...pdf

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions:

Minimum chiller efficiencies provided in Table 6.8.1-3 of ASHRAE 90.1-2016 Energy Standard for Buildings Except Low-Rise Residential Buildings

Table 1 – ASHRAE 90.1-2016 Table 6.8.1-3

Equipment Type	Size Category	Units	Path A	Path B
Air-cooled chillers	< 150 tons	EER (Btu/Wh)	≥ 10.1 FL, ≥ 13.7 IPLV.IP	≥ 9.7 FL, ≥ 15.8 IPLV.IP
Air-cooled chillers	≥ 150 tons	EER (Btu/Wh)	≥ 10.1 FL, ≥ 14.0 IPLV.IP	≥ 9.7 FL, ≥ 16.1 IPLV.IP
Air-cooled without condenser, electrically operated	All capacities	EER (Btu/Wh)	Must be rated with matching condensers and comply with air-cooled chiller efficiency requirements	Must be rated with matching condensers and comply with air-cooled chiller efficiency requirements
Water-cooled, electrically operated, positive displacement	< 75 tons	kW/ton	≤ 0.750 FL, ≤ 0.600 IPLV.IP	≤ 0.780 FL, ≤ 0.500 IPLV.IP
Water-cooled, electrically operated, positive displacement	≥ 75 tons < 150 tons	kW/ton	≤ 0.720 FL, ≤ 0.560 IPLV.IP	≤ 0.750 FL, ≤ 0.490 IPLV.IP
Water-cooled, electrically operated, positive displacement	≥ 150 tons < 300 tons	kW/ton	≤ 0.660 FL, ≤ 0.540 IPLV.IP	≤ 0.680 FL, ≤ 0.440 IPLV.IP
Water-cooled, electrically operated, positive displacement	≥300 tons and <600 tons	kW/ton	≤0.610 FL, ≤0.520 IPLV.IP	≤0.625 FL, ≤0.410 IPLV.IP
Water-cooled, electrically operated, positive displacement	≥600 tons	kW/ton	≤0.560 FL, ≤0.500 IPLV.IP	≤0.585 FL, ≤0.380 IPLV.IP

Water-cooled, electrically operated, centrifugal	< 150 tons	kW/ton	≤ 0.610 FL, ≤ 0.550 IPLV.IP	≤ 0.695 FL, ≤ 0.440 IPLV.IP
Water-cooled, electrically operated, centrifugal	≥ 150 tons < 300 tons	kW/ton	≤ 0.610 FL, ≤ 0.550 IPLV.IP	≤ 0.635 FL, ≤ 0.400 IPLV.IP
Water-cooled, electrically operated, centrifugal	≥300 tons and <400 tons	kW/ton	≤0.560 FL, ≤0.520 IPLV.IP	≤0.595 FL, ≤0.390 IPLV.IP
Water-cooled, electrically operated, centrifugal	≥400 tons and <600 tons	kW/ton	≤0.560 FL, ≤0.500 IPLV.IP	≤0.585 FL, ≤0.380 IPLV.IP
Water-cooled, electrically operated, centrifugal	≥600 tons	kW/ton	≤0.560 FL, ≤0.500 IPLV.IP	≤0.585 FL, ≤0.380 IPLV.IP

Efficient Measure Assumptions:

Efficient equipment must exceed the base measure efficiencies.

Actual equivalent full-load hours (EFLH) can vary based on operating conditions and may result in higher or lower energy savings.[3]

Energy and Demand Savings

Energy Savings[4] [5]

Annual Energy Savings (kWh/yr) = TONS x ($\text{IPLV}_{\text{base}}$ – IPLV_{ee}) x $\text{EFLH}_{\text{cooling}}$

where: TONS – chiller nominal cooling capacity

$\text{IPLV}_{\text{base}}$ – Integrated part load value (kW/ton) of baseline chiller; use Path A values for constant speed chillers and Path B for variable speed chillers (based on proposed case)

IPLV_{ee} – Integrated part load value (kW/ton) for energy efficient chiller from application

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, EFLH for cooling for new and existing buildings provided in section 4.4 HVAC End Use https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[5] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Version 12, Oct. 22, 2024 https://dps.ny.gov/system/files/documents/2024/12/technical-resource-manual-version-12-filed-october-28-2024-effective-january-1-2025.pdf

$EFLH_{cooling}$ – Equivalent full load hours for cooling. If unknown, assume 1,000, or select based on building type

Connected Demand Savings

Demand Savings (kW) = TONS x ($IPLV_{base}$ – $IPLV_{ee}$)

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

End Use Load Profile

EM&V-Commercial-Cooling

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.05112%	0.00000%	0.00000%	0.00000%

Effective Useful Life (EUL)

New York TRM[6] and Minnesota TRM[7] assumes 20 years while Illinois TRM[8] and Wisconsin TRM[9] assume 23 years. Assume 20 years for Ontario.

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[6] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Version 12, Oct. 22, 2024 https://dps.ny.gov/system/files/documents/2024/12/technical-resource-manual-version-12-filed-october-28-2024-effective-january-1-2025.pdf

[7] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Version 4.1, January 31, 2024 https://mn.gov/commerce-stat/trm/releases/4.1.pdf

[8] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[9] Wisconsin Focus on Energy 2024 Technical Reference Manual, Jan. 07, 2024 https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

Revision History

Revision #	Description/Comment	Date Revised
0	New measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020
1	Included as a Quasi-Prescriptive measure	Oct. 2021
2	Updated references and formatting	Dec. 2023
3	Updated Table 1, EM&V peak definition and references	Jan. 2025

Process Chiller

Water-Cooled, Industrial

Measure Description

Energy Efficient Equipment Description

Water-cooled chillers that exceed the minimum efficiency requirements of ASHRAE 90.1-2016 Table 6.8.1-3

Base Equipment Description

Water-cooled chillers that meet the minimum efficiency requirements of ASHRAE 90.1-2016 Table 6.8.1-3

Code, Standards and Regulations

Ontario O.Reg. 509/18[1] - Schedule 4, Section 21

- Applies to water chillers manufactured January 1, 2017 or later
- Applies to vapour-compression, air-cooled chillers with a capacity of < 700 kW (200 ton), AND
- Vapour-compression reciprocating, rotary screw, scroll, or centrifugal water-cooled with a capacity < 8,800 kW (2,500 ton), AND
- Air- or water-cooled single-effect, or direct- or indirect-fired double-effect absorption water chiller.

Minimum chiller efficiencies provided in Table 6.8.1-3 of ASHRAE 90.1-2016 Energy Standard for Buildings Except Low-Rise Residential Buildings[2]

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[1] Ontario O.Reg. 509-18: Energy and Water Efficiency - Appliances and Products https://www.ontario.ca/laws/regulation/180509

[2] Energy Standard for Buildings Except Low-Rise Residential Buildings https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90.1-2016/90_1_2016_t_v_y_al_an_ao_at_aw_ay...pdf

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions:

Minimum chiller efficiencies provided in Table 6.8.1-3 of ASHRAE 90.1-2016 Energy Standard for Buildings Except Low-Rise Residential Buildings

Table 1 – ASHRAE 90.1-2016 Table 6.8.1-3

Equipment Type	**Size Category**	**Units**	**Path A**	**Path B**
Air-cooled chillers	< 150 tons	EER (Btu/Wh)	≥ 10.1 FL, ≥ 13.7 IPLV.IP	≥ 9.7 FL, ≥ 15.8 IPLV.IP
Air-cooled chillers	≥ 150 tons	EER (Btu/Wh)	≥ 10.1 FL, ≥ 14.0 IPLV.IP	≥ 9.7 FL, ≥ 16.1 IPLV.IP
Air-cooled without condenser, electrically operated	All capacities	EER (Btu/Wh)	Must be rated with matching condensers and comply with air-cooled chiller efficiency requirements	Must be rated with matching condensers and comply with air-cooled chiller efficiency requirements
Water-cooled, electrically operated, positive displacement	< 75 tons	kW/ton	≤ 0.750 FL, ≤ 0.600 IPLV.IP	≤ 0.780 FL, ≤ 0.500 IPLV.IP
Water-cooled, electrically operated, positive displacement	≥ 75 tons < 150 tons	kW/ton	≤ 0.720 FL, ≤ 0.560 IPLV.IP	≤ 0.750 FL, ≤ 0.490 IPLV.IP
Water-cooled, electrically operated, positive displacement	≥ 150 tons < 300 tons	kW/ton	≤ 0.660 FL, ≤ 0.540 IPLV.IP	≤ 0.680 FL, ≤ 0.440 IPLV.IP
Water-cooled, electrically operated, positive displacement	≥300 tons and <600 tons	kW/ton	≤0.610 FL, ≤0.520 IPLV.IP	≤0.625 FL, ≤0.410 IPLV.IP
Water-cooled, electrically operated, positive displacement	≥600 tons	kW/ton	≤0.560 FL, ≤0.500 IPLV.IP	≤0.585 FL, ≤0.380 IPLV.IP
Water-cooled, electrically operated, centrifugal	< 150 tons	kW/ton	≤ 0.610 FL, ≤ 0.550 IPLV.IP	≤ 0.695 FL, ≤ 0.440 IPLV.IP
Water-cooled, electrically operated, centrifugal	≥ 150 tons < 300 tons	kW/ton	≤ 0.610 FL, ≤ 0.550 IPLV.IP	≤ 0.635 FL, ≤ 0.400 IPLV.IP

Water-cooled, electrically operated, centrifugal	≥300 tons and <400 tons	kW/ton	≤0.560 FL, ≤0.520 IPLV.IP	≤0.595 FL, ≤0.390 IPLV.IP
Water-cooled, electrically operated, centrifugal	≥400 tons and <600 tons	kW/ton	≤0.560 FL, ≤0.500 IPLV.IP	≤0.585 FL, ≤0.380 IPLV.IP
Water-cooled, electrically operated, centrifugal	≥600 tons	kW/ton	≤0.560 FL, ≤0.500 IPLV.IP	≤0.585 FL, ≤0.380 IPLV.IP

Efficient Measure Assumptions:

Efficient equipment must exceed the base measure efficiencies.

Actual equivalent full-load hours (EFLH) can vary based on operating conditions and may result in higher or lower energy savings.[3]

FL = Full-load chiller efficiency under peak conditions. Use Path A minimum efficiency from Table 6.8.1-3 for constant speed chillers and Path B for variable speed chiller (based on proposed case)

Energy and Demand Savings

Energy Savings[4] [5]

Annual Energy Savings (kWh/yr) = $TONS \times (IPLV_{base} - IPLV_{ee}) \times EFLH_{cooling}$

where: TONS – chiller nominal cooling capacity

$IPLV_{base}$ – Integrated part load value (kW/ton) of baseline chiller; use Path A values for constant speed chillers and Path B for variable speed chillers (based on proposed case)

$IPLV_{ee}$ – Integrated part load value (kW/ton) for energy efficient chiller from application

$EFLH_{cooling}$ – Equivalent full load hours for cooling. If unknown, assume 1,000, or select based on building type

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, EFLH for cooling for new and existing buildings provided in section 4.4 HVAC End Use https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[5] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Version 12, Oct. 22, 2024 https://dps.ny.gov/system/files/documents/2024/12/technical-resource-manual-version-12-filed-october-28-2024-effective-january-1-2025.pdf

Connected Demand Savings

$$\text{Demand Savings (kW)} = \text{TONS} \times (\text{IPLV}_{base} - \text{IPLV}_{ee})$$

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

$$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$$

End Use Load Profile

EM&V-Commercial-Cooling

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.05112%	0.00000%	0.00000%	0.00000%

Effective Useful Life (EUL)

New York TRM[6] and Minnesota TRM[7] assumes 20 years while Illinois TRM[8] and Wisconsin TRM[9] assume 23 years. Assume 20 years for Ontario.

Revision History

Revision #	Description/Comment	Date Revised
0	New measure developed by Posterity Group for 2021-2024 CDM Framework	Dec. 2020

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[6] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Version 12, Oct. 22, 2024 https://dps.ny.gov/system/files/documents/2024/12/technical-resource-manual-version-12-filed-october-28-2024-effective-january-1-2025.pdf

[7] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Version 4.1, January 31, 2024 https://mn.gov/commerce-stat/trm/releases/4.1.pdf

[8] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[9] Wisconsin Focus on Energy 2024 Technical Reference Manual, Jan. 07, 2024 https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

1	Included as a Quasi-Prescriptive measure	Oct. 2021
2	Updated Table 1, EM&V peak definition, references and formatting	Dec. 2023
3	Updated Table 1, EM&V peak definition and references	Jan. 2025

Solar Photovoltaic Systems

Measure Description

Energy Efficient Equipment Description

Installation of rooftop solar photovoltaic (PV) panels to generate clean, renewable energy, reducing reliance on grid electricity and enhancing energy efficiency.

Micro-Generation kW-DC up to 10 kW

Small to Medium Generation kW-AC greater than 10 kW and less than 1 MW

Base Equipment Description

The existing condition where no solar photovoltaic (PV) system is installed.

Code, Standards and Regulations

The Solar Ready Guidelines specify design considerations for new homes to prepare for future solar PV system installations, including structural and electrical modifications[1]. The system must adhere to the Canadian Electrical Code (CEC) Part I (CSA C22.1) for electrical safety and proper system integration[2]. Compliance with CSA standards such as CSA C61215 for photovoltaic modules and CSA C22.2 No. 107.1 for inverters and controllers is also required[3]. The installation must meet local building codes, ensuring structural integrity for rooftop systems and adherence to safety standards. Lastly, net metering regulations, set by local utilities or provincial authorities, may apply depending on the jurisdiction, enabling the system to feed excess power back into the grid.

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[1] Natural Resources Canada. The Solar Ready Guidelines.
Solar Ready Guidelines - Natural Resources Canada
Solar Ready Guidelines

[2] The Canadian Electrical Code (CEC)

[3] The Canadian Electrical Code (CEC)

Resource Savings

Measure Assumptions

Base Measure Demand Assumptions

The base measure assumes the existing condition where no solar photovoltaic (PV) system is installed.

Energy Efficient Measure Demand Assumptions

Energy savings from the installation of the solar photovoltaic (PV) system were estimated using the System Advisor Model (SAM) developed by the National Renewable Energy Laboratory (NREL). The model considered two tilt angles and five orientations (east, southeast, south, southwest, and west), with simulations run for a 1 kW-DC system across 12 different city locations to account for varying climates and solar resource availability. The results from the model incorporate factors such as local weather patterns, shading, and system performance.

The annual energy savings were categorized based on two tilt angles and three groups of orientations: one representing southern-facing orientations (averaging southeast, south, and southwest), one for east-facing orientation, and one for west-facing orientation.

The input assumptions and weather data used in the SAM modeling are provided in the tables below[4]:

Table 1: Input Assumptions used in the SAM Modelling

Input Description	Value	Source/Notes
DC to AC Ratio	1.2	Industry standard
Inverter Efficiency	96%	Supported by a wide range of inverter technologies available in industry research
Total System Losses	18.37%	Derived from an analysis of multiple components (i.e. soiling, shading, etc.) with supporting research from various sources

Table 2: Weather station data* used in the SAM modelling

Location	Station ID
Toronto	1079516
Windsor	999104
London	1035736

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[4] National Renewable Energy Laboratory (NREL). System Advisor Model (SAM). Available at: https://sam.nrel.gov

Ottawa	1188963
Thunder Bay	866511
Sudbury	1017924
Kingston	1163411
Parry Sound	1063901
Dryden	786892
Peawanuck	947989
Niagara Falls	1086528
Walkerton	1038426

*Default in SAM, sourced from the National Solar Radiation Database (NSRDB)

Energy and Demand Savings

Energy Savings

kWhsavings = SystemkW x kWhdeemed

SystemkW is the size of the installed solar PV system, expressed in kW-dc

kWh$_{deemed}$ is the annual energy savings based on a 1 kW-dc system modeled from NREL's SAM (Based on scenarios and city locations). It is expressed in kWh.

Table 3: kWh$_{deemed}$ by Location, Orientation, and Tilt Angle

Location	South Facing with Tilt Angle 22.5°	South Facing with Tilt Angle 37.5°	East Facing with Tilt Angle 22.5°	East Facing with Tilt Angle 37.5°	West Facing with Tilt Angle 22.5°	West Facing with Tilt Angle 37.5°
Toronto	1185	1198	1031	983	1020	966
Windsor	1205	1212	1055	1001	1039	978
London	1157	1163	1014	963	1008	955
Ottawa	1125	1152	970	935	949	903
Thunder Bay	1125	1161	954	922	954	919
Sudbury	1101	1131	942	910	932	895
Kingston	1141	1160	995	955	973	922
Parry Sound	1145	1164	988	945	985	943
Dryden	1037	1071	883	856	884	857
Peawanuck	1052	1108	854	834	880	868

Niagara Falls	1129	1129	997	945	992	937
Walkerton	1128	1135	995	951	988	942

Connected Demand Savings

Connected Demand Savings = SystemkW x kW_{deemed}

kW_{deemed} is the average reduction in electricity demand from the grid during the peak demand period of 3 PM to 9 PM on summer weekdays (from June 1 to September 30).

Table 4: kW_{deemed} by Location, Orientation, and Tilt Angle

Location	**South Facing with Tilt Angle 22.5°**	**South Facing with Tilt Angle 37.5°**	**East Facing with Tilt Angle 22.5°**	**East Facing with Tilt Angle 37.5°**	**West Facing with Tilt Angle 22.5°**	**West Facing with Tilt Angle 37.5°**
Toronto	0.1361	0.1298	0.0665	0.0412	0.2030	0.2302
Windsor	0.1534	0.1457	0.0757	0.0444	0.2277	0.2572
London	0.1464	0.1397	0.0705	0.0419	0.2182	0.2476
Ottawa	0.1090	0.1043	0.0503	0.0323	0.1703	0.1948
Thunder Bay	0.1709	0.1651	0.0911	0.0582	0.2383	0.2654
Sudbury	0.1326	0.1274	0.0664	0.0429	0.1964	0.2220
Kingston	0.1145	0.1098	0.0557	0.0368	0.1743	0.1986
Parry Sound	0.1373	0.1309	0.0649	0.0386	0.2091	0.2379
Dryden	0.1237	0.1203	0.0589	0.0402	0.1881	0.2155
Peawanuck	0.1465	0.1426	0.0728	0.0476	0.2135	0.2419
Niagara Falls	0.1352	0.1292	0.0626	0.0380	0.2076	0.2373
Walkerton	0.1458	0.1398	0.0700	0.0420	0.2196	0.2504

Summer Peak Demand Savings

Peak Demand Savings (kW_{peak}) = $kWhs_{avings}$ x SPDF

SPDF = Summer Peak Demand Factor

Lifetime Energy Savings

Lifetime Energy Savings (kWh) = $\sum_{i=1}^{EUL} Annual\ Energy\ Savings \times (1 - Degrade\_Rate)^{i-1}$

Degrade_Rate is the degradation rate and assumed to be 0.5%[5]

End Use Load Profile

Custom Load Profile based on consultant – Resource Innovations

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
Various	0.00000%	N/A	0.00000%

Effective Useful Life (EUL)

This measure is assumed to last 20 years[6]

Revision History

Revision #	**Description/Comment**	**Date Revised**
0	Measure Substantiation sheet created by Resource Innovations	Jan-2025

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[5] National Renewable Energy Laboratory (NREL). Lifetime of PV Panels https://www.nrel.gov/state-local-tribal/blog/posts/stat-faqs-part2-lifetime-of-pv-panels.html

[6] National Renewable Energy Laboratory (NREL). Lifetime of PV Panels. https://www.nrel.gov/state-local-tribal/blog/posts/stat-faqs-part2-lifetime-of-pv-panels.html

Variable Speed Domestic Cold Water Booster Pump System

Measure Description

Energy Efficient Equipment Description

Optimized domestic cold water booster pump capacity with VFD controls for high-rise residential and commercial buildings.

Base Equipment Description

Existing domestic cold water booster pump system with constant speed motor for high-rise residential and commercial buildings.

Code, Standards and Regulations

OBC SB-10 Division 3 Energy Efficiency Design After December 31 2016 requires booster pump systems of all new built commercial buildings or major retrofits must conform to the ASHRAE 90.1-2013. The code does not apply to the upgrading of existing booster systems as it is not considered as new built or major retrofits.

Resource Savings Assumptions

Measure Assumptions

Base Measure: Existing constant speed booster pump system.

Conservation Measure: Optimized booster pump capacity with VFD controls.

Energy and Demand Savings

Energy Savings

Energy savings assumption: energy savings algorithm was developed based on the adjusted Pump Affinity Law and accepted for previous Retrofit custom track projects:

$$\Delta\text{kWh} = 0.746 * 365 * \frac{\text{LF}}{\text{Eff}} * \{\sum_{t=0}^{t=23} (\text{FF}_{\text{base}})^{2.5} \quad * HP_{base} - \sum_{t=0}^{t=23} (\text{FF}_{\text{ee}})^{2.5} \quad * \text{HP}_{\text{ee}}\}$$

Terms	Unit	Value
ΔkWh, Annual Energy Savings	kWh	Calculated
0.746, Conversion from horsepower to kW	kW/hp	0.746
LF, Load Factor based on average of Daily Operating Hours (see Daily Operating Hours & Flow Factors in Ontario provided by manufacturer)	%	60%
Eff, Motor Efficiency, assuming 85%	%	85%
t, Time of a day	hour	0 - 23
FF_{base}, Base Case Average Flow Factor, constant speed	%	100
FF_{ee}, Energy Efficient Case Flow Factor, average of Daily Flow Factors (see Typical Daily Operating Hours & Flow Factors in Ontario provided by manufacturer)	%	Table 1
HP_{base}, Base Case Motor Horsepower, assumed based on End-Use	hp	Entered by Administrator
HP_{ee}, Energy Efficient Case Motor horsepower	hp	Applicant Input

Quasi Prescriptive Construct: $\Delta\text{kWh} = \text{A x B}$

where: $\text{A} = 0.746 * 365 * \frac{LF}{Eff} * 24 * \{\text{HP}_{\text{ratio}} - (\text{FF}_{\text{ee}})^{2.5}\}$

$\text{B} = \text{HPee}$

HP_{ratio} - base case and energy efficient case horsepower ratio (Table 1)

FF_{ee} - energy efficient case flow factor (%) derived for different end-uses (Table 1)

A - Energy Savings Factor (kWh/hp) calculated (Table 1)

B – Hpee; energy efficiency total horsepower (hp); applicant input

Table 1 – Energy Savings Factor

End Use	**HP_{ratio} (%)**	**FF_{ee} (%)**	**A (kWh/hp)**
Residential Installation	130.00	58	4,815
Office Installation	110.00	48	4,338
Hotel Installation	110.00	54	4,086

Connected Demand Savings

Connected Demand Savings (ΔkW) = $0.746 * (\text{HPbase} - \text{HPee})$

Quasi Prescriptive Construct: $\Delta \text{kW} = \text{B x C}$

where: C - connected demand factor (kW/hp); 3rd variable of Quasi Prescriptive Construct, Administrator Input (Table 2)

$C = 0.746 \text{ x } (HP_{ratio} - 1)$

Table 2 – Connected Demand Factor

End Use	C (kW/hp)
Residential Installation	0.2238
Office Installation	0.0746
Hotel Installation	0.0746

Summer Peak Demand Savings

EM&V Peak Demand Savings (ΔkWpeak): $\Delta \text{KWpeak} = \Delta \text{kWh} * \text{SPDF}$

Quasi Prescriptive Construct: $\Delta \text{kWpeak} = \text{A x B x SPDF}$

End Use Load Profile

To be defined (custom)

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
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Effective Useful Life (EUL)

Measure	EUL (years)
VFD Domestic Cold Water Booster Pump System	15[1]

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[1] TRM Program Year 2023 https://hawaiienergy.com/about/information-reports/

Revision History

Revision #	Description/Comment	Date Revised
0	New Measure created for Bi-Annual Changes	Mar 2022
1	Updated references and formatting	Oct. 2023

Appendix – Daily Operating Hours & Flow Factors

Table 3 – Daily Flow Factor for Residential End-User

Hour	FFbase (Duty-Standby)	FFbase (Duty-Standby)	FFee (Duty-Standby)	FFee (Duty-Standby)	FFee (Duty-Standby)	FFee (Duty-Standby)	FFee (Lead-Lag)	FFee (Lead-Lag)
Hour	**Duty**	**Standby**	**Duty**	**Standby**	**Lead**	**Lag**	**Lead**	**Lag**
0:00	100%	0%	53%	0%	100%	0%	61%	0%
1:00	100%	0%	41%	0%	100%	0%	48%	0%
2:00	100%	0%	33%	0%	100%	0%	38%	0%
3:00	100%	0%	29%	0%	100%	0%	%	0%
4:00	100%	0%	29%	0%	100%	0%	33%	0%
5:00	100%	0%	35%	0%	100%	0%	41%	0%
6:00	100%	0%	53%	0%	100%	0%	61%	0%
7:00	100%	0%	70%	0%	100%	0%	79%	0%
8:00	100%	0%	76%	0%	100%	100%	44%	44%
9:00	100%	0%	73%	0%	100%	100%	41%	41%
10:00	100%	0%	76%	0%	100%	100%	42%	42%
11:00	100%	0%	78%	0%	100%	100%	43%	43%
12:00	100%	0%	78%	0%	100%	100%	43%	43%
13:00	100%	0%	71%	0%	100%	0%	78%	0%
14:00	100%	0%	68%	0%	100%	0%	76%	0%
15:00	100%	0%	62%	0%	100%	0%	69%	0%
16:00	100%	0%	65%	0%	100%	0%	73%	0%
17:00	100%	0%	67%	0%	100%	0%	75%	0%
18:00	100%	0%	73%	0%	100%	100%	41%	41%
19:00	100%	0%	76%	0%	100%	100%	42%	42%
20:00	100%	0%	80%	0%	100%	100%	44%	44%
21:00	100%	0%	81%	0%	100%	100%	45%	45%
22:00	100%	0%	74%	0%	100%	100%	41%	41%
23:00	100%	0%	65%	0%	100%	0%	73%	0%

Table 4 – Daily Flow Factor for Office/Commercial End User

Hour	FFbase (Duty-Standby)	FFbase (Duty-Standby)	FFee (Duty-Standby)	FFee (Duty-Standby)	FFbase (Lead-lag)	FFbase (Lead-lag)	FFee (Lead-Lag)	FFee (Lead-Lag)
Hour	**Duty**	**Standby**	**Duty**	**Standby**	**Lead**	**Lag**	**Lead**	**Lag**
0:00	100%	0%	26%	0%	100%	0%	40%	0%
1:00	100%	0%	25%	0%	100%	0%	38%	0%
2:00	100%	0%	24%	0%	100%	0%	36%	0%
3:00	100%	0%	23%	0%	100%	0%	36%	0%
4:00	100%	0%	25%	0%	100%	0%	38%	0%
5:00	100%	0%	28%	0%	100%	0%	42%	0%
6:00	100%	0%	45%	0%	100%	0%	67%	0%
7:00	100%	0%	53%	0%	100%	0%	77%	0%
8:00	100%	0%	58%	0%	100%	0%	78%	0%
9:00	100%	0%	66%	0%	100%	100%	45%	45%
10:00	100%	0%	71%	0%	100%	100%	50%	50%
11:00	100%	0%	73%	0%	100%	100%	50%	50%
12:00	100%	0%	75%	0%	100%	100%	52%	52%
13:00	100%	0%	75%	0%	100%	100%	51%	51%
14:00	100%	0%	71%	0%	100%	100%	49%	49%
15:00	100%	0%	69%	0%	100%	100%	47%	47%
16:00	100%	0%	61%	0%	100%	100%	43%	43%
17:00	100%	0%	51%	0%	100%	0%	74%	0%
18:00	100%	0%	39%	0%	100%	0%	57%	0%
19:00	100%	0%	34%	0%	100%	0%	51%	0%
20:00	100%	0%	30%	0%	100%	0%	44%	0%
21:00	100%	0%	29%	0%	100%	0%	43%	0%
22:00	100%	0%	32%	0%	100%	0%	49%	0%
23:00	100%	0%	25%	0%	100%	0%	37%	0%

Table 5 – Daily Flow Factor for Hotel/Hospitality End User

Hour	FFbase (Duty-Standby)	FFbase (Duty-Standby)	FFee (Duty-Standby)	FFee (Duty-Standby)	FFbase (Lead-lag)	FFbase (Lead-lag)	FFee (Lead -Lag)	FFee (Lead -Lag)
Hour	**Duty**	**Standby**	**Duty**	**Standby**	**Lead**	**Lag**	**Lead**	**Lag**
0:00	100%	0%	41%	0%	100%	0%	51%	0%
1:00	100%	0%	30%	0%	100%	0%	40%	0%
2:00	100%	0%	28%	0%	100%	0%	46%	0%
3:00	100%	0%	23%	0%	100%	0%	32%	0%
4:00	100%	0%	21%	0%	100%	0%	30%	0%
5:00	100%	0%	28%	0%	100%	0%	41%	0%
6:00	100%	0%	51%	0%	100%	0%	67%	0%
7:00	100%	0%	73%	0%	100%	100%	44%	44%
8:00	100%	0%	78%	0%	100%	100%	46%	46%
9:00	100%	0%	79%	0%	100%	100%	47%	47%
10:00	100%	0%	72%	0%	100%	100%	43%	43%
11:00	100%	0%	68%	0%	100%	100%	41%	41%
12:00	100%	0%	60%	0%	100%	0%	74%	0%
13:00	100%	0%	57%	0%	100%	0%	70%	0%
14:00	100%	0%	56%	0%	100%	0%	69%	0%
15:00	100%	0%	54%	0%	100%	0%	66%	0%
16:00	100%	0%	56%	0%	100%	0%	67%	0%
17:00	100%	0%	57%	0%	100%	0%	70%	0%
18:00	100%	0%	55%	0%	100%	0%	68%	0%
19:00	100%	0%	52%	0%	100%	0%	66%	0%
20:00	100%	0%	52%	0%	100%	0%	68%	0%
21:00	100%	0%	54%	0%	100%	0%	66%	0%
22:00	100%	0%	60%	0%	100%	0%	76%	0%
23:00	100%	0%	51%	0%	100%	0%	66%	0%

Energy Management Information System (EMIS)

Measure Description

Energy Efficient Equipment Description

Energy Management Information Systems (EMIS) shall be in accordance with NRCan's Guidelines, ISO 50001 compliant energy management systems recognized by the 50001 Ready Canada program, ISO 50001 certified energy management systems, or Superior Energy Performance certified energy management systems, or other custom approaches.

EMIS shall include the following capabilities as a minimum - Energy Review, Energy Baseline, Energy performance indicators, Energy objectives, Targets and action plans, Competence, Training and awareness; and Compliance

Base Equipment Description

There is no energy management information system currently installed in the industrial facility or augmentation to the existing EMIS on site.

Code, Standards and Regulations

There is no applicable codes, standards or regulations.

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Total Facility Annual Baseline Energy Consumption in Gigajoule (GJ) including all fuel types including electricity, natural gas, propone, oil, etc.

Energy Efficient Measure Assumptions

The percentage of electricity is assumed 30%

The percentage of other fuel types is assumed 70%

The percentage of savings of the annual baseline energy consumption is assumed 6% attributed to the EMIS energy efficiency measure.

Electricity Fuel savings is 1.8% (30% x 6%) and other fuel savings is 4.2% (70% x 6%)

Conversion Factor from GJ to kWh is 277.778 kWh/GJ

Assumed Hours of Operation

Operating hours are based on facility types as follows:

1-shift (8/5) 1,976 hours 7 AM – 3 PM, weekdays, minus some holidays and scheduled down time

2-shift (16/5) 3,952 hours, 7AM – 11 PM, weekdays, minus some holidays and scheduled down time

3-shift (24/5) 5,928 hours 24 hours per day, weekdays, minus some holidays and scheduled down time

4-shift (24/7) 8,320 hours 24 hours per day, 7 days a week minus some holidays and scheduled down time

Weighted average 5,702 hours (Weighting of 16% single shift, 23% two shift, 25% three shift and 36% continual based on DOE evaluation of the Compressed Air Challenge

Energy and Demand Savings

Energy Savings

Annual Electricity Energy Savings (kWh/yr) = Annual Energy Consumption (GJ) x 277.778 kWh/GJ x 6% x 30%

Connected Demand Savings

Demand Savings (kW) = Annual Electricity Energy Savings (kWh/yr) ÷ 5,702 hours/yr

Summer Peak Demand Savings

Summer Peak demand savings kW_{peak} are calculated by multiplying the Annual Energy Savings kWh with the Summer Peak Demand Factor from the Energy Load Profile. Refer to CE Tool for the formatted load shapes:

kW_{peak} = Annual Electricity Energy Savings (kWh/yr) * Summer Peak Demand Factor (SPDF)

End Use Load Profile

Load Profile Name: PSP-Industrial-Miscellaneous_Industrial-Process_Other

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01142%	0.01142%	0.01142%	0.01142%

Effective Useful Life (EUL)

Energy Management Information System is assumed an effective useful life of 15 years

Revision History

Revision #	Description/Comment	Date Revised
0	Subsheet created	November 2024

Injection Moulding Machine

Measure Description

The plastic injection molding industry has a long history that dates back to the 19th century in Europe and America. Throughout the decades, many chemists and inventors have used a wide variety of plastic materials in the process.

However, the types of presses and machines used in the injection molding process have boiled down to two: Hydraulic and Electric with a Hybrid machine available.

Hydraulic injection molding presses were historically the only option available until a company in Japan introduced the first electric machine in 1983. Since then, electric machines have risen in popularity. However, hydraulic machines continue to be the most widely used type available everywhere except Japan.

One of the big reasons hydraulic machines continued to dominate injection molding is because the machine itself was cheaper than electronic machines. However, the benefits of electric machines often offset that initial cost over the long haul.

Electric Machine Benefits

Traditional hydraulic injection molding machines are less efficient than electric machines because they consume energy even while in idle. Electric injecting molding machines only use energy when in action, meaning the motor output is only equal to that of the load requirements.

Electric machines are digitally controlled while hydraulic systems are driven by hoses, valves and pipes – leading to much of the lost energy. All-electric machines have the benefit of being higher speed and more efficient during the whole process because independent motors control everything from the injection to extruder to clamping and ejection.

The process can be tuned in faster with electric presses rather than a hydraulic press because hydraulic presses have a lot more components and fluids that have to come up to temperature. This allows for less start-up and run scrap, when using an electric press which saves money.

This all adds up to a faster, tighter, cleaner and more repeatable process with less waste, leading to an average energy reduction of 50 to 75 percent when compared to hydraulic machines.

Another benefit to all-electric machines is there is no chance of leakage, meaning there is less down time and material contamination. And because there is no oil or filters to replace, consumable expenses are less.

The Hybrid Option

Some have gone to a hydraulic-electric machine that offers some energy saving benefits of electric machines along with some of the added power hydraulic machines offer. However, because three of the four axes typically are hydraulic, the efficiency and energy loss makes these machines less optimal than the electric injection molding machines.

Although electric machines may be more expensive than hydraulic machines, the savings over time are dramatic, justifying the investment. This maximized performance allows companies that use all-electric injection molding machines to deliver the best products and solutions for manufacturing partners.

At Pleasant Precision Inc., we use efficient electric injection molding machines that always deliver the best quality possible. This is one of the reasons we have built a strong record of delivering high precision and success to our partners while performing under the tightest tolerances in the plastics industry.

Code, Standards and Regulations

No applicable code, standard or regulations govern the energy consumption for industrial molding machines

Resource Savings Assumptions

Measure Assumptions

Savings assumption is based on actual savings from custom applications for Injection Molding Machines in the Conservation First and Interim Framework.

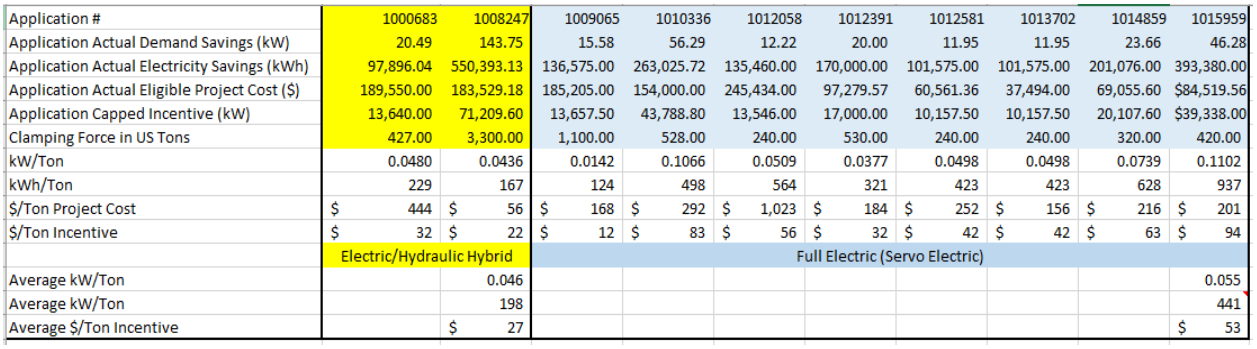
Energy and Demand Savings

Energy Savings Assumption:

The energy savings assumption is based on actual savings from custom applications for Injection Molding Machines in the Conservation First and Interim Framework.

Injection Molding Machine – Full Electric (Servo Electric) – 441 kWh/Clamping Ton

Injection Molding Machine – Electric/Hydraulic Hybrid – 198 kWh/Clamping Ton



Application #	1000683	1008247	1009065	1010336	1012058	1012391	1012581	1013702	1014859	1015959
Application Actual Demand Savings (kW)	20.49	143.75	15.58	56.29	12.22	20.00	11.95	11.95	23.66	46.28
Application Actual Electricity Savings (kWh)	97,896.04	550,393.13	136,575.00	263,025.72	135,460.00	170,000.00	101,575.00	101,575.00	201,076.00	393,380.00
Application Actual Eligible Project Cost ($)	189,550.00	183,529.18	185,205.00	154,000.00	245,434.00	97,279.57	60,561.36	37,494.00	69,055.60	$84,519.56
Application Capped Incentive (kW)	13,640.00	71,209.60	13,657.50	43,788.80	13,546.00	17,000.00	10,157.50	10,157.50	20,107.60	$39,338.00
Clamping Force in US Tons	427.00	3,300.00	1,100.00	528.00	240.00	530.00	240.00	240.00	320.00	420.00
kW/Ton	0.0480	0.0436	0.0142	0.1066	0.0509	0.0377	0.0498	0.0498	0.0739	0.1102
kWh/Ton	229	167	124	498	564	321	423	423	628	937
$/Ton Project Cost	$ 444	$ 56	$ 168	$ 292	$ 1,023	$ 184	$ 252	$ 156	$ 216	$ 201
$/Ton Incentive	$ 32	$ 22	$ 12	$ 83	$ 56	$ 32	$ 42	$ 42	$ 63	$ 94
	Electric/Hydraulic Hybrid		Full Electric (Servo Electric)							
Average kW/Ton		0.046								0.055
Average kW/Ton		198								441
Average $/Ton Incentive		$ 27								$ 53

Connected Demand Savings Assumption:

The connected demand savings assumption is based on actual savings from custom applications for Injection Molding Machines in the Conservation First and Interim Framework.

Injection Molding Machine – Full Electric (Servo Electric) – 0.055 kW/Clamping Ton

Injection Molding Machine – Electric/Hydraulic Hybrid – 0.046 kW/Clamping Ton

Summer Peak Demand Savings

Summer Peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkW_{peak} = ΔkWh * Summer Peak Demand Factor

$\Delta kW_{peak\ (Servo)}$ = 441 kWh x 0.011415525% = 0.050 kW/Clamping Ton

$\Delta kW_{peak\ (Hybrid)}$ = 198 kWh x 0.011415525% = 0.023 kW/ClampingTon

End Use Load Profile

PSP-Industrial-Miscellaneous_Industrial-Process_Other

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01142%	0.01142%	0.01142%	0.01142%

Effective Useful Life (EUL)

Measure	EUL (years)
Injection Molding Machine	20[1]

Revision History

Revision #	Description/Comment	Date Revised
0	New measure created for Bi-Annual Changes	Nov. 2021
1	Updated references and formatting	Dec. 2023
2	Updated EM&V peak definition, moved Incremental Costs to Appendix A and references	Jan. 2025

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[1] 2024 Michigan Energy Measures Database
https://www.michigan.gov/mpsc/regulatory/energy-optimization/michigan-energy-measures-database

Greenhouse Advanced Lighting Control

Measure Description

Energy Efficient Equipment Description

A horticultural lighting control system that is capable of using weather forecasts and PAR sensors/broad spectrum light sensor to automatically control the on/off/dimming of luminaires and devices based on the grower's lighting recipes. The system must also be capable of the following lighting control strategies: continuous dimming, zoning and scheduling. The system must also have reporting/trending capabilities, at the minimum, it must be able to report on the lighting runtime per zone.

Base Equipment Description

LED/HID/fluorescent lighting systems with no existing controls or basic lighting control systems

Code, Standards and Regulations

No codes, standards and regulations exist for this measure.

Resource Savings Assumptions

Measure Assumptions

Assumed Crops

Based on feedback from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and histroical Retrofit participation data, tomatoes, peppers, and cucumbers are the most popular crops grown in southern Ontario greenhouses. For simplicity, all crops are assumed to be summer crops planted in December and final harvest in October with a few weeks after final harvest for clean out before the next crop is planted. All crops are assumed to be production stage (i.e. seedling and grafting stage of the plant is grown in a different location).

Table 1 - Crop Assumptions

Crop	Tomatoes	Peppers	Cucumbers
$DLI_{required}$ (mol/m^2/day)[1]	35	37.5	27.5
Photoperiod (hrs)[1]	18	20	18
PPFD (μmol/s/m^2)[2]	429	429	259
# of harvests per year[3]	1 (30 days)	1 (30 days)	5 (30 days)

Energy Efficient Assumed Hours of Use

The horticultural lighting control system is assumed to automatically control the grow lights run time to meet the crops lighting needs based on sun light availability.

$DLI_{supplemental} = DLI_{required} – (DLI_{sunlight} \times TLF)$

where: $DLI_{supplemental}$ – daily light integral required to be supplemented by the grow lights (mol/m^2/day)

$DLI_{required}$ – daily light integral required for the crop (mol/m^2/day); see Table 1

$DLI_{sunlight}$ – average daily light integral from 2010-2021 (mol/m^2/day)

TLF – transmission loass factor; assume 25% light loss from outside to inside the greenhouse

$DHOU = DLI_{supplemental} / (PPFD \times 1{,}000{,}000 \times 3600)$

where: DHOU - daily hours of use; grow light daily hours of use capped at the photoperiod (hrs); see Table 1.

PPFD - Photosynthetic photon flux density (μmol/s/m^2); see Table 1

Annual Hours of Use_{EE} – sum of the daily hours of use minus the downtime during harvesting/cleaning/replanting where the grow lights are assumed to be off.

Annual Hours of $Use_{EE} = \Sigma$ ($DHOU_i$ - # of harvests per year) for all days

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[1] Lumigrow, "LED grower's guide for vine crops," https://lumigrow.com/wp-content/uploads/2017/07/LumiGrow-LED-Growers-Guide-for-Vine-Crops-1.pdf

[2] The assumed Photosynthetic Photon Flux Density (PPFD) are derived from actual LED grow light Retrofit applications.

[3] For tomatoes and peppers, the assumed grow light down time for harvesting/clean up/ replanting is four weeks; for cucumbers, the assumed grow light down time for harvesting/clean up/ replanting is one week.

Table 2 – Energy Efficient Hours of Use

Crop	**Annual Hours of Use$_{EE}$[4]**
Tomatoes	2848
Peppers	3339
Cucumbers	2784

Assumed location

The assumed site location of the greenhouse (for calculating the sunlight availability) is Kingsville, Ontario. The daily light integral (DLI) for the location was averaged from 2010-2021 for "All Sky Surface Photosynthetically Active Radiation (PAR)".[5]

Energy and Demand Savings

Annual Energy Savings (kWh/yr) = $kW_{controlled}$ x SF x HOU

where: $kW_{controlled}$ – total lighting wattage controlled by the horticultural lighting control system from participant data

SF – control savings factor; calculated by dividing the average annual hours of use of the energy efficient case by the average basline annual hours of use; assume 0.14%

HOU – average baseline annual hours of use between the three crops; assume 3488 hours; the baseline grow lights operates based on the photoperiod per crop; grow lights are assumed to be off from May 1 to September 30.

Annual Hours of Use_{BL} = Σ ($Photoperiod_i$ - # of harvests per year) for all days

Table 3 – Baseline Hours of Use

Crop	**Annual Hours of Use$_{BL}$[6]**
Tomatoes	3294
Peppers	3660
Cucumbers	3510
Average	**3488**

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There are no connected demand savings attributable to this measure.

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[4] See "Horticultural Lighting Controls savings assumptions.xlsx" for full calculations

[5] NASA, Prediction Of Worldwide Energy Resources, https://power.larc.nasa.gov/data-access-viewer/

[6] See "Horticultural Lighting Controls savings assumptions.xlsx" for full calculations

Summer Peak Demand Savings

There are no summer peak demand savings for this measure.

Effective Useful Life (EUL)

Measure	EUL (years)
Greenhouse advanced lighting control	16[7]

Revision History

Revision #	Description/Comment	Date Revised
0	Horticultural Lighting Controls	Aug. 2022
1	Updated references and formatting	Jan. 2024
2	Updated Peak Demand Savings	Jan. 2025

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[7] Assumed to be same as the Networked Lighting Controls, 2020 Wisconsin Focus on Energy Technical Reference Manual https://s3.us-east-1.amazonaws.com/focusonenergy/staging/Focus_on_Energy_2020_TRM.pdf

Networked Lighting Controls

Measure Description

Energy Efficient Equipment Description

A networked lighting control (NLC) system that meets the DesignLights Consortium (DLC) Networked Lighting Control specifications. In order for a networked lighting control system to be DLC listed, it must be capable of networking luminaires and devices, occupancy sensing, daylight harvesting, high-end trim, zoning, addressability of luminaires and devices, and continuous dimming[1]. Controls must be listed and approved by the Design Light Consortium (DLC).

For an NLC system to be DLC qualified, it must have the following system capabilities:

- Networking of Luminaires and Devices
- Occupancy Sensing
- Daylight Harvesting
- High End Trim
- Zoning
- Luminaire and Device Addressability
- Continuous Dimming

Base Equipment Description

The baseline condition is an LED or fluorescent lighting systems with no existing controls or basic lighting control systems.[2]

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[1] Design Lights Consortium, Networked Lighting Control Systems Technical Requirements, version NLC5, updated June 23, 2023 https://www.designlights.org/our-work/networked-lighting-controls/technical-requirements/nlc5/

[2] Focus on Energy, "Wisconsin Focus on Energy 2019 Technical Reference Manual," Public Service Commission of Wisconsin, 2019. https://focusonenergy.com/evaluation-reports/wisconsin-focus-on-energy-technical-reference-manual-program-year-2019

Code, Standards and Regulations

No codes and standards applicable for this measure.

Resource Savings

Measure Assumptions

$LPD_{controlled}$ (W/ft^2) – lighting wattage controlled

SF (%) – savings factor for advanced lighting controls

HOU – average annual run hours

Table 1 - Lighting hours based on Facility Types

Facility Type	Assumed Annual Operating Hrs
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	4089
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	3759

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = ($LPD_{controlled}$ /1000) x SF x HOU

Table 2 – Input Assumptions for Annual Energy Savings Calculation

Facility Type	Lighting Power Density (W/ft²)[3]	Average Savings Factor[4]	SF x HOU
Lighting - Food Retail	0.61	0.47	2,854.78
Lighting – Hospital	1.05	0.47	2,435.54
Lighting - Large Hotel (Corridor/Lobby)	0.75	0.47	3,705.48
Lighting - Large Non-Food Retail	1.06	0.44	1,799.16
Lighting - Large Office	0.79	0.63	2,274.30
Lighting - Nursing Home	0.61	0.47	2,024.76
Lighting - Other Commercial Buildings	0.61	0.47	1,342.79
Lighting - Other Non-Food Retail	1.06	0.44	1,799.16
Lighting – Restaurant	0.82	0.47	2,401.70
Lighting – Schools	0.82	0.47	1,220.12
Lighting - University Colleges	0.81	0.28	911.40
Lighting - Warehouse Wholesale	0.9	0.82	3,082.38

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There are no connected demand savings attributable to this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkW_{peak} = ΔkWh * Summer Peak Demand Factor

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

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[3] From table 9.5.1 in the OBC SB-10 Supplementary Standard. Nursing Homes, Food Retail and Other Commercial are not listed in the SB-10 Supplementary Standard so Focus on Energy's default value of 0.61 W/ft2 was used.

[4] From Table 5, in DLC's report on Energy Savings from Networked Lighting Controls. Where unknown, the average value of 0.47 was used.

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

EM&V Peak Definition

Table 3 – EM&V Peak Definition

Lighting End Use	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%

Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%

Effective Useful Life (EUL)

Measure	EUL (years)
Networked Lighting Controls	15[5]

Revision History

Revision #	Description/Comment	Date Revised
0	Networked Lighting Controls	Jul. 2020
2	Updated EM&V peak definition, formatting and references	Jan. 2025

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[5] Wisconsin Focus on Energy 2024 Technical Reference Manual, Jan. 07, 2024. https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

Add Door to Open Refrigerated Display Case

Measure Description

Energy Efficient Equipment Description

Retrofitting doors to existing refrigerated display cases. The doors are designed to fit right onto the open multi-deck style cases with minimal case modification. The measure savings are based on a per linear foot of case enclosed.

Base Equipment Description

Open multi-deck refrigerated display case

Code, Standards and Regulations

No codes, standards and regulations exist for this measure.

Resource Savings Assumptions

Energy and Demand Savings[1]

Energy Savings

Annual Energy Savings (kWh/yr) = P_c x F_i x (1- F_{CR}) / 3412 x (LF x 8760 / COP_R - HRS_c / COP_H) x LEN

where: LEN - case length in feet

P_c - total case load in Btu/hr per linear foot; assume 1500 Btuh/ft for cooler and 1850 Btuh/ft for freezer

F_i - amount of case load associated with infiltration reduction; assume 68%

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[1] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs v4.0, Jan. 31, 2023 https://mn.gov/commerce-stat/trm/releases/4.0.pdf

F_{CR} – amount of case load associated with conduction and radiation; assume 13%

3412 – conversion factor, Btu/h per kW

LF – case load factor, the compressor duty cycle needed to maintain case temperatures; assume 62% for cooler and 80% for freezer

8760 – annual operating hours

COP_R – coefficient of performance of refrigeration system; assume 2.5 for cooler and 1.3 for freezer

HRS_c – annual cooling hours; assume 3228[2]

COP_H – cooling coefficient of performance of HVAC system; assume 3.2

Table 1 – Annual Energy Savings per Linear Ft (kWh/linear ft)

Refrigeration Equipment	Annual Energy Savings (kWh/ft)
Cooler	302.67
Freezer	1,405.61

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There is no connected demand savings for this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 2 – Summer Peak Demand Savings per Linear Ft (kW/linear ft)

Refrigeration Equipment	Summer Peak Demand Savings (kWh/ft)
Cooler	0.043
Freezer	0.200

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[2] CDD x 24 hrs / (average temperature above balance point of 65F – 65F). CDD65=547. Average temp above balance pt = 69.06F

End Use Load Profile

PSP-Business-Commercial-Refrigerated_Display_Case_Food Retail

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01422%	0.01220%	0.02406%	0.01579%

Effective Useful Life (EUL)

Measure	EUL (years)
Add door to refrigerated display case	15[3]

Revision History

Revision #	Description/Comment	Date Revised
0	Substantiation sheet created	Feb. 2022
1	Updated formatting and reference	Jan. 2024
2	Updated EM&V peak definition, Peak Demand savings formatting and references. Removed Section for Calculating Other Resource Savings	Jan. 2025

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[3] PG&E Workpaper, “Add Doors to Open Medium Temperature Cases – PGE3PREF116R3”, June 2019.

Refrigeration Compressors

Measure Description

Energy Efficient Equipment Description

This measure involves the purchase and installation of a high-efficiency discus or scroll compressor in a refrigeration system. The high-efficiency discus or scroll compressor increases operating efficiency and reduces energy consumption of the system. The measure savings are based on a per compressor horsepower (HP) of the refrigerated system.

Base Equipment Description

Standard discus or scroll compressor in a refrigeration system

Code, Standards and Regulations

Not Applicable. Currently there is no energy efficiency regulations for refrigeration compressors but rather at the federal level, there are energy efficiency regulations for the commercial refrigeration equipment such as commercial refrigerators, refrigerator-freezers, freezers, walk-in freezer, walk-in coolers and display cabinets.[1,2]

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[1] https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/6861

[2] https://www.ontario.ca/laws/regulation/180509#BK11

Resource Savings

Measure Assumptions

Table 1 – Compressor kWh Savings per HP (kWh/hp)

Compressor Type	Low Temperature (-35°F to -5°F SST) (Ref. Temp -20°F SST)	Medium Temperature (0°F to 30°F SST) (Ref. Temp 20°F SST)	High Temperature (35°F to 55°F SST) (Ref. Temp 45°F SST)	Average
Discus	517	601	652	590.00
Scroll	208	432	363	334.33

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = $HP_{compressor}$ x Compressor kWh Savings per HP

Annual Energy Savings (kWh/yr) = HP_{discus} x 590

Annual Energy Savings (kWh/yr) = HP_{scroll} x 334.33

Table 2 – Annual Energy Savings for Various Compressor Sizes (kWh/yr)

Compressor Type	HP	Low Temp	Medium Temp	High Temp	Average
Discus	3	1,551	1,803	1,956	1,770
Discus	4	2,068	2,404	2,608	2,360
Discus	5	2,585	3,005	3,260	2,950
Discus	6	3,102	3,606	3,912	3,540
Scroll	2	416	864	726	669
Scroll	3	624	1,296	1,089	1,003
Scroll	4	832	1,728	1,452	1,337
Scroll	5	1,040	2,160	1,815	1,672
Scroll	6	1,248	2,592	2,178	2,006

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Annual Energy Savings (kWh/yr) / FLH

where: FLH – full load hours; assume 5858 hours per year

Table 3 – Average Demand Savings for Various Compressor Sizes (kW)

Compressor Type	HP	Low Temp	Medium Temp	High Temp	Average
Discus	3	0.26	0.31	0.33	0.30
Discus	4	0.35	0.41	0.45	0.40
Discus	5	0.44	0.51	0.56	0.50
Discus	6	0.53	0.62	0.67	0.60
Scroll	2	0.07	0.15	0.12	0.11
Scroll	3	0.11	0.22	0.19	0.17
Scroll	4	0.14	0.29	0.25	0.23
Scroll	5	0.18	0.37	0.31	0.29
Scroll	6	0.21	0.44	0.37	0.34

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kW_{peak} = \Delta kWh * \text{Summer Peak Demand Factor}$

Table 4 – Average Summer Peak Demand Savings for Various Compressor Sizes (kW)

Compressor Type	HP	Low Temp	Medium Temp	High Temp	Average
Discus	3	0.22	0.26	0.28	0.25
Discus	4	0.29	0.34	0.37	0.34
Discus	5	0.37	0.43	0.46	0.42
Discus	6	0.44	0.51	0.56	0.50
Scroll	2	0.06	0.12	0.10	0.10
Scroll	3	0.09	0.18	0.15	0.14
Scroll	4	0.12	0.25	0.21	0.19
Scroll	5	0.15	0.31	0.26	0.24
Scroll	6	0.18	0.37	0.31	0.29

End Use Load Profile

PSP-Business-Commercial-Refrigerated_Display_Case_Food Retail

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01422%	0.01220%	0.02406%	0.01579%

Effective Useful Life (EUL)

Measure	EUL (years)
Refrigeration Compressor	15[3]

Revision History

Revision #	Description/Comment	Date Revised
0	Created sub sheet	Jun. 2002
1	Updated EM&V peak definition, Peak Demand Savings, formatting and references	Jan. 2025

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Instant Discount Program Measures (Lighting)

4’ T5/T5HO LED Tube Replacement Lamp (UL Type A, B, & C)

Measure Description

Energy Efficient Equipment Description

4’ T5/T5HO LED tube replacement lamp (UL Type A, B & C)

≤28W minimum 1600 lumen output

≤32W minimum 3200 lumen output

Base Equipment Description

Measure Mix of 4' T5 fluorescent lamp 28W and T5 LED

Measure Mix of 4' T5HO fluorescent lamp 54W and T5HO LED

Code, Standards and Regulations

No code, standards or regulations exist for this measure

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 1 – Base measure wattages (kW)[1]

Base Measure	Base Wattages
4' T5 fluorescent lamp 28W	0.032
4' T5HO fluorescent lamp 54W	0.060

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[1] Xcel Energy input wattage guide. https://www.xcelenergy.com/staticfiles/xe/Marketing/MN-Bus-Lighting-Input-Wattage-Guide.pdf

Energy Efficient Measure Assumptions

Table 2 – Efficient measure wattages (kW)[2]

Efficient Measure	Efficient Wattages
4' T5 LED Tube replacement (UL Type A, B, & C) ≤28W Minimum 1600 Lumen Output	0.019
4' T5HO LED Tube replacement (UL Type A, B, & C) ≤32W Minimum 3200 Lumen Output	0.028

Assumed Hours of Operation

Table 3 - Lighting hours based on Facility Types

Facility Type	Assumed Annual Operating Hours
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408
Lighting - Industrial	4473

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(\text{kWh/yr})_{\text{base}}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(\text{kWh/yr})_{\text{conservation}}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(\text{kWh/yr})_{\text{base}}$ - Annual Energy Consumption $(\text{kWh/yr})_{\text{conservation}}$

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[2] The wattages are averages of all Energy Star LED Decorative (non-candelabra base) Lamp that fall within the specified wattage and lumens range. Accessed (Oct. 2018).

Table 4 – Annual Energy Savings (kWh/yr)

Lighting End Use	4' T5 LED Tube replacement (UL Type A, B, & C) ≤28W Minimum 1600 Lumen Output	4' T5HO LED Tube replacement (UL Type A, B, & C) ≤32W Minimum 3200 Lumen Output
Food Retail	77.87	194.13
Hospital	66.43	165.62
Large Hotel (Corridor/Lobby)	101.07	251.97
Large Non-Food Retail	40.01	99.75
Large Office	46.28	115.38
Nursing Home	55.23	137.68
Other Commercial Buildings	51.28	127.84
Other Non-Food Retail	52.42	130.68
Restaurant	65.51	163.32
Schools	33.28	82.97
University Colleges	41.73	104.03
Warehouse Wholesale	56.51	140.88
Industrial	57.34	142.96

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 5 – Connected Demand Savings (kW)

Efficient Measures	Connected Demand Savings (kW)
4' T5 LED Tube replacement (UL Type A, B, & C) ≤28W Minimum 1600 Lumen Output	0.0128
4' T5HO LED Tube replacement (UL Type A, B, & C) ≤32W Minimum 3200 Lumen Output	0.0320

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 6 – Summer Peak Demand Savings (kW)

Lighting End Use	**4' T5 LED Tube replacement (UL Type A, B, & C) ≤28W Minimum 1600 Lumen Output**	**4' T5HO LED Tube replacement (UL Type A, B, & C) ≤32W Minimum 3200 Lumen Output**
Food Retail	0.0107	0.0267
Hospital	0.0075	0.0188
Large Hotel (Corridor/Lobby)	0.0132	0.0330
Large Non-Food Retail	0.0059	0.0148
Large Office	0.0059	0.0146
Nursing Home	0.0076	0.0190
Other Commercial Buildings	0.0047	0.0117
Other Non-Food Retail	0.0076	0.0189
Restaurant	0.0103	0.0257
Schools	0.0013	0.0033
University Colleges	0.0043	0.0106
Warehouse Wholesale	0.0067	0.0167
Industrial	0.0062	0.0154

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 7 – EM&V Peak Definition

Lighting End Use	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%
Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%
Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

Integral LED Troffer lifespan assumed to be 50,000 hours[3].

Table 8 – Effective Useful Life (EUL) by Facility Type

Facility Type	EUL (years)
Lighting - Food Retail	8
Lighting – Hospital	10
Lighting - Large Hotel (Corridor/Lobby)	6
Lighting - Large Non-Food Retail	12
Lighting - Large Office	14
Lighting - Nursing Home	12
Lighting - Other Commercial Buildings	18
Lighting - Other Non-Food Retail	12
Lighting – Restaurant	10
Lighting – Schools	19
Lighting - University Colleges	15
Lighting - Warehouse Wholesale	13
Lighting - Industrial	18

Revision History

Revision #	Description/Comment	Date Revised
0	Substantiation sheet created	Nov. 2018
1	Updated life cycle incremental costs	Nov. 2020
2	Updated annual operating hours for large non-food retail and warehouse/wholesale, references and formatting	Nov. 2023
3	Updated EM&V peak definition, Peak Demand Savings and references. Added Industrial Lighting End Use category	Jan. 2025

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

4’ T8 /8’ T8 LED/LED U-Bend Lamp

Measure Description

Energy Efficient Equipment Description

4’ T8 LED/LED U-bend lamp (UL Type A, B & C)

≤15W minimum 1500 lumen output

≤22W minimum 2100 lumen output

8’ T8 LED lamp (UL Type A, B, & C)

≤43W minimum 3200 lumen output

Base Equipment Description

Measure Mix of 4' T12 40W, T8 32W fluorescent lamp and T8 LED

Measure Mix of 4' T12 34W, T8 25W fluorescent lamp and T8 LED

Measure Mix of 8' T12 75W and T8 59W w/ electronic ballast

Code, Standards and Regulations

No code, standards or regulations exist for this measure

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 1 – Base measure wattages (kW)[1]

Base Measure	Base Wattages (kW)
Measure Mix of 4' T12 34W, T8 25W fluorescent lamp and T8 LED	0.0248
Measure Mix of 4' T12 40W, T8 32W fluorescent lamp and T8 LED	0.0314
Measure Mix of 8' T12 75W and T8 59W w/ electronic ballast	0.0692

Energy Efficient Measure Assumptions

Table 2 – Efficient measure wattages (kW)[2]

Base Measure	Efficient Wattages (kW)
4' T8 LED / LED U-Bend Lamp (UL Type A, B, & C) ≤15W Minimum 1500 Lumen Output	0.013
4' T8 LED / LED U-Bend Lamp (UL Type A, B, & C) ≤22W Minimum 2100 Lumen Output	0.018
8' T8 LED / LED U-Bend Lamp (UL Type A, B, & C) ≤43W Minimum 3200 Lumen Output	0.038

Assumed Hours of Operation

Table 3 - Lighting hours based on Facility Types

Facility Type	Assumed Annual Operating Hours
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408

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[1] IESO Baseline Lighting Study, 2021.

[2] The wattages non-weighted average tested wattage of all 4' T8 LED (type A,B,C) meeting measure description on DLC QPL accessed Sept 21, 2018.

Lighting - Industrial	4473

Energy and Demand Savings

Energy Savings

Annual Energy Consumption (kWh/yr)base = Base Measure Wattage x Operating Hours

Annual Energy Consumption (kWh/yr)conservation = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption (kWh/yr)base - Annual Energy Consumption (kWh/yr)conservation

Table 4 – Annual Energy Savings (kWh)

Lighting End Use	4' T8 LED/LED U-Bend Lamp (UL Type A, B, & C) ≤15W	4' T8 LED/LED U-Bend Lamp (UL Type A, B, & C) ≤22W	8' T8 LED/LED U-Bend Lamp (UL Type A, B, & C) ≤43W
Food Retail	71.37	81.33	191.03
Hospital	60.89	69.39	162.97
Large Hotel (Corridor/Lobby)	92.64	105.57	247.95
Large Non-Food Retail	36.67	41.79	98.16
Large Office	42.42	48.34	113.53
Nursing Home	50.62	57.68	135.49
Other Commercial Buildings	47.00	53.56	125.80
Other Non-Food Retail	48.05	54.75	128.60
Restaurant	60.04	68.42	160.71
Schools	30.50	34.76	81.64
University Colleges	38.25	43.58	102.37
Warehouse Wholesale	51.79	59.02	138.63
Industrial	52.56	59.89	140.68

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 5 – Connected Demand Savings (kW)

Efficient Measures	Connected Demand Savings (kW)
4' T8 LED / LED U-Bend Lamp (UL Type A, B, & C) ≤15W Minimum 1500 Lumen Output	0.0118

4' T8 LED / LED U-Bend Lamp (UL Type A, B, & C) ≤22W Minimum 2100 Lumen Output	0.0134
8' T8 LED / LED U-Bend Lamp (UL Type A, B, & C) ≤43W Minimum 3200 Lumen Output	0.0315

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 6 – Summer Peak Demand Savings (kW)

Lighting End Use	4' T8 LED/LED U-Bend Lamp (UL Type A, B, & C) ≤15W	4' T8 LED/LED U-Bend Lamp (UL Type A, B, & C) ≤22W	8' T8 LED/LED U-Bend Lamp (UL Type A, B, & C) ≤43W
Food Retail	0.0098	0.0112	0.0263
Hospital	0.0069	0.0079	0.0185
Large Hotel (Corridor/Lobby)	0.0121	0.0138	0.0324
Large Non-Food Retail	0.0054	0.0062	0.0146
Large Office	0.0054	0.0061	0.0144
Nursing Home	0.0070	0.0080	0.0187
Other Commercial Buildings	0.0043	0.0049	0.0115
Other Non-Food Retail	0.0069	0.0079	0.0186
Restaurant	0.0095	0.0108	0.0253
Schools	0.0012	0.0014	0.0032
University Colleges	0.0039	0.0045	0.0105
Warehouse Wholesale	0.0061	0.0070	0.0164
Industrial	0.0057	0.0065	0.0152

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 7 – EM&V Peak Definition

Lighting End Use	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%

University Colleges	0.01023%	0.01086%	0.01497%	0.01370%
Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%
Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

Integral LED Troffer lifespan assumed to be 50,000 hours[3].

Table 8 – Effective Useful Life (EUL) by Facility Type

Facility Type	EUL (years)
Lighting - Food Retail	8
Lighting – Hospital	10
Lighting - Large Hotel (Corridor/Lobby)	6
Lighting - Large Non-Food Retail	12
Lighting - Large Office	14
Lighting - Nursing Home	12
Lighting - Other Commercial Buildings	18
Lighting - Other Non-Food Retail	12
Lighting – Restaurant	10
Lighting – Schools	19
Lighting - University Colleges	15
Lighting - Warehouse Wholesale	13
Lighting - Industrial	18

Revision History

Revision #	Description/Comment	Date Revised
0	Substantiation sheet created	Nov. 2018
1	Updated life cycle incremental costs	Nov. 2020
2	Updated annual operating hours for large non-food retail and warehouse/wholesale, references and formatting	Nov. 2023

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

3	Updated EM&V peak definition, Peak Demand Savings and references. Added Industrial Lighting End Use category	Jan. 2025

8' LED Linear Ambient Fixtures

Measure Description

Energy Efficient Equipment Description

8' LED linear ambient fixture (≥4500 - <9000 lumen output)

8' LED linear ambient fixture (≥9000 lumen output)

Base Equipment Description

Measure mix of T8 (Electronic Ballast) and T12 (8' ES Magnetic Ballast & 8' Megnetic Ballast)

Code, Standards and Regulations

No codes, standards or regulations exist for this measure

Resource Savings Assumptions

Measure Assumptions

Table 1 – Base and Efficient Measure Wattages (kW)

Measure	**Base Wattage (kW)**	**Efficient Wattage (kW)**
8' LED linear ambient fixture (≥4500 - <9000 lumen output)	0.070	0.044
8' LED linear ambient fixture (≥9000 lumen output)	0.117	0.093

Assumed Hours of Operation

Table 2 - Lighting hours based on Facility Types

Lighting End Use	Assumed Annual Operating Hrs
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408
Lighting - Industrial	4473

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{conservation}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{conservation}$

Table 3 – Annual Energy Savings (kWh/yr)

Lighting End Use	8' LED linear ambient fixture (≥4500 - <9000 lumen output)	8' LED linear ambient fixture (≥9000 lumen output)
Food Retail	158.71	146.50
Hospital	135.41	124.99
Large Hotel (Corridor/Lobby)	206.01	190.16
Large Non-Food Retail	81.55	75.28
Large Office	94.33	87.07
Nursing Home	112.57	103.91
Other Commercial Buildings	104.52	96.48
Other Non-Food Retail	106.85	98.63
Restaurant	133.52	123.25
Schools	67.83	62.62

University Colleges	85.05	78.51
Warehouse Wholesale	115.18	106.32
Industrial	116.88	107.89

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 4 – Connected Demand Savings (kW)

Measure	Connected Demand Savings (kW)
8' LED linear ambient fixture (≥4500 - <9000 lumen output)	0.070
8' LED linear ambient fixture (≥9000 lumen output)	0.117

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kWpeak = \Delta kWh$ * Summer Peak Demand Factor

Table 5 – Summer Peak Demand Savings (kW)

Lighting End Use	8' LED linear ambient fixture (≥4500 - <9000 lumen output)	8' LED linear ambient fixture (≥9000 lumen output)
Food Retail	0.0218	0.0202
Hospital	0.0154	0.0142
Large Hotel (Corridor/Lobby)	0.0270	0.0249
Large Non-Food Retail	0.0121	0.0112
Large Office	0.0120	0.0110
Nursing Home	0.0156	0.0144
Other Commercial Buildings	0.0096	0.0088
Other Non-Food Retail	0.0154	0.0142
Restaurant	0.0210	0.0194
Schools	0.0027	0.0025
University Colleges	0.0087	0.0080
Warehouse Wholesale	0.0136	0.0126
Industrial	0.0126	0.0117

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 6 – EM&V Peak Definition

Lighting End Use	**Summer Peak Demand (kW/kWh)**	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%

Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%
Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%
Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

LED fixtures lifespan assumed to be 50,000 hours[1].

Table 7 – Effective Useful Life (EUL) by Facility Type

Facility Type	**EUL (years)**
Lighting - Food Retail	8
Lighting – Hospital	10
Lighting - Large Hotel (Corridor/Lobby)	6
Lighting - Large Non-Food Retail	12
Lighting - Large Office	14
Lighting - Nursing Home	12
Lighting - Other Commercial Buildings	18
Lighting - Other Non-Food Retail	12
Lighting – Restaurant	10
Lighting – Schools	19
Lighting - University Colleges	15
Lighting - Warehouse Wholesale	13
Lighting - Industrial	18

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Revision History

Revision #	Description/Comment	Date Revised
0	LED 8' Linear Ambient Luminaire (≥4500 Lumen Output)	July 2020
1	Updated annual operating hours for large non-food retail and warehouse/wholesale, references and formatting	Nov. 2023
2	Updated EM&V peak definition, Peak Demand Savings and references. Added Industrial Lighting End Use category	Jan. 2025

8’ LED Linear Ambient Retrofit Kit

Measure Description

Energy Efficient Equipment Description

8' LED linear ambient retrofit kit (≥4500 - <9000 lumen output)

8' LED linear ambient retrofit kit (≥9000 lumen output)

Base Equipment Description

Measure mix of one lamp 8’ T12 and T8

Measure mix of two lamp 8’ T12 and T8

Code, Standards and Regulations

No codes, standards or regulations exist for this measure

Resource Savings Assumptions

Measure Assumptions

Table 1 – Base and Efficient Measure Wattages (kW)

Measure	Base Wattage (kW)	Efficient Wattage (kW)
8' LED linear ambient retrofit kit (≥4500 - <9000 lumen output)	0.071	0.045
8' LED linear ambient retrofit kit (≥9000 lumen output)	0.122	0.084

Assumed Hours of Operation

Table 2 - Lighting hours based on Facility Types

Lighting End Use	Assumed Annual Operating Hrs
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408
Lighting - Industrial	4473

Energy and Demand Savings

Energy Savings

Annual Energy Consumption (kWh/yr)$_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption (kWh/yr)$_{conservation}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption (kWh/yr)$_{base}$ - Annual Energy Consumption (kWh/yr)$_{conservation}$

Table 3 – Annual Energy Savings (kWh)

Lighting End Use	8' LED linear ambient retrofit kit (≥4500 - <9000 lumen output)	8' LED linear ambient retrofit kit (≥9000 lumen output)
Food Retail	157.92	230.81
Hospital	134.73	196.92
Large Hotel (Corridor/Lobby)	204.98	299.59
Large Non-Food Retail	81.15	118.60
Large Office	93.86	137.18
Nursing Home	112.01	163.70
Other Commercial Buildings	104.00	152.00
Other Non-Food Retail	106.31	155.38
Restaurant	132.86	194.18
Schools	67.50	98.65
University Colleges	84.63	123.69

Warehouse Wholesale	114.61	167.50
Industrial	116.30	169.97

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 4 – Connected Demand Savings (kW)

Measure	Connected Demand Savings (kW)
8' LED linear ambient retrofit kit (≥4500 - <9000 lumen output)	0.026
8' LED linear ambient retrofit kit (≥9000 lumen output)	0.038

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 5 – Summer Peak Demand Savings (kW)

Lighting End Use	8' LED linear ambient retrofit kit (≥4500 - <9000 lumen output)	8' LED linear ambient retrofit kit (≥9000 lumen output)
Food Retail	0.0217	0.0318
Hospital	0.0153	0.0223
Large Hotel (Corridor/Lobby)	0.0268	0.0392
Large Non-Food Retail	0.0120	0.0176
Large Office	0.0119	0.0174
Nursing Home	0.0155	0.0226
Other Commercial Buildings	0.0095	0.0139
Other Non-Food Retail	0.0153	0.0224
Restaurant	0.0209	0.0306
Schools	0.0027	0.0039
University Colleges	0.0087	0.0127
Warehouse Wholesale	0.0136	0.0199
Industrial	0.0126	0.0184

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 6 – EM&V Peak Definition

Lighting End Use	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%

Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%
Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%
Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

LED fixtures lifespan assumed to be 50,000 hours[1].

Table 7 – Effective Useful Life (EUL) by Facility Type

Facility Type	EUL (years)
Lighting - Food Retail	8
Lighting – Hospital	10
Lighting - Large Hotel (Corridor/Lobby)	6
Lighting - Large Non-Food Retail	12
Lighting - Large Office	14
Lighting - Nursing Home	12
Lighting - Other Commercial Buildings	18
Lighting - Other Non-Food Retail	12
Lighting – Restaurant	10
Lighting – Schools	19
Lighting - University Colleges	15
Lighting - Warehouse Wholesale	13
Lighting - Industrial	18

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Revision History

Revision #	Description/Comment	Date Revised
0	LED 8' Linear Ambient Luminaire (≥4500 Lumen Output)	July 2020
1	Updated annual operating hours for large non-food retail and warehouse/wholesale, references and formatting	Nov. 2023
2	Updated EM&V peak definition, Peak Demand Savings and references. Added Industrial Lighting End Use category	Jan. 2025

Integral LED Troffer and LED Linear Ambient Fixture

Measure Description

Energy Efficient Equipment Description

Integral LED Troffer and Linear Ambient Fixture (2′x2′, 1′x4′, 2′x4′)

Base Equipment Description

Measure mix of T12 and T8 lamps

Table 1 – Base and Energy Efficient Measures

Energy Efficient Measure	Base Measure
Integral LED Fixture (2′x2′, > 2000 lumens)	Measure Mix of T12U-bend 34W and T8U-bend 32W - 2 lamps
Integral LED Fixture (1′x4′, > 1500 lumens)	Measure Mix of 4' T12 40W and T8 32W - 2 lamps
Integral LED Fixture (2′x4′, 3000 lumens)	Measure Mix of 4' T12 40W and T8 32W - 3 lamps

Code, Standards and Regulations

The DesignLights Consortium (DLC) qualifies commercial LED luminaires, retrofit kits, linear replacement lamps, mogul (E39 and E40) screw-base replacement lamps, and four pin-base replacement lamps for CFLs for inclusion in DLC Members’ energy efficiency rebate and incentive programs.

1×4, 2×2, and 2×4 Luminaires for Ambient Lighting of Interior Commercial Spaces. These are common recessed, suspended, or surface-mounted fixtures intended to provide ambient lighting in settings such as office spaces, schools, retail stores, and other commercial environments.

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 2 – Base Measure Wattages (kW)[1]

Base Measure	Wattages (kW)
Measure Mix of T12U-bend 34W and T8U-bend 32W - 2 lamps	0.06618
Measure Mix of 4' T12 40W and T8 32W - 2 lamps	0.06438
Measure Mix of 4' T12 40W and T8 32W - 3 lamps	0.09193

Energy Efficient Measure Assumptions

Table 3 – Efficient Measure Wattages (kW)[2]

Efficient Measure	Wattages (kW)
Integral LED Fixture (2’x2’, > 2000 lumens)	0.0390
Integral LED Fixture (1’x4’, > 1500 lumens)	0.0386
Integral LED Fixture (2’x4’, 3000 lumens)	0.0440

Assumed Hours of Operation

Table 4 - Lighting hours based on Facility Types

Facility Type	Assumed Annual Operating Hrs
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110

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[1] EM&V Baseline Adjustment 2021

[2] Integral LED Troffer power consumptions vary among manufacturers. Average input wattage from all DLC listed fixtures that match the measure description, https://www.designlights.org/QPL (Accessed Jan 2016)

Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408
Lighting - Industrial	4473

Energy and Demand Savings

Energy Savings

Annual Energy Consumption (kWh/yr)$_{\text{base}}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption (kWh/yr)$_{\text{conservation}}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption (kWh/yr)$_{\text{base}}$ - Annual Energy Consumption (kWh/yr)$_{\text{conservation}}$

Table 5 – Annual Energy Savings (kWh)

Lighting End Use	**Annual Energy Savings (kWh) of Integral LED Fixture (2’x2’, > 2000 lumens)**	**Annual Energy Savings (kWh) of Integral LED Fixture (1’x4’, > 1500 lumens)**	**Annual Energy Savings (kWh) of Integral LED Fixture (2’x4’, 3000 lumens)**
Food Retail	165.09	156.59	291.13
Hospital	140.85	133.59	248.37
Large Hotel (Corridor/Lobby)	214.29	203.25	377.88
Large Non-Food Retail	84.83	80.46	149.59
Large Office	98.12	93.07	173.03
Nursing Home	117.09	111.06	206.48
Other Commercial Buildings	108.72	103.12	191.72
Other Non-Food Retail	111.14	105.41	195.99
Restaurant	138.89	131.74	244.92
Schools	70.56	66.92	124.43
University Colleges	88.47	83.91	156.01
Warehouse Wholesale	119.81	113.64	211.27
Industrial	121.58	115.31	214.39

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Efficient Measure Wattage

Table 6 – Connected Demand Savings (kW)

Efficient Measure	Connected Demand Savings (kW)
Integral LED Fixture (2'x2', > 2000 lumens)	0.0272
Integral LED Fixture (1'x4', > 1500 lumens)	0.0258
Integral LED Fixture (2'x4', 3000 lumens)	0.0479

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 7 – Summer Peak Demand Savings

Lighting End Use	Summer Peak Demand Savings (kW) of Integral LED Fixture (2'x2', > 2000 lumens)	Summer Peak Demand Savings (kW) of Integral LED Fixture (1'x4', > 1500 lumens)	Summer Peak Demand Savings (kW) Integral LED Fixture (2'x4', 3000 lumens)
Food Retail	0.023	0.022	0.040
Hospital	0.016	0.015	0.028
Large Hotel (Corridor/Lobby)	0.028	0.027	0.049
Large Non-Food Retail	0.013	0.012	0.022
Large Office	0.012	0.012	0.022
Nursing Home	0.016	0.015	0.029
Other Commercial Buildings	0.010	0.009	0.018
Other Non-Food Retail	0.016	0.015	0.028
Restaurant	0.022	0.021	0.039
Schools	0.003	0.003	0.005
University Colleges	0.009	0.009	0.016
Warehouse Wholesale	0.014	0.013	0.025
Industrial	0.013	0.012	0.023

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 8 – EM&V Peak Definition

Lighting End Use	**Summer Peak Demand (kW/kWh)**	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%

Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%
Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%
Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

Integral LED Troffer lifespan assumed to be 50,000 hours[3].

Table 9 – Effective Useful Life (EUL) by Facility Type

Facility Type	EUL (years)
Lighting - Food Retail	8
Lighting – Hospital	10
Lighting - Large Hotel (Corridor/Lobby)	6
Lighting - Large Non-Food Retail	12
Lighting - Large Office	14
Lighting - Nursing Home	12
Lighting - Other Commercial Buildings	18
Lighting - Other Non-Food Retail	12
Lighting – Restaurant	10
Lighting – Schools	19
Lighting - University Colleges	15
Lighting - Warehouse Wholesale	13
Lighting - Industrial	18

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Oct. 2008
1	Base case upgraded to T8	Jan. 2016
2	Baseline Equipment Costs Updated	June 2019

[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

3	Updated lifetime incremental costs + baseline adjustments	Sep. 2020
4	Updated annual operating hours for large non-food retail and warehouse/wholesale, references and formatting	Nov. 2023
5	Updated the EM&V peak definition, Peak Demand Savings, and associated references. Added the Industrial Lighting End Use category. Corrected the Annual Energy Savings (kWh) values in Table 5 for Large Non-Food Retail and Warehouse Wholesale, specifically for the Integral LED Fixture (2’x2’, > 2000 lumens) and Integral LED Fixture (1’x4’, > 1500 lumens), to align with the MAL/CDMIS and Annual Energy Savings were calculated based on Tables 2, 3 and 4	Jan. 2025

Integral LED Troffer and Linear Retrofit Kits

Measure Description

Energy Efficient Equipment Description

Integral LED Troffer and Linear Ambient Retrofit Kits (2′x2′, 1′x4′, 2′x4′)

Base Equipment Description

Measure mix of T12 and T8 lamps

Table 1 – Base and Energy Efficient Measures

Energy Efficient Measure	Base Measure
Integral LED Fixture (2′x2′, > 2000 lumens)	Measure Mix of T12U-bend 34W and T8U-bend 32W - 2 lamps
Integral LED Fixture (1′x4′, > 1500 lumens)	Measure Mix of 4' T12 40W and T8 32W - 2 lamps
Integral LED Fixture (2′x4′, 3000 lumens)	Measure Mix of 4' T12 40W and T8 32W - 3 lamps

Code, Standards and Regulations

The DesignLights Consortium (DLC) qualifies commercial LED luminaires, retrofit kits, linear replacement lamps, mogul (E39 and E40) screw-base replacement lamps, and four pin-base replacement lamps for CFLs for inclusion in DLC Members’ energy efficiency rebate and incentive programs.

1×4, 2×2, and 2×4 Luminaires for Ambient Lighting of Interior Commercial Spaces. These are common recessed, suspended, or surface-mounted fixtures intended to provide ambient lighting in settings such as office spaces, schools, retail stores, and other commercial environments.

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 2 – Base Measure Wattages (kW)[1]

Base Measure	Wattages (kW)
Measure Mix of T12U-bend 34W and T8U-bend 32W - 2 lamps	0.06617
Measure Mix of 4' T12 40W and T8 32W - 2 lamps	0.06437
Measure Mix of 4' T12 40W and T8 32W - 3 lamps	0.09191

Energy Efficient Measure Assumptions

Table 3 – Efficient Measure Wattages (kW)[2]

Efficient Measure	Wattages (kW)
Integral LED Fixture (2'x2', > 2000 lumens)	0.032
Integral LED Fixture (1'x4', > 1500 lumens)	0.031
Integral LED Fixture (2'x4', 3000 lumens)	0.042

Assumed Hours of Operation

Table 4 - Lighting hours based on Facility Types

Facility Type	Assumed Annual Operating Hrs
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408
Lighting - Industrial	4473

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[1] EM&V Baseline Adjustment 2021

[2] Intergral LED Troffer power consumptions vary among manufacturers. Average input wattage from all DLC listed fixtures that match the measure description, https://www.designlights.org/QPL (Accessed Jan 2016)

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(\text{kWh/yr})_{\text{base}}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(\text{kWh/yr})_{\text{conservation}}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(\text{kWh/yr})_{\text{base}}$ - Annual Energy Consumption $(\text{kWh/yr})_{\text{conservation}}$

Table 5 – Annual Energy Savings (kWh)

Lighting End Use	**Annual Energy Savings (kWh) for Integral LED Fixture (2'x2', > 2000 lumens)**	**Annual Energy Savings (kWh) for Integral LED Fixture (1'x4', > 1500 lumens)**	**Annual Energy Savings (kWh) for Integral LED Fixture (2'x4', 3000 lumens)**
Food Retail	207.55	202.69	303.15
Hospital	177.07	172.92	258.63
Large Hotel (Corridor/Lobby)	269.40	263.09	393.49
Large Non-Food Retail	106.64	104.15	155.77
Large Office	123.35	120.47	180.18
Nursing Home	147.20	143.76	215.01
Other Commercial Buildings	136.68	133.48	199.64
Other Non-Food Retail	139.72	136.45	204.08
Restaurant	174.61	170.52	255.04
Schools	88.71	86.63	129.57
University Colleges	111.22	108.62	162.46
Warehouse Wholesale	150.62	147.09	220.00
Industrial	152.84	149.26	223.25

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Efficient Measure Wattage

Table 6 – Connected Demand Savings (kW)

Efficient Measure	**Connected Demand Savings (kW)**
Integral LED Fixture (2'x2', > 2000 lumens)	0.0342
Integral LED Fixture (1'x4', > 1500 lumens)	0.0334
Integral LED Fixture (2'x4', 3000 lumens)	0.0499

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$

Table 7 – Summer Peak Demand Savings

Lighting End Use	**Summer Peak Demand Savings (kW) of Integral LED Fixture (2'x2', > 2000 lumens)**	**Summer Peak Demand Savings (kW) of Integral LED Fixture (1'x4', > 1500 lumens)**	**Summer Peak Demand Savings (kW) of Integral LED Fixture (2'x4', 3000 lumens)**
Food Retail	0.029	0.028	0.042
Hospital	0.020	0.020	0.029
Large Hotel (Corridor/Lobby)	0.035	0.034	0.051
Large Non-Food Retail	0.016	0.015	0.023
Large Office	0.016	0.015	0.023
Nursing Home	0.020	0.020	0.030
Other Commercial Buildings	0.013	0.012	0.018
Other Non-Food Retail	0.020	0.020	0.029
Restaurant	0.028	0.027	0.040
Schools	0.004	0.003	0.005
University Colleges	0.011	0.011	0.017
Warehouse Wholesale	0.018	0.017	0.026
Industrial	0.017	0.016	0.024

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 8 – EM&V Peak Definition

Lighting End Use	**Summer Peak Demand (kW/kWh)**	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%
Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%

Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

Integral LED Troffer lifespan assumed to be 50,000 hours[3].

Table 9 – Effective Useful Life (EUL) by Facility Type

Facility Type	EUL (years)
Lighting - Food Retail	8
Lighting – Hospital	10
Lighting - Large Hotel (Corridor/Lobby)	6
Lighting - Large Non-Food Retail	12
Lighting - Large Office	14
Lighting - Nursing Home	12
Lighting - Other Commercial Buildings	18
Lighting - Other Non-Food Retail	12
Lighting – Restaurant	10
Lighting – Schools	19
Lighting - University Colleges	15
Lighting - Warehouse Wholesale	13
Lighting - Industrial	18

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Oct. 2008
1	Base case upgraded to T8	Jan. 2016
2	Baseline Equipment Costs Updated	June 2019
3	Updated lifetime incremental costs + baseline adjustments	Sep. 2020
4	Updated annual operating hours for large non-food retail and warehouse/wholesale, references and formatting	Nov. 2023

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

5	Updated the EM&V peak definition, Peak Demand Savings, and associated references. Added the Industrial Lighting End Use category. Corrected the Annual Energy Savings (kWh) values in Table 5 for Large Non-Food Retail and Warehouse Wholesale, specifically for the Integral LED Fixture (2’x2’, > 2000 lumens) and Integral LED Fixture (1’x4’, > 1500 lumens), to align with the MAL/CDMIS and the calculated values based on Tables 2-4	Jan. 2025

LED High Bay Fixtures

Measure Description

Energy Efficient Equipment Description

LED high bay fixture

Base Equipment Description

Average HID lamps and T8 HO lamps

Code, Standards and Regulations

No codes, standards and regulations exist for this measure.

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 1 – Base Measure Wattages (kW)

Base Measure	Wattages (kW)
Average 250 W HID lamp/T8 HO	0.236
Average 320 W HID lamp/T8 HO	0.289
Average 400 W HID lamp/T8 HO	0.367
Average 750 W HID lamp/T8 HO	0.350
Average 1000 W HID lamp/T8 HO	0.901

Energy Efficient Measure Assumptions

Table 2 – Efficient Measure Wattages (kW)

Efficient Measure	Wattages (kW)
≥10,000 lumens & < 105 W	0.0857
≥12,200 lumens & < 132 W	0.1019

≥15,500 lumens & < 178 W	0.1390
≥20,100 lumens & < 305 W	0.1940
≥34,700 lumens & ≥ 305 W	0.3450

Assumed Hours of Operation

Table 3 - Lighting hours based on Facility Types

Facility Type	Assumed Annual Operating Hrs
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408
Lighting - Industrial	4473

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{conservation}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{conservation}$

Table 4 – Annual Energy Savings (kWh)

Lighting End Use	≥10,000 lumens & < 105 W	≥12,200 lumens & < 132 W	≥15,500 lumens & < 178 W	≥20,100 lumens & < 305 W	≥34,700 lumens & ≥ 305 W
Food Retail	912.92	1,136.45	1,384.87	947.54	3,377.14
Hospital	778.85	969.55	1,181.50	808.39	2,881.19
Large Hotel (Corridor/Lobby)	1,184.97	1,475.10	1,797.55	1229.90	4,383.50
Large Non-Food Retail	469.09	583.94	711.59	486.88	1,735.28
Large Office	542.58	675.43	823.08	563.16	2,007.16

Nursing Home	647.49	806.03	982.22	672.05	2,395.25
Other Commercial Buildings	601.20	748.40	912.00	624.00	2,224.00
Other Non-Food Retail	614.58	765.05	932.29	637.88	2,273.48
Restaurant	768.03	956.08	1,165.08	797.16	2,841.16
Schools	390.18	485.71	591.89	404.98	1,443.38
University Colleges	489.23	609.01	742.14	507.78	1,809.78
Warehouse Wholesale	662.52	824.74	1,005.02	687.65	2,450.85
Industrial	672.29	836.90	1,019.84	697.79	2,486.99

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 5 – Connected Demand Savings (kW)

Efficient Measure	Connected Demand Savings (kW)
≥10,000 lumens & < 105 W	0.1503
≥12,200 lumens & < 132 W	0.1871
≥15,500 lumens & < 178 W	0.2280
≥20,100 lumens & < 305 W	0.1560
≥34,700 lumens & ≥ 305 W	0.5560

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 6 – Summer Peak Demand Savings (kW)

Lighting End Use	≥10,000 lumens & < 105 W	≥12,200 lumens & < 132 W	≥15,500 lumens & < 178 W	≥20,100 lumens & < 305 W	≥34,700 lumens & ≥ 305 W
Food Retail	0.126	0.156	0.191	0.130	0.465
Hospital	0.088	0.110	0.134	0.092	0.327
Large Hotel (Corridor/Lobby)	0.155	0.193	0.235	0.161	0.574
Large Non-Food Retail	0.070	0.087	0.106	0.072	0.257
Large Office	0.069	0.086	0.104	0.071	0.255
Nursing Home	0.089	0.111	0.136	0.093	0.331
Other Commercial Buildings	0.055	0.069	0.083	0.057	0.204
Other Non-Food Retail	0.089	0.110	0.135	0.092	0.328
Restaurant	0.121	0.151	0.184	0.126	0.448

Schools	0.015	0.019	0.023	0.016	0.057
University Colleges	0.050	0.062	0.076	0.052	0.185
Warehouse Wholesale	0.079	0.098	0.119	0.081	0.290
Industrial	0.073	0.090	0.110	0.075	0.269

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 7 – EM&V Peak Definition

Lighting End Use	**Summer Peak Demand (kW/kWh)**	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%

Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%
Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%
Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

LED high bay fixtures lifespan assumed to be 50,000 hours[1].

Table 8 – Effective Useful Life (EUL) by Facility Type

Facility Type	**EUL (years)**
Lighting - Food Retail	10
Lighting – Hospital	11
Lighting - Large Hotel (Corridor/Lobby)	8
Lighting - Large Non-Food Retail	14
Lighting - Large Office	16
Lighting - Nursing Home	14
Lighting - Other Commercial Buildings	20
Lighting - Other Non-Food Retail	14
Lighting – Restaurant	12

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Lighting – Schools	22
Lighting - University Colleges	18
Lighting - Warehouse Wholesale	16
Lighting - Industrial	20

Revision History

Revision #	Description/Comment	Date Revised
0	Substantiation sheet created	Sep. 2020
1	Updated annual operating hours for large non-food retail and warehouse/wholesale, references and formatting	Nov. 2023
2	Updated the EM&V peak definition, Peak Demand Savings, and associated references. Added the Industrial Lighting End Use category. Updated the base case of the 750 HID lamp/T8 HO from 0.63 kW to 0.35 kW (as recommended by Resource Innovations based on their latest Retrofit program evaluation	Jan. 2025

LED Low Bay Fixtures

Measure Description

Energy Efficient Equipment Description

Low-Bay luminaires for commercial and industrial buildings with wattage from 50 W up to and including 100 W. Includes pendent, recessed, or surface-mounted fixtures specific for indoor ceiling spaces (intended for <25'). Low-bay luminaires have a lumen output of ≤10,000 lumen, otherwise the fixture is categorized as high-bay

Base Equipment Description

Measure mix of 4-lamp Tandem T12, T8 and T5 Strip Fixture

Code, Standards and Regulations

No codes, standards and regulations exist for this measure.

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Measure mix of 4-lamp tandem T12, T8 and T5 strip fixture wattage = 0.11477 kW

Energy Efficient Measure Assumptions

LED low bay fixture ≤100W and ≤10,000 lumens wattage = 0.053 kW

Assumed Hours of Operation

Table 1 - Lighting hours based on Facility Types

Facility Type	Assumed Annual Operating Hrs
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884

Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408
Lighting - Industrial	4473

Energy and Demand Savings

Energy Savings

Annual Energy Consumption (kWh/yr)$_{\text{base}}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption (kWh/yr)$_{\text{conservation}}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption (kWh/yr)$_{\text{base}}$ - Annual Energy Consumption (kWh/yr)$_{\text{conservation}}$

Table 2 – Annual Energy Savings (kWh)

Lighting End Use	Annual Energy Savings (kWh)
Food Retail	375.19
Hospital	320.09
Large Hotel (Corridor/Lobby)	486.99
Large Non-Food Retail	192.78
Large Office	222.99
Nursing Home	266.11
Other Commercial Buildings	247.08
Other Non-Food Retail	252.58
Restaurant	315.64
Schools	160.35
University Colleges	201.06
Warehouse Wholesale	272.28
Industrial	276.30

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Demand Savings (kW) = 0.1148 – 0.053 = 0.0618 kW

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$

Table 3 – Summer Peak Demand Savings (kW)

Lighting End Use	Summer Peak Demand Savings (kW)
Food Retail	0.052
Hospital	0.036
Large Hotel (Corridor/Lobby)	0.064
Large Non-Food Retail	0.029
Large Office	0.028
Nursing Home	0.037
Other Commercial Buildings	0.023
Other Non-Food Retail	0.036
Restaurant	0.050
Schools	0.006
University Colleges	0.021
Warehouse Wholesale	0.032
Industrial	0.030

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 4 – EM&V Peak Definition

Lighting End Use	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%

Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%
Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

LED high bay fixtures lifespan assumed to be 50,000 hours[1].

Table 5 – Effective Useful Life (EUL) by Facility Type

Facility Type	EUL (years)
Lighting - Food Retail	8
Lighting – Hospital	10
Lighting - Large Hotel (Corridor/Lobby)	6
Lighting - Large Non-Food Retail	12
Lighting - Large Office	14
Lighting - Nursing Home	12
Lighting - Other Commercial Buildings	18
Lighting - Other Non-Food Retail	12
Lighting – Restaurant	10
Lighting – Schools	19
Lighting - University Colleges	15
Lighting - Warehouse Wholesale	13
Lighting - University Colleges	18

Revision History

Revision #	Description/Comment	Date Revised
0	LED Low-Bay Luminaires for Commercial and Industrial Buildings	Jul. 2020
1	Updated annual operating hours for large non-food retail and warehouse/wholesale, references and formatting	Nov. 2023
2	Updated the EM&V peak definition, Peak Demand Savings, and associated references. Added the Industrial Lighting End Use category	Jan. 2025

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

LED Recessed Downlights

Measure Description

Energy Efficient Equipment Description

Products that are Solid State Luminaire (SSL) downlight retrofit kits and/or LED downlight fixtures (w/ integrated LEDs) for recessed downlight applications are eligible for this incentive.

The product must have a Fixture Type classification of "Downlight Recessed" or "Down Light Solid State Retrofit" by Energy Star and must be approved and listed on the Energy Star Qualified Commercial Lighting List for fixtures.

Base Equipment Description

Energy Star® Pin Base CFL Downlight with fixture efficiency between 50% and 70%

Code, Standards and Regulations

Energy Star® LED recessed downlights are eligible under qualified luminaries using solid state lighting (SSL) for both residential and commercial applications.

Criteria Item	Energy Star® Requirements
Maximum Allowable Luminaire Aperture	Luminaire aperture must be less than or equal to 8 inches in diameter (if circular) or on any side (if rectangular).
Minimum Light Output	≤ 4.5” Aperture: 345 lumens (initial) > 4.5” Aperture: 575 lumens (initial)
Minimum Luminaire Efficacy	35 lm/W
Allowable CCTs	2700 K, 3000 K and 3500 K

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 1 – Base Measure Wattages (kW)

Base Measure	Wattages (kW)
15W or 18W CFL Downlight (average between 15W and 18W)	0.0165
22W CFL Downlight	0.022
26W CFL Downlight	0.026

Energy Efficient Measure Assumptions

Table 2 – Efficient Measure Wattages (kW)

Efficient Measure	Wattages (kW)
≥400 < 600 lumens LED Downlight	0.0094
≥600 < 800 lumens LED Downlight	0.012
≥800 lumens LED Downlight	0.0153

Assumed Hours of Operation

Table 3 - Lighting hours based on Facility Types

Facility Type	Assumed Annual Operating Hrs
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408
Lighting - Industrial	4473

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{conservation}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{conservation}$

Table 4 – Annual Energy Savings (kWh)

Lighting End Use	≥400 <600 lumens	≥600 >800 lumens	≥800 lumens
Food Retail	43.13	60.74	64.99
Hospital	36.79	51.82	55.45
Large Hotel (Corridor/Lobby)	55.98	78.84	84.36
Large Non-Food Retail	22.16	31.21	33.40
Large Office	25.63	36.10	38.63
Nursing Home	30.59	43.08	46.10
Other Commercial Buildings	28.40	40.00	42.80
Other Non-Food Retail	29.03	40.89	43.75
Restaurant	36.28	51.10	54.68
Schools	18.43	25.96	27.78
University Colleges	23.11	32.55	34.83
Warehouse Wholesale	31.30	44.08	47.17
Industrial	31.76	44.73	47.86

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 5 – Connected Demand Savings (kW)

Efficient Measure	Connected Demand Savings (kW)
≥400 < 600 lumens LED Downlight	0.0071
≥600 < 800 lumens LED Downlight	0.0100
≥800 lumens LED Downlight	0.0107

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 6 – Summer Peak Demand Savings (kW)

Lighting End Use	≥400 <600 lumens	≥600 >800 lumens	≥800 lumens
Food Retail	0.0059	0.0084	0.0089
Hospital	0.0042	0.0059	0.0063
Large Hotel (Corridor/Lobby)	0.0073	0.0103	0.0110
Large Non-Food Retail	0.0033	0.0046	0.0050
Large Office	0.0033	0.0046	0.0049
Nursing Home	0.0042	0.0060	0.0064
Other Commercial Buildings	0.0026	0.0037	0.0039
Other Non-Food Retail	0.0042	0.0059	0.0063
Restaurant	0.0057	0.0081	0.0086
Schools	0.0007	0.0010	0.0011
University Colleges	0.0024	0.0033	0.0036
Warehouse Wholesale	0.0037	0.0052	0.0056
Industrial	0.0034	0.0048	0.0052

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 7 – EM&V Peak Definition

Lighting End Use	**Summer Peak Demand (kW/kWh)**	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%
Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%
Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

LED high bay fixtures lifespan assumed to be 50,000 hours[1].

Table 8 – Effective Useful Life (EUL) by Facility Type

Facility Type	EUL (years)
Lighting - Food Retail	7
Lighting – Hospital	8
Lighting - Large Hotel (Corridor/Lobby)	6
Lighting - Large Non-Food Retail	11
Lighting - Large Office	12
Lighting - Nursing Home	10
Lighting - Other Commercial Buildings	15
Lighting - Other Non-Food Retail	11
Lighting – Restaurant	9
Lighting – Schools	17
Lighting - University Colleges	14
Lighting - Warehouse Wholesale	12
Lighting - Industrial	15

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Nov. 2010
1	Updated measure assumptions	Jul. 2013
2	Updated measure assumptions	Jan. 2016
3	Baseline Equipment Costs Updated	Jun. 2019
4	Updated life cycle incremental cost	Sep. 2020
5	Updated annual operating hours for large non-food retail and warehouse/wholesale, references and formatting	Nov. 2023
6	Updated the EM&V peak definition, Peak Demand Savings, associated references and added Industrial Lighting End Use category	Jan. 2025

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

LED Reflector (Flood/Spot) Lamp Pin and Screw Base

Measure Description

Energy Efficient Equipment Description

LED reflector (flood/spot) lamp pin and screw base BR's, PAR's, MR's, and R's style.

The LED lamp must be classified as a Reflector (flood/spot) Lamp by Energy Star and must be approved and listed on the Energy Star Certified Light Bulbs List.

Base Equipment Description

Halogen or incandescent lamp

Table 1 – Base and Energy Efficient Measures

Energy Efficient Measure LED Reflector	**Base Measure Halogen or Incandescent**
≤ 7W ≥ 250 Lumens	20W - 35W
≤ 14W ≥ 400 Lumens	35W - 38W
≤ 16W ≥ 600 Lumens	38W - 43W
≤ 20W ≥ 800 Lumens	43W - 60W
≤ 30W ≥ 1100 Lumens	60W - 80W

Code, Standards and Regulations

Integral LED lamps are defined as lamps with LEDs, an integrated LED driver, and an ANSI standardized base designed to connect to the branch circuit via an ANSI standardized lampholder/socket. These criteria include integral LED lamps of non-standard form, and those intended to replace standard general service incandescent lamps, decorative (candelabra style) lamps, and reflector lamps.[1]

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[1] Energy Star® Program Requirements for Integral LED Lamps Partner Commitments amended March 22, 2010. https://www.energystar.gov/ia/partners/product_specs/program_reqs/Integral_LED_Lamps_Program_Requirements.pdf

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 2 – Wattages of Halogen or Incandescent Reflector Lamps

Base Measure	Base kW
20W - 35W	0.0275
35W - 38W	0.0365
38W - 43W	0.0405
43W - 60W	0.0515
60W - 80W	0.0700

Energy Efficient Measure Assumptions

Table 3 – Wattages of LED Reflector Lamps

EE Measure	EE kW
≤ 7W ≥ 250 Lumens	0.0060
≤ 14W ≥ 400 Lumens	0.0075
≤ 16W ≥ 600 Lumens	0.0110
≤ 20W ≥ 800 Lumens	0.0130
≤ 30W ≥ 1100 Lumens	0.0175

Assumed Hours of Operation

Table 4 - Lighting hours based on Facility Types

Facility Type	Assumed Annual Operating Hrs
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408
Lighting - Industrial	4473

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{conservation}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{conservation}$

Table 5 – Annual Energy Savings (kWh)

End Use	≤ 7W ≥ 250 Lumens	≤ 14W ≥ 400 Lumens	≤ 16W ≥ 600 Lumens	≤ 20W ≥ 800 Lumens	≤ 30W ≥ 1100 Lumens
Food Retail	130.59	176.15	179.18	233.85	318.89
Hospital	111.41	150.28	152.87	199.51	272.06
Large Hotel (Corridor/Lobby)	169.51	228.64	232.58	303.53	413.91
Large Non-Food Retail	67.10	90.51	92.07	120.16	163.85
Large Office	77.62	104.69	106.50	138.99	189.53
Nursing Home	92.62	124.93	127.09	165.86	226.17
Other Commercial Buildings	86.00	116.00	118.00	154.00	210.00
Other Non-Food Retail	87.91	118.58	120.63	157.43	214.67
Restaurant	109.87	148.19	150.75	196.74	268.28
Schools	55.81	75.28	76.58	99.95	136.29
University Colleges	69.98	94.40	96.02	125.32	170.89
Warehouse Wholesale	94.77	127.83	130.04	169.71	231.42
Industrial	96.17	129.72	131.95	172.21	234.83

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 6 – Connected Demand Savings (kW)

Efficient Measure	Connected Demand Savings (kW)
≤ 7W ≥ 250 Lumens	0.0215
≤ 14W ≥ 400 Lumens	0.0290
≤ 16W ≥ 600 Lumens	0.0295
≤ 20W ≥ 800 Lumens	0.0385
≤ 30W ≥ 1100 Lumens	0.0525

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 7 – Summer Peak Demand Savings (kW)

End Use	**≤ 7W ≥ 250 Lumens**	**≤ 14W ≥ 400 Lumens**	**≤ 16W ≥ 600 Lumens**	**≤ 20W ≥ 800 Lumens**	**≤ 30W ≥ 1100 Lumens**
Food Retail	0.0180	0.0242	0.0247	0.0322	0.0439
Hospital	0.0126	0.0170	0.0173	0.0226	0.0309
Large Hotel (Corridor/Lobby)	0.0222	0.0299	0.0304	0.0397	0.0542
Large Non-Food Retail	0.0100	0.0134	0.0137	0.0178	0.0243
Large Office	0.0098	0.0133	0.0135	0.0176	0.0240
Nursing Home	0.0128	0.0173	0.0176	0.0229	0.0313
Other Commercial Buildings	0.0079	0.0106	0.0108	0.0141	0.0192
Other Non-Food Retail	0.0127	0.0171	0.0174	0.0227	0.0310
Restaurant	0.0173	0.0234	0.0238	0.0310	0.0423
Schools	0.0022	0.0030	0.0030	0.0039	0.0054
University Colleges	0.0072	0.0097	0.0098	0.0128	0.0175
Warehouse Wholesale	0.0112	0.0151	0.0154	0.0201	0.0274
Industrial	0.0104	0.0140	0.0143	0.0186	0.0254

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 8 – EM&V Peak Definition

Lighting End Use	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%
Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%
Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%
Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

Integral LED Troffer lifespan assumed to be 25,000 hours[2].

Table 9 – Effective Useful Life (EUL) by Facility Type

Facility Type	EUL (years)
Lighting - Food Retail	4
Lighting – Hospital	5
Lighting - Large Hotel (Corridor/Lobby)	3
Lighting - Large Non-Food Retail	6
Lighting - Large Office	7
Lighting - Nursing Home	6
Lighting - Other Commercial Buildings	9
Lighting - Other Non-Food Retail	6
Lighting – Restaurant	5
Lighting – Schools	10
Lighting - University Colleges	8
Lighting - Warehouse Wholesale	7
Lighting - Industrial	9

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Nov. 2010
1	Updated measure assumptions	July 2013
2	Updated measures assumptions	June 2016
3	Baseline Equipment Costs Updated	June 2019
4	Updated life cycle incremental costs	Sep. 2020
5	Updated annual operating hours for large non-food retail and warehouse/wholesale, references and formatting	Nov. 2023
6	Updated the EM&V peak definition, Peak Demand Savings, and associated references. Added the Industrial Lighting End Use category	Jan. 2025

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Occupancy Sensors

Measure Description

Energy Efficient Equipment Description

Occupancy sensors in an enclose variable occupancy space including a) switch plate mounted occupancy sensor; b) ceiling or wall mounted occupancy sensor; c) fixture mounted occupancy sensor (high bay) for fixtures ≥ 100W; and d) fixture mounted occupancy sensor (all other) for fixtures < 100W

Base Equipment Description

Measure mix of 95% no occupancy sensor and 5% replacing existing occupancy sensor or other type of control

Code, Standards and Regulations

The Ontario Building Code requirements under ASHRAE 90.1-2010 section 9.4.1.2b stipulates the use of occupancy sensors for lighting controls in spaces with variable occupancy spaces such as classrooms, conference rooms, and storage rooms.[1]

Resource Savings Assumptions

Measure Assumptions

Base Measure Assumptions

Table 1 – Base Lighting Wattages

Occupancy Sensors	Base Lighting Wattages (W)
Switch plate mounted sensor	150
Ceiling/wall mounted sensor	300
Fixture mounted sensor (high bay) for fixtures ≥ 100W – 150W	120
Fixture mounted sensor (all other) for fixtures < 100W	30

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[1] ASHRAE Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings

Conservation Measure Assumptions

Table 2 – Energy Saving Factors[2]

Occupancy Sensors	Energy Saving Factor
Switch plate mounted sensor	0.285
Ceiling/wall mounted sensor	0.41
Fixture mounted sensor (high bay) for fixtures ≥ 100W	0.41
Fixture mounted sensor (all other) for fixtures < 100W	0.41

Assumed Hours of Operation

Table 3 - Lighting hours based on Facility Types

Facility Type	Assumed Annual Operating Hours
Lighting - Food Retail	6074
Lighting – Hospital	5182
Lighting - Large Hotel (Corridor/Lobby)	7884
Lighting - Large Non-Food Retail	3121
Lighting - Large Office	3610
Lighting - Nursing Home	4308
Lighting - Other Commercial Buildings	4000
Lighting - Other Non-Food Retail	4089
Lighting – Restaurant	5110
Lighting – Schools	2596
Lighting - University Colleges	3255
Lighting - Warehouse Wholesale	4408
Lighting - Industrial	4473

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Lighting Wattage (W) x Operating Hours (H) x Energy Saving Factor x kW/1000 W x Adjustment Factor[3]

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[2] 2015 Prescriptive Lighting Measure Review, Navigant. Values sourced from Illinoi TRM

[3] Assume 95% to account for 95% with no sensor and 5% for existing sensor for all occupancy sensors except switch plate mounted occupancy sensor.

Table 4 – Annual Energy Savings (kWh)

End Use	Switch plate mounted sensor	Ceiling/ wall mounted sensor	Fixture mounted sensor (high bay) for fixtures ≥ 100W	Fixture mounted sensor (all other) for fixtures < 100W
Food Retail	259.66	709.75	283.90	70.97
Hospital	221.53	605.52	242.21	60.55
Large Hotel (Corridor/Lobby)	337.04	921.25	368.50	92.12
Large Non-Food Retail	133.42	364.69	145.88	36.47
Large Office	154.33	421.83	168.73	42.18
Nursing Home	184.17	503.39	201.36	50.34
Other Commercial Buildings	171.00	467.40	186.96	46.74
Other Non-Food Retail	174.80	477.80	191.12	47.78
Restaurant	218.45	597.10	238.84	59.71
Schools	110.98	303.34	121.34	30.33
University Colleges	139.15	380.35	152.14	38.03
Warehouse Wholesale	188.44	515.07	206.03	51.51
Industrial	191.22	522.67	209.07	52.27

Connected Demand Savings

There is no connected demand savings attributable to this measure.

Summer Peak Demand Savings

Summer Peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with a Summer Peak Demand Factor from the Energy Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 5 – Summer Peak Demand Savings (kW)

End Use	Switch plate mounted sensor	Ceiling/ wall mounted sensor	Fixture mounted sensor (high bay) for fixtures ≥ 100W	Fixture mounted sensor (all other) for fixtures < 100W
Food Retail	0.0357	0.0977	0.0391	0.0098
Hospital	0.0251	0.0687	0.0275	0.0069
Large Hotel (Corridor/Lobby)	0.0441	0.1205	0.0482	0.0121
Large Non-Food Retail	0.0198	0.0541	0.0216	0.0054
Large Office	0.0196	0.0535	0.0214	0.0053
Nursing Home	0.0255	0.0696	0.0278	0.0070
Other Commercial Buildings	0.0157	0.0428	0.0171	0.0043

Other Non-Food Retail	0.0252	0.0689	0.0276	0.0069
Restaurant	0.0344	0.0941	0.0376	0.0094
Schools	0.0044	0.0120	0.0048	0.0012
University Colleges	0.0142	0.0389	0.0156	0.0031
Warehouse Wholesale	0.0223	0.0610	0.0244	0.0042
Industrial	0.0207	0.0565	0.0226	0.0056

End Use Load Profile

PSP-Business-Food_Retail-Lighting_Interior_General

PSP-Business-Hospital-Lighting_Interior_General

PSP-Business-Large_Hotel-Lighting_Interior_General

PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Large_Office-Lighting_Interior_General

PSP-Business-Nursing_Home-Lighting_Interior_General

PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General

PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General

PSP-Business-Restaurant-Lighting_Interior_General

PSP-Business-Schools-Lighting_Interior_General

PSP-Business-University_Colleges-Lighting_Interior_General

PSP-Business-Warehouse_Wholesale-Lighting_Interior_General

PSP-Business-Lighting_Industrial_General

EM&V Peak Definition

Table 6 – EM&V Peak Definition

Lighting End Use	**Summer Peak Demand (kW/kWh)**	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
Food Retail	0.01376%	0.01393%	0.01447%	0.01447%
Hospital	0.01134%	0.01042%	0.01436%	0.01120%

Large Hotel (Corridor/Lobby)	0.01309%	0.01415%	0.01563%	0.01514%
Large Non-Food Retail	0.01483%	0.01462%	0.01483%	0.01483%
Large Office	0.01268%	0.01132%	0.01796%	0.01477%
Nursing Home	0.01382%	0.01365%	0.01533%	0.01451%
Other Commercial Buildings	0.00915%	0.00400%	0.02356%	0.00411%
Other Non-Food Retail	0.01443%	0.01035%	0.02225%	0.02000%
Restaurant	0.01576%	0.01572%	0.01643%	0.01640%
Schools	0.00395%	0.00453%	0.00554%	0.00488%
University Colleges	0.01023%	0.01086%	0.01497%	0.01370%
Warehouse Wholesale	0.01185%	0.00736%	0.02308%	0.01000%
Industrial	0.01080%	0.00946%	0.02252%	0.01086%

Effective Useful Life (EUL)

EUL of occupancy sensors is estimated to be 32,000 hours.[4]

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Oct. 2008
1	Added end use load profiles based on BEACON Modeling Tool	Dec. 2010
2	Updated measure description, savings estimates, incremental costs and savings estimates.	Jul. 2013

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[4] 2015 Prescriptive Lighting Measure Review, Navigant. Values sourced from Illinoi TRM.

3	Updated measure description, savings estimates, incremental costs and savings estimates.	Sep. 2016
4	Revised fixture mounted and ceiling mounted assumptions.	Aug. 2018
5	Updated life cycle incremental costs	Sep. 2020
6	Updated formatting	Jan. 2024
7	Updated EM&V peak definition, Peak Demand Savings and references. Added Industrial Lighting End Use category	Jan. 2025

Refrigerated Display Case LED Fixture

Measure Description

Energy Efficient Equipment Description

Refrigerated display case LED lighting

- Horizontal Installation shall be less than 13W with nominal length of 24” to 48”.
- Vertical Installation shall be less than 30W with nominal length of 48” to 72”

Base Equipment Description

Measure mix (80% T8 and 20% T12)

Code, Standards and Regulations

Fixtures must be listed and approved by the Design Light Consortium (DLC) and categorized as a horizontal / vertical refrigerated case luminaire. Luminaire must have an external driver.

Resource Savings Assumptions

Measure Assumptions

Table 1 – Base measure wattages (kW)[1]

Refrigerated Display Case Installation Type	Wattage (kW)
Measure mix 80% T8 (24.6W), 20% T12 (30W). Average of 2'-4' T8 (17W, 25W, 32W) Average of 2'-4' T12 (20W, 30W, 40W)	0.026

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[1] Lighting baseline adjustment (2018)

Measure mix 80% T8 (39W), 20% T12 (49W). Average of 4'-6' T8 (32W, 40W, 46W) Average of 4'-6' T12 (40W, 50W, 57W)	0.041

Table 2 – Efficient measure wattages (kW)

Refrigerated Display Case Installation Type	Wattages (kW)
Horizontal installation (<12 W per fixture)	0.012
Vertical installation (<30W per fixture)	0.029

Annual operating hours – assume lighting – food retail hours (6074 hours)

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{conservation}$ = Conservation Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{conservation}$

Table 3 – Annual energy savings (kWh/yr)

Refrigerated Display Case Installation Type	Annual Energy Savings (kWh)
Horizontal installation	85.04
Vertical installation	72.89

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 4 – Connected demand savings (kW)

Refrigerated Display Case Installation Type	Connected Demand Savings (kW)
Horizontal installation	0.014
Vertical installation	0.012

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

End Use Load Profile

PSP-Business-Commercial-Refrigerated_Display_Case_Food Retail

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01422%	0.01220%	0.02406%	0.01579%

Effective Useful Life (EUL)

LED fixtures lifespan assumed to be 50,000 hours[2]. Assuming lighting – food retail hours as 6074, EUL is 8 years.

Revision History

Revision #	Description/Comment	Date Revised
0	Included in the Measures and Assumptions List	Oct. 2008
1	Base case upgraded to T8	Jan. 2016
2	Baseline equipment cost updated	Jun. 2019
3	Updated lifetime incremental costs + baseline adjustments	Sep. 2020
4	Updated references and formatting	Dec. 2023
5	Updated the EM&V peak definition, Peak Demand Savings, and associated references	Jan. 2025

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024, 4.5.4 LED Bulbs and Fixtures https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Small Business Program Measures (Non-Lighting)

Automatic Door Closer

Walk-in Coolers and Freezers

Measure Description

Energy Efficient Equipment Description

The efficient case includes adding an automatic door closer on walk-in cooler or freezer doors that was previously not equipped with one. This measure saves energy by reducing the infiltration of warm air into the refrigeration case by reducing the amount of time that doors are open. The door must firmly close the door when it is within 1 inch of full closure.

Base Equipment Description

The baseline is assumed to be a walk-in cooler or freezer without an automatic door closer.

Code, Standards and Regulations

No code, standards and regulations exist for automatic door closer.

Resource Savings Assumptions

Energy and Demand Savings[1]

The building energy simulation engine DOE-2 (version DOE-2.2-R52o) was used to simulate base case and measure case unit energy consumption (UEC), using modified DEER2020/2023 building prototypes and CZ2022 weather files.

The unit energy savings (UES) were calculated as the difference between the modeled total (whole building) energy consumption of the base case and measure case models per door subject to the measure.

The base case and measure case UEC were aggregated across four vintages (2003, 2007, 2011, and 2015) that represent median existing commercial building stock using the

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[1] California eTRM https://www.caetrm.com

DEER2020 commercial building weights and model post-processing methodology. The unit energy savings were averaged using 672 permutations or scenarios of various input assumptions for both cooler and freezer.

Given one cooler door and one freezer door per energy model, the per-door UES are equal to whole-building energymodel savings.

Energy Savings

Measure	Annual Energy Savings (kWh/yr)
Automatic door closer for walk-in coolers	1,566
Automatic door closer for walk-in freezers	3,031

Connected Demand Savings

Measure	Connected Savings (kW)
Automatic door closer for walk-in coolers	0.312
Automatic door closer for walk-in freezers	0.371

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$

Measure	Summer Peak Demand Savings (kW)
Automatic door closer for walk-in coolers	0.183
Automatic door closer for walk-in freezers	0.354

End Use Load Profile

PSP-Business-Commercial-Refrigeration

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01169%	0.01128%	0.01260%	0.01165%

Effective Useful Life (EUL)

Measure	EUL (years)
Automatic door close	8[2]

Revision History

Revision #	Description/Comment	Date Revised
0	Created the substantiation sheet	Jan. 2024
1	Updated by Resource Innovations	Jan. 2025

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[2] California eTRM https://www.caetrm.com

Condenser Coil Cleaning

Measure Description

Energy Efficient Equipment Description

Condenser coil cleaning for coolers and freezers

Base Equipment Description

Dirty condenser coils

Code, Standards and Regulations

No code, standards and regulations exist for cleaning condenser coils.

Resource Savings Assumptions

Measure Assumptions

Energy savings for this measure was adapted from the Business Refrigeration Program.

Energy and Demand Savings

Energy Savings

Measure	Annual Energy Savings (kWh/yr)[1]
Condenser coil cleaning (for coolers)	289
Condenser coil cleaning (for freezers)	243

Connected Demand Savings

No demand savings

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[1] 2017 Program Evaluation: Business Refrigeration Incentive (BRI) Local Program, Appendix B, Nov. 2018.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Measure	Summer Peak Demand Savings (kW)
Condenser coil cleaning (for coolers)	0.034
Condenser coil cleaning (for freezers)	0.028

End Use Load Profile

PSP-Business-Commercial-Refrigeration

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01169%	0.01128%	0.01260%	0.01165%

Effective Useful Life (EUL)

EUL is assumed to be one (1) year since cleaning condensing coil is an operations & maintenance measure.

Revision History

Revision #	Description/Comment	Date Revised
0	Created the substantiation sheet	Jan. 2024

ECM for Condenser Fans

Coolers and Freezers

Measure Description

Energy Efficient Equipment Description

Electronically commutated motors (ECM) installed on condenser fans in a cooler or freezer. These EC motors save energy by reducing the power required to run the condenser fan.

Base Equipment Description

Coolers and freezers with shaded-pole motor (SP) or permanent split capacitor (PSC) condenser fan motors.

Code, Standards and Regulations

Code of Federal Regulations requires condenser fans manufactured on or after January 1, 2009 must be equipped with electronically commutated motors (brushless direct current motors); permanent split capacitor-type motors; or 3-phase motors.[1]

There are currently no Canadian regulations on minimum energy efficiency for walk-in refrigerators and freezers.[2]

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[1] Code of Federal Regulations Section 431.306. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-R/subject-group-ECFR7b3ae3c843e7b5a/section-431.306

[2] https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiencyregulations/

Resource Savings Assumptions

Measure Assumptions

Table 1 – Condenser Fan Motor Efficiencies[3]

Input Watts	SP Efficiency	Weight[4]	PSC Efficiency	Weight[4]	EC Efficiency
9	17%	91%	43%	9%	72%
12	22%	91%	48%	9%	74%
16	22%	91%	48%	9%	74%
30 (1/25 HP)	25%	91%	53%	9%	76%
37 (1/20 HP)	25%	91%	53%	9%	76%
50 (1/15 HP)	25%	91%	53%	9%	76%
150 (1/5 HP)	25%	91%	53%	9%	76%

Note: SP (single-phase pole); PSC (permanent split capacitor);
EC (electronically commutated)

Load Factor (LF) = 0.9[5]

Duty Cycle (DC) = 0.57[6]

Average annual hours per year: 8760 hrs

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(\text{kWh/yr})_{\text{base}} = \text{HP}_{\text{motor}} \times \text{LF } (\%) \times 0.746 \text{ kW/hp} \times 1/\eta_{\text{base}} \times$ Duty Cycle x Hours per year (H)

Table 2 – Annual Baseline Energy Consumption (kWh/year)

Motor Size (W)	SP	PSC	Unknown
9	237.91	94.06	224.96
12	245.12	112.35	233.17
16	326.83	149.80	310.89
30 (1/25 HP)	539.27	254.37	513.63

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[3] California Technical Reference Manual https://www.caetrm.com (Fan Motor for a Refrigerated Display Case – Shaft Output Power of 9W, ECM Retrofit for a Walk-In Cooler or Freezer – Typical Evaporator Fan 1/40 hp, ECM Retrofit for a Walk-In Cooler or Freezer – Typical Evaporator Fan 1/20 hp)

[4] 2024 Wisconsin Focus on Energy Technical Reference Manual https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

[5] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs v4.1 January 31, 2024 https://mn.gov/commerce-stat/trm/releases/4.1.pdf

[6] Interim Framework Refrigeration Efficiency Program 2021 Evaluation Report, September 2022 https://ieso.ca/Sector-Participants/Energy-Efficiency/Evaluation-Measurement-and-Verification

37 (1/20 HP)	665.09	313.72	633.47
50 (1/15 HP)	898.78	423.95	856.04
150 (1/5 HP)	2,696.33	1,271.85	2,568.13

Annual Energy Consumption $(kWh/yr)_{ee} = HP_{motor}$ x LF (%) x 0.746 kW/hp x $1/\eta_{EE}$ x Duty Cycle x Hours per year (H)

Table 3 – Annual Energy Efficient Consumption (kWh/year)

Motor Size (W)	ECM
9	237.91
12	245.12
16	326.83
30 (1/25 HP)	539.27
37 (1/20 HP)	665.09
50 (1/15 HP)	898.78
150 (1/5 HP)	2,696.33

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{ee}$

Table 4 – Annual Energy Savings (kWh/year)

Motor Size (W)	SP	PSC	Unknown
9	181.74	37.88	168.79
12	172.25	39.47	160.30
16	229.66	52.63	213.73
30 (1/25 HP)	361.88	76.98	336.24
37 (1/20 HP)	446.31	94.94	414.69
50 (1/15 HP)	603.13	128.30	560.39
150 (1/5 HP)	1,809.38	384.90	1,681.18

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Power Reduction (kW) = HP_{motor} x LF (%) x 0.746 kW/hp x $(1/\eta_{base} - 1/\eta_{EE})$

Table 5 – Connected Demand Savings (kW)

Motor Size (W)	SP	PSC	Unknown
9	0.036	0.008	0.034
12	0.034	0.008	0.032
16	0.046	0.011	0.043
30 (1/25 HP)	0.072	0.015	0.067
37 (1/20 HP)	0.089	0.019	0.083
50 (1/15 HP)	0.121	0.026	0.112
150 (1/5 HP)	0.362	0.077	0.337

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 6 – Summer Peak Demand Savings (kW)

Motor Size (W)	SP	PSC	Unknown
9	0.022	0.005	0.020
12	0.020	0.005	0.019
16	0.027	0.006	0.025
30 (1/25 HP)	0.043	0.009	0.039
37 (1/20 HP)	0.053	0.011	0.049
50 (1/15 HP)	0.072	0.015	0.065
150 (1/5 HP)	0.215	0.046	0.196

End Use Load Profile

PSP-Business-Commercial-Refrigeration

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01188%	0.01121%	0.01266%	0.01165%

Effective Useful Life (EUL)

Measure	EUL (years)
ECM for Condenser Fans	15[7]

Revision History

Revision #	Description/Comment	Date Revised
0	Created the substantiation sheet	Jan. 2024
1	Updated by Resource Innovations	Jan. 2025

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[7] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs v4.1 January 31, 2024 https://mn.gov/commerce-stat/trm/releases/4.1.pdf

ECM for Evaporator Fans

Coolers and Freezers

Measure Description

Energy Efficient Equipment Description

Electronically commutated motors (ECM) installed on evaporator fans for reach-in or walk-in refrigerated cases. These EC motors save energy by decreasing the power required to run the evaporator fan, as well as reducing the cooling load by removing waste heat generated by older fans, i.e. interactive effects.

Base Equipment Description

The reach-in or walk-in refrigerated case uses an uncontrolled and continuously run single-phase pole (SP) or permanent split capacitor (PSC) evaporator fan.

Code, Standards and Regulations

The Code of Federal Regulations requires that condenser fans manufactured on or after January 1, 2009 must be equipped with EC, PSC, or three-phase motors.[1]

There are currently no Canadian regulations on minimum energy efficiency for walk-in refrigerators and freezers. However, high-efficiency options can be specified when ordering new units or when retrofitting existing units.[2]

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[1] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 12 (effective Jan. 1, 2025) https://dps.ny.gov/system/files/documents/2024/12/technical-resource-manual-version-12-filed-october-28-2024-effective-january-1-2025.pdf

[2] https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/commercial-refrigeration-self-contained/6871

Resource Savings Assumptions

Measure Assumptions

Table 1 – Evaporator Fan Motor Efficiencies[3]

Input Watts	SP Efficiency	Weight[4]	PSC Efficiency	Weight[4]	ECM Efficiency
9	17%	91%	43%	9%	72%
12	22%	91%	48%	9%	74%
16	22%	91%	48%	9%	74%
30 (1/25 HP)	25%	91%	53%	9%	76%
37 (1/20 HP)	25%	91%	53%	9%	76%
50 (1/15 HP)	25%	91%	53%	9%	76%
150 (1/5 HP)	25%	91%	53%	9%	76%

Note: SP (single-phase pole); PSC (permanent split capacitor);
EC (electronically commutated)

Load Factor (LF) = 0.9[5]

$\%ON_{Uncontrolled}$ = Effective runtime of the motor without controls, if runtime is unknown, assume 97.8%[5]

Annual operating hours = 8760 hrs

Table 2 – Waste Heat Factor

Refrigeration Equipment	Existing Motor Type	Waste Heat Factor, WHF_e
Cooler	Single-phase Pole (SP)	1.38
Cooler	Permanent Split Capacitor (PSC	1.19
Freezer	Single-phase Pole (SP)	1.76
Freezer	Permanent Split Capacitor (PSC	1.38

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[3] California Technical Reference Manual https://www.caetrm.com (Fan Motor for a Refrigerated Display Case – Shaft Output Power of 9W, ECM Retrofit for a Walk-In Cooler or Freezer – Typical Evaporator Fan 1/40 hp, ECM Retrofit for a Walk-In Cooler or Freezer – Typical Evaporator Fan 1/20 hp)

[4] 2024 Wisconsin Focus on Energy Technical Reference Manual https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

[5] State of Pennsylvania Technical Reference Manual, Volume 3: Commercial & Industrial Measures. Sep. 2024 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base} = HP_{Base} \times 0.746/\eta_{Base} \times LF \times \%ON_{Uncontrolled} \times$ Operating Hours $\times\ WHF_e$

Table 3 – Annual Baseline Energy Consumption (kWh/year)

Motor Size (W)	Cooler (SP)	Cooler (PSC)	Cooler (Unknown)	Freezer (SP)	Freezer (PSC)	Freezer (Unknown)
	563.32	192.05	529.91	718.44	222.71	673.83
12	580.39	229.39	548.80	740.21	266.01	697.54
16	773.86	305.85	731.74	986.95	354.69	930.05
30 (1/25 HP)	1,276.87	519.37	1,208.69	1,628.47	602.30	1,536.11
37 (1/20 HP)	1,574.80	640.56	1,490.72	2,008.44	742.83	1,894.54
50 (1/15 HP)	2,128.11	865.62	2,014.49	2,714.11	1,003.83	2,560.19
150 (1/5 HP)	6,384.34	2,596.86	6,043.46	8,142.34	3,011.48	7,680.57

Annual Energy Consumption $(kWh/yr)_{ee} = HP_{ee} \times 0.746/\eta_{ee} \times LF \times \%ON_{Uncontrolled} \times$ Operating Hours $\times\ WHF_e$

Table 4 – Annual Efficient Energy Consumption (kWh/year)

Motor Size (W)	Cooler (SP)	Cooler (PSC)	Cooler (Unknown)	Freezer (SP)	Freezer (PSC)	Freezer (Unknown)
9	133.01	114.69	131.36	169.63	133.01	166.34
12	172.55	148.79	170.41	220.06	172.55	215.79
16	230.07	198.39	227.22	293.42	230.07	287.72
30 (1/25 HP)	420.02	362.19	414.82	535.68	420.02	525.27
37 (1/20 HP)	518.03	446.70	511.61	660.67	518.03	647.83
50 (1/15 HP)	700.04	603.66	691.36	892.80	700.04	875.45
150 (1/5 HP)	2,100.11	1,810.97	2,074.09	2,678.40	2,100.11	2,626.36

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{ee}$

Table 5 – Annual Energy Savings (kWh/year)

Motor Size (W)	Annual Energy Savings for Cooler	Annual Energy Savings for Freezer
9	398.55	507.49
12	378.39	481.75
16	504.52	642.33
30 (1/25 HP)	793.88	1,010.84
37 (1/20 HP)	979.11	1,246.70
50 (1/15 HP)	1,323.13	1,684.74
150 (1/5 HP)	3,969.38	5,054.21

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Demand Savings (kW) = HP x 0.746 x $(1/\eta_{Base} - 1/\eta_{ee})$ x LF

Table 6 – Connected Demand Savings (kW)

Motor Size (W)	Connected Demand Savings (kWh) for Coolers	Connected Demand Savings (kWh) for Freezers
9	0.034	0.034
12	0.032	0.032
16	0.043	0.043
30	0.067	0.067
37	0.083	0.083
50	0.112	0.112
150	0.337	0.337

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 7 – Summer Peak Demand Savings (kW)

Motor Size (W)	Summer Peak Demand Savings (kWh) for Coolers	Summer Peak Demand Savings (kWh) for Freezers
9	0.047	0.059
12	0.044	0.056
16	0.059	0.075
30	0.093	0.118
37	0.114	0.146
50	0.155	0.197
150	0.464	0.591

End Use Load Profile

PSP-Business-Commercial-Refrigeration

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01169%	0.01128%	0.01260%	0.01165%

Effective Useful Life (EUL)

Measure	EUL (years)
ECM for Evaporator Fans	15[6]

Revision History

Revision #	Description/Comment	Date Revised
0	Created the substantiation sheet	Jan. 2024
1	Updated by Resource Innovations	Jan. 2025

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[6] State of Pennsylvania Technical Reference Manual, Volume 3: Commercial & Industrial Measures. Sep. 2024 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

Night Cover

Reach-in Coolers

Measure Description

Energy Efficient Equipment Description

Retractable curtains on horizontal and vertical open refrigerated display cases. These covers are deployed during off-business hours and create a thermal barrier against circulating ambient air, therefore saving energy by reducing the load on the refrigeration system.

Base Equipment Description

Refrigerated display case is of open type, and there is no thermal barrier between ambient air and inside the display case.

Code, Standards and Regulations

No code, standards and regulations exist for night covers.

Resource Savings Assumptions

Measure Assumptions

TDEC = Total daily energy consumption (kWh/day); calculated based on the total display area (TDA)

TDA = Total display area (length x height)

Length = Length of the night cover

Height = Height of the night cover; assume 6.5 ft.

ESF = Energy savings factor; 0.015 x hourly usage of night cover per day assumed to be 6 hours per day, hence, assume 0.09

Annual Days of the Year = 365 days

Table 1 – Total Daily Energy Consumption Algorithm[1, 2]

Equipment Family[2]	**Condensing Unit Configuration**	**Rating Temperature**	**TDEC Algorithm**
Vertical Open	Remote Condensing	Medium (38°F)	(0.64 x TDA) + 4.07
Vertical Open	Remote Condensing	Low (0°F)	(2.20 x TDA) + 6.85
Vertical Open	Self-Contained	Medium (38°F)	(1.69 x TDA) + 4.71
Vertical Open	Self-Contained	Low (0°F)	(4.25 x TDA) + 11.82
Horizontal Open	Remote Condensing	Medium (38°F)	(0.35 x TDA) + 2.88
Horizontal Open	Remote Condensing	Low (0°F)	(0.55 x TDA) + 6.88
Horizontal Open	Self-Contained	Medium (38°F)	(0.72 x TDA) + 5.55
Horizontal Open	Self-Contained	Low (0°F)	(1.90 x TDA) + 7.08

Table 2 – Total Daily Energy Consumption (kWh/day)

Equipment Family	**Condensing Unit Configuration**	**Rating Temperature**	**TDEC (4' length)**	**TDEC (6' length)**
Vertical Open	Remote Condensing	Medium (38°F)	21	29
Vertical Open	Remote Condensing	Low (0°F)	64	93
Vertical Open	Self-Contained	Medium (38°F)	49	71
Vertical Open	Self-Contained	Low (0°F)	122	178
Horizontal Open	Remote Condensing	Medium (38°F)	12	17
Horizontal Open	Remote Condensing	Low (0°F)	21	28
Horizontal Open	Self-Contained	Medium (38°F)	24	34
Horizontal Open	Self-Contained	Low (0°F)	56	81

Energy and Demand Savings

Energy Savings[1]

Annual Energy Savings (kWh/yr) = TDEC x ESF x 365

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[1] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 11 (effective Jan. 1, 2024) https://dps.ny.gov/system/files/documents/2023/12/nys-trm-v11_filing.pdf

[2] The ice cream rating temperature was excluded from the calculations of daily usage, as the majority of units are expected to be in the higher temperature range.

Table 3 – Annual Energy Savings (kWh/year)

Equipment Family	Condensing Unit Configuration	Rating Temperature	Annual Energy Savings (4' length)	Annual Energy Savings (6' length)
Vertical Open	Remote Condensing	Medium (38°F)	680	954
Vertical Open	Remote Condensing	Low (0°F)	2,104	3,044
Vertical Open	Self-Contained	Medium (38°F)	1,598	2,320
Vertical Open	Self-Contained	Low (0°F)	4,018	5,833
Horizontal Open	Remote Condensing	Medium (38°F)	394	543
Horizontal Open	Remote Condensing	Low (0°F)	696	931
Horizontal Open	Self-Contained	Medium (38°F)	797	1,105
Horizontal Open	Self-Contained	Low (0°F)	1,855	2,667
Average			**1,518**	**2,174**

Connected Demand Savings

No demand savings.

Summer Peak Demand Savings

Summer peak demand savings is assumed to be zero since night covers are used during off-peak hours.

Effective Useful Life (EUL)

Measure	EUL (years)
Night cover	5[3]

Revision History

Revision #	Description/Comment	Date Revised
0	Created the substantiation sheet	Jan. 2024
1	Updated by Resource Innovations	Jan. 2025

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[3] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 11 (effective Jan. 1, 2024) https://dps.ny.gov/system/files/documents/2023/12/nys-trm-v11_filing.pdf

Strip Curtains

Walk-in Coolers & Freezers

Measure Description

Energy Efficient Equipment Description

Strip curtains for walk-in coolers and freezers. Strip curtains reduce the refrigeration load associated with the infiltration of non-refrigerated air into the refrigerated spaces of walk-in coolers or freezers.[1]

Base Equipment Description

No strip curtains installed.

Code, Standards and Regulations

No code, standards and regulations exist for strip curtains.

Resource Savings Assumptions

Measure Assumptions

Table 1 – Default Energy Savings and Assumed Door Area[2]

Facility Type	**Pre-Existing Curtains**	**Doorway Area (sq. ft.)**	**Annual Energy Savings per sq ft (Cooler)**	**Annual Energy Savings per sq ft (Freezer)**
Supermarket	Yes	21	40.9	168.5
Supermarket	No	21	119.9	494.3
Convenience Store	Yes	21	6.3	10
Convenience Store	No	21	23.6	33.2
Restaurant	Yes	21	6.2	32.4
Restaurant	No	21	22.5	114

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[1] Wisconsin Focus on Energy 2024 Technical Reference Manual, Jan. 07, 2024
https://assets.focusonenergy.com/production/inline-files/Focus-on-Energy-2024-TRM.pdf

[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Annual Energy Savings per sq ft x Door Area

Table 2 – Annual Energy Savings (kWh/year)

Facility Type	Pre-Existing Curtains	Annual Energy Savings (Cooler)	Annual Energy Savings (Freezer)
Supermarket	Yes	859	3,539
Supermarket	No	2,518	10,380
Convenience Store	Yes	132	210
Convenience Store	No	496	697
Restaurant	Yes	130	680
Restaurant	No	473	2,394
Average		**768**	**2,983**

Connected Demand Savings

No connected demand savings.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 3 – Summer Peak Demand Savings (kW)

Facility Type	Pre-Existing Curtains	Summer Peak Demand Savings (Cooler)	Summer Peak Demand Savings (Freezer)
Supermarket	Yes	0.100	0.414
Supermarket	No	0.294	1.213
Convenience Store	Yes	0.015	0.025
Convenience Store	No	0.058	0.081
Restaurant	Yes	0.015	0.080
Restaurant	No	0.055	0.280
Average		**0.090**	**0.349**

End Use Load Profile

PSP-Business-Commercial-Refrigeration

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01169%	0.01128%	0.01260%	0.01165%

Effective Useful Life (EUL)

Measure	EUL (years)
Strip curtains	4[3]

Revision History

Revision #	Description/Comment	Date Revised
0	Created the substantiation sheet	Jan. 2024
1	Updated by Resource Innovations	Jan. 2025

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Smart Thermostat

Measure Description

Energy Efficient Equipment Description

Web-enabled smart thermostat installed in small commercial and industrial buildings. These thermostats are capable of remotely adjusting the set point and/or establishing a schedule of time.

Base Equipment Description

The HVAC system is a single-zone, and includes only packaged HVAC units of 10 tons or less. The HVAC is controlled by a manual or programmable thermostat.[1]

Code, Standards and Regulations

No code, standards and regulations exist for this measure.

Resource Savings Assumptions

Measure Assumptions[1]

%ElecHeat – Percentage of heating savings assumed to be electric; if heat source is unknown, assume 0.08

$kBtu/hr_{heat}$ – Capacity of the heating equipment; if unknown, assume 114.5

$kBtu/hr_{cool}$ – Capacity of the cooling equipment; if unknown, assume 61

HSPF2 – Heating seasonal performance factor, if unknown, assume 5.1

SEER2 - Cooling seasonal energy efficiency ratio, if unknown, assume 12.4

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 (4.4.48) https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

$EFLH_{heat}$ - Equivalent full load heating hours, see Table 1[2]

$EFLH_{cool}$ - Equivalent full load cooling hours, see Table 2[3]

Heating_Reduction - Percentage reduction in heating energy consumption due to thermostat; assume 8.8%

Cooling_Reduction - Percentage reduction in cooling energy consumption due to thermostat; assume 17.7%

ΔTherms – Therm savings if heating source is gas (kBtu); calculated as follows:

$$\Delta Therms = ((1 - \%ElecHeat) \times EFLH_{heat}) \times Capacity \times 1/AFUE \times Heating\_Reduction \times BAF)/100{,}000$$

Table 1 – Equivalent Full Load Heating Hours

Facility Type	Eastern Ontario (Ottawa)	Southern Ontario (Toronto & Waterloo)	Northern Ontario (Sault Ste Marie)	Southern West Ontario (Windsor)	GTA (Mississauga)
Weight Percentage	**26%**	**12%**	**26%**	**10%**	**26%**
MURBs	552	484	354	277	363
Auto Repair	3,649	3,455	1,221	809	3,325
Big Box Retail	620	509	1,221	809	554
Fast Food Restaurant	1,690	1,526	2,109	1,151	1,426
Full-Service Restaurant	1,746	1,602	2,109	1,151	1,502
Grocery	620	509	1,068	733	554
Manufacturing Facility	1,286	1,320	568	406	1,278
Hotel/Motel - Guest	832	787	3,846	2,371	1,037
Religious Building	1,015	1,006	1,719	1,178	954
Small Office	861	793	527	321	747
Small Retail	1,134	1,006	1,221	809	984
Warehouse	1,094	1,023	1,258	847	916
Unknown	1,309	1,156	1,224	779	1,195
University / College	1,028	1,092	1,078	719	923
High School	654	602	1,018	636	601
Hospital	1,958	2,012	71	147	2,193
Hotel/Motel - Common	977	855	3,846	2,371	915
Large Office	1,733	1,496	527	321	1,572

MURBS – Multi Unit Residential Buildings

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[2] Conducted a Cooling Degree Days (CDD) and Heating Degree Days (HDD) analysis of other jurisdictional cities and mapped them to Ontario cities. Extract the Equivalent Full Load Hours (EFLH) values from those cities in available TRMs and use them for Ontario cities

[3] Conducted a Cooling Degree Days (CDD) and Heating Degree Days (HDD) analysis of other jurisdictional cities and mapped them to Ontario cities. Extract the Equivalent Full Load Hours (EFLH) values from those cities in available TRMs and use them for Ontario cities

Table 2 – Equivalent Full Load Cooling Hours

Facility Type	Eastern Ontario (Ottawa)	Southern Ontario (Toronto & Waterloo)	Northern Ontario (Sault Ste Marie)	Southern West Ontario (Windsor)	GTA (Mississauga)
Weight Percentage	**26%**	**12%**	**26%**	**10%**	**26%**
MURBs	668	684	577	1395	782
Auto Repair	223	244	464	735	272
Big Box Retail	688	760	464	735	769
Fast Food Restaurant	436	501	374	550	512
Full-Service Restaurant	389	514	374	550	437
Grocery	688	760	542	654	769
Manufacturing Facility	370	435	309	570	400
Hotel/Motel - Guest	997	959	1,084	1,386	734
Religious Building	204	202	455	753	227
Small Office	671	714	323	458	742
Small Retail	599	644	464	735	642
Warehouse	228	194	86	174	234
Unknown	474	572	647	873	501
University / College	597	550	369	640	714
High School	420	411	139	267	433
Hospital	1,243	1,145	977	1,030	1,242
Hotel/Motel - Common	2,858	3,131	1,084	1,386	2,797
Large Office	981	946	323	458	1074

MURBS – Multi Unit Residential Buildings

EER2 - Energy efficiency ratio of the equipment; assume 10.9 Btu-W/hr

Capacity - Nominal heating input capacity of heating system; assume 114,500 Btu/hr

AFUE - Annual fuel utilization efficiency rating; assume 0.8

BAF – Baseline adjustment factor, assume 0.8

F_e - Ratio of energy consumed by the furnace fan to the annual fuel consumption, assume 7.7%

29.3 – kWh per Therm

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = Annual Energy Savings $(kWh/yr)_{heating}$ + Annual Energy Savings $(kWh/yr)_{cooling}$

Annual Energy Savings $(kWh/yr)_{heating}$ = (%ElecHeat x $kBtu/hr_{heat}$ x 1/HSPF2 x $EFLH_{heat}$ x Heating_Reduction x BAF) + (ΔTherms x F_e x 29.3)

Annual Energy Savings $(kWh/yr)_{cooling}$ = $kBtu/hr_{cool}$ x 1/SEER2 x $EFLH_{cool}$ x Cooling_Reduction x BAF

Table 3 – Annual Energy Savings (kWh/yr)

Facility Type	Annual Energy Savings (kWh)
MURBs	661
Auto Repair	1,127
Big Box Retail	719
Fast Food Restaurant	876
Full-Service Restaurant	869
Grocery	712
Manufacturing Facility	612
Hotel/Motel - Guest	1,296
Religious Building	632
Small Office	635
Small Retail	773
Warehouse	482
Unknown	800
University / College	727
High School	477
Hospital	1,249
Hotel/Motel - Common	2,193
Large Office	947
Average	**877 kWh/yr**

MURBS – Multi Unit Residential Buildings

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = $kBtu/hr_{cool}$ x 1/EER2 x Cooling_Reduction x BAF

Demand Savings (kW) = 61 x (1/10.9) x 17.7% x 0.8 = 0.792 kW

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kWpeak = \Delta kWh_{cooling}$ * Summer Peak Demand Factor

Table 4 – Summer Peak Demand Savings (kW)

Facility Type	Annual Energy Savings (kWh)
MURBs	661
Auto Repair	1,127
Big Box Retail	719
Fast Food Restaurant	876
Full-Service Restaurant	869
Grocery	712
Manufacturing Facility	612
Hotel/Motel - Guest	1,296
Religious Building	632
Small Office	635
Small Retail	773
Warehouse	482
Unknown	800
University / College	727
High School	477
Hospital	1,249
Hotel/Motel - Common	2,193
Large Office	947
Average	**877 kWh/yr**

End Use Load Profile

PSP-Business-Commercial-Cooling_DX

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.05114%	0.00000%	0.09330%	0.00000%

Effective Useful Life (EUL)

Measure	EUL (years)
Smart Thermostat	11[4,5]

Revision History

Revision #	Description/Comment	Date Revised
0	Created the substantiation sheet	Jan. 2024
1	Updated by Resource Innovations	Jan. 2025

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[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 (4.4.48) https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[5] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 11 (effective Jan. 1, 2024) https://dps.ny.gov/system/files/documents/2023/12/nys-trm-v11_filing.pdf

Residential Measures (Prescriptive)

Energy Star® Compact Chest Freezer

Measure Description

Energy Efficient Equipment Description

Energy Star certified residential compact chest freezer with a max refrigerated volume <7.75 ft3.

Base Equipment Description

Existing standard residential compact freezer baseline equipment is assumed to be a model that meets the federal minimum standard for energy efficiency.

Code, Standards and Regulations

Both Canada's Energy Efficiency Regulations[1] and Ontario regulation 404/12[2] state that the residential compact chest freezer with a max refrigerated volume <7.75 ft^3 and manufactured on or after September 15, 2014 must meet the following energy efficiency standard:

Product Type	**Max. Energy Consumption (kWh/yr)[3]**
Compact chest freezers and all other compact freezers	9.25 x *AV + 136.8

*AV - Adjusted volume of the freezer in ft^3 = Freezer Volume x 1.73

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[1] Canada's Energy Efficiency Regulations on Freezers https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6941

[2] Ontario Regulation 404/12 Energy and Water Efficiency – Appliance and Products https://www.ontario.ca/laws/regulation/120404

[3] Canada's Energy Efficiency Regulations on Freezers https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6941

Resource Savings

Base Measure Assumptions

Existing standard residential compact chest freezer manufactured after September 15 2014 and the baseline Unit Energy Consumption (UEC_{base})[4]

Base Measure Assumptions

Compact chest freezer size[5] = 5.49 ft^3

AV = adjusted volume = Freezer Volume x 1.73 = 5.49 ft^3 x 1.73 = 9.5 ft^3

UEC_{base} – Baseline unit energy consumption

UEC_{base} = 9.25 x AV + 136.8 = 224.7 kWh/yr

Energy Efficient Measure Assumptions

Energy Star certified residential compact chest freezer replacing existing standard residential compact chest freezer having average freezer volume of less than 7.75 ft^3 and 36 inches or less in height. The Unit Energy Consumption of the efficient measure (UECee) is based on Energy Star Standard[6]

UEC_{ee} – The unit energy consumption of the Energy Efficient measure

UEC_{ee} = 8.33 x AV + 123.1 = 8.33 x 9.5 + 123.1 = 202.2 kWh/yr

Energy and Demand Savings[7]

Energy Savings

Annual Energy Savings (ΔkWhsavings) = UEC_{base} – UEC_{ee} = 224.7 kWh/yr – 202.2 kWh/yr = 22.4 kWh/yr

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[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 13.0 Volume 3: Residential Measures, Final, Sep. 20, 2024, Section 5.1.5 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[5] Energy Star certified-residential-freezers-2024-11-12 list

[6] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 13.0 Volume 3: Residential Measures, Final, Sep. 20, 2024, Section 5.1.5 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[7] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 13.0 Volume 3: Residential Measures, Final, Sep. 20, 2024, Section 5.1.5 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Connected Demand Savings

The average connected demand savings (kW) is the annual energy savings divided by the annual operating hours (HOU). Assume 8760 hours.

Average connected demand savings (kW) = 22.4 / 8760 = 0.0026

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kW_{peak} = \Delta kWh * \text{Summer Peak Demand Factor}$

$\Delta kW_{peak} = 35.26 \times 0.0001321 = 0.0030 \text{ kW}$

End Use Load Profile

PSP-Consumer-Residential-Freezers

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.01321%	0.01131%	0.01403%	0.01142%

Effective Useful Life (EUL)

Measure	**EUL (years)**
Compact Chest Freezer	10[8]

Revision History

Revision #	**Description/Comment**	**Date Revised**
0	Created in Measures & Assumptions List	Sep. 2020

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[8] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 13.0 Volume 3: Residential Measures, Final, Sep. 20, 2024, Section 5.1.5

https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

1	Reclassify Compact Chest Freezer and Early Retirement Baseline	Nov. 2021
2	Updated references and formatting	Nov. 2023
3	Updated by Resource Innovations	Jan. 2025

Energy Star® Freezer

Measure Description

Energy Efficient Equipment Description

Residential Energy Star certified freezers in the following categories:

- Freezer Replacement (ENERGY STAR Qualified 7.75-12 cu ft)
- Freezer Replacement (ENERGY STAR Qualified 12-14.4 cu ft)
- Freezer Replacement (ENERGY STAR Qualified 14.5 - 16.0 cu ft)

Base Equipment Description

Early replacement of existing residential freezers.

Code, Standards and Regulations

Both Canada's Energy Efficiency Regulations[1] and Ontario regulation 404/12[2] state residential freezer with a max capacity of 850 L (30 ft^3) and manufactured on or after September 15, 2014 must meet the following energy efficiency standard (note, AV= Adjusted Volume = Freezer Volume x 1.73):

Table 1 - Energy performance standard for freezers[3]

Type	Size*	Defrost	Ice Maker	Max. Energy Consumption (kWh/yr)**
Freestanding Upright	Large	Automatic	Yes	0.305 x AV + 312.3
Freestanding Upright	Large	Automatic	No	0.305 x AV + 228.3

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[1] Canada's Energy Efficiency Regulations on Freezers https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6941

[2] Ontario Regulation 404/12 Energy and Water Efficiency – Appliance and Products https://www.ontario.ca/laws/regulation/120404

[3] Canada's Energy Efficiency Regulations on Freezers https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6941

Freestanding Upright	Large	Manual	No	0.197 x AV + 193.7
Freestanding Upright	Compact	Automatic	No	0.359 x AV + 351.9
Freestanding Upright	Compact	Manual	No	0.306 x AV + 225.7
Built-in Upright	Large	Automatic	Yes	0.348 x AV + 344.9
Built-in Upright	Large	Automatic	No	0.348 x AV + 260.9
Chest	with automatic defrost system	with automatic defrost system	with automatic defrost system	0.362 x AV + 148.1
Chest	All other chest freezers	All other chest freezers	All other chest freezers	0.257 x AV + 107.8
Chest	compact chest freezers and all other compact freezers	compact chest freezers and all other compact freezers	compact chest freezers and all other compact freezers	0.327 x AV + 136.8

*Compact is a refrigerated volume less than 7.75 ft3

** AV = Adjusted volume of the freezer in liters (Freezer volume x1.73)

Resource Savings

Measure Assumptions

Base Measure Assumptions

Early replacement of existing freezer assuming existing annual unit energy consumption (UEC_{exist}) for one third of effective useful life (EUL)[4]. A new baseline (UEC_{base}) meeting Canada energy efficiency regulations will be assumed for the remaining two thirds of the EUL[5].

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[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep 20, 2024, Section 5.1.5 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[5] Canada's Energy Efficiency Regulations on Freezers https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6941

Table 2 – Baseline Unit Energy Consumption (kWh/yr)

Type	Capacity Range (ft^3)	Average volume (cu ft)	UEC_{exist}[6]	UEC_{base}
Upright Freezers with automatic defrost	ENERGY STAR Qualified 7.75≤ and <12.0	9.9	713	375.8
Upright Freezers with automatic defrost	ENERGY STAR Qualified 12.0≤ and <14.5	13.25	713	426.3
Upright Freezers with automatic defrost	ENERGY STAR Qualified 14.5≤ and <16.0	15.25	713	456.2
Chest Freezers and all other freezers	ENERGY STAR Qualified 7.75≤ and <12.0	9.9	435	232.1
Chest Freezers and all other freezers	ENERGY STAR Qualified 12.0≤ and <14.5	13.25	435	274.6
Chest Freezers and all other freezers	ENERGY STAR Qualified 14.5≤ and <16.0	15.25	435	299.8

Energy Efficient Measure Assumptions

Actual energy consumption values for UEC_{ee} and UEC_{exist} should be used when available. If the actual annual energy consumption is not available, default values should be used.

Table 3 – Energy Efficient unit energy consumption (kWh/yr)

Freezer Type	Capacity Range (ft^3)	ENERGY STAR Maximum Energy Usage in kWh/year	UEC_{ee}
Upright Freezers with automatic defrost	ENERGY STAR Qualified 7.75≤ and <12.0	7.76 x AV + 205.5	338.07
Upright Freezers with automatic defrost	ENERGY STAR Qualified 12.0≤ and <14.5	7.76 x AV + 205.5	383.38
Upright Freezers with automatic defrost	ENERGY STAR Qualified 14.5≤ and <16.0	7.76 x AV + 205.5	410.23
Chest Freezers and all other freezers	ENERGY STAR Qualified 7.75≤ and <12.0	6.56 x AV + 97.0	209.07
Chest Freezers and all other freezers	ENERGY STAR Qualified 12.0≤ and <14.5	6.56 x AV + 97.0	247.37
Chest Freezers and all other freezers	ENERGY STAR Qualified 14.5≤ and <16.0	6.56 x AV + 97.0	270.07

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[6] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, Version 11, Page 54-55 (Refrigerator and Freezer - Upright Freezer for year range of 2001-2010 for the size below 16.5 ft, Chest Freezer for year range of 2001-2010 for the size below 16.5 ft)
https://dps.ny.gov/system/files/documents/2023/12/nys-trm-v11_filing.pdf

Energy and Demand Savings

Energy Savings[7]

Annual Energy Consumption of the base measure, $(kWh/yr)_{base}$ = $(UEC_{exist}$ x %EREP) + $(UEC_{Base}$ x %REMAIN)

where: %EREP - percentage of EUL of existing operational unit; assumed one third of EUL or 33%

%REMAIN - percentage of EUL of a standard unit (1 - %EREP); assume 67%

Annual Energy Consumption of the energy effcient measure $(kWh/yr)_{ee}$ = UEC_{ee}

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{ee}$

Table 4 – Annual Energy Savings (kWh/yr) per freezer type and capacity

Freezer Type	Capacity Range (ft^3)	Base Measure Energy Consumption $(kWh/yr)_{base}$	Efficient Measure Energy Consumption $(kWh/yr)_{ee}$	Annual Energy Savings (kWh/yr)
Upright	7.75≤ and <12.0	488.2	338.1	150.16
Upright	12.0≤ and <14.5	521.8	383.4	138.47
Upright	14.5≤ and <16.0	541.8	410.2	131.54
Chest	7.75≤ and <12.0	299.8	209.1	90.68
Chest	12.0≤ and <14.5	328.1	247.4	80.71
Chest	14.5≤ and <16.0	344.9	270.1	74.80

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Average Demand Savings (kW) = Annual Energy Savings (kWh/yr) / 8760

Table 5 – Average Demand Savings (kW)

Freezer Type	Capacity Range (ft^3)	Base kW	Efficient kW	Average Demand Savings (kW)
Upright	7.75≤ and <12.0	0.0557	0.0386	0.0171

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[7] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep 20, 2024, Section 5.1.5
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Upright	12.0≤ and <14.5	0.0596	0.0438	0.0158
Upright	14.5≤ and <16.0	0.0618	0.0468	0.0150
Chest	7.75≤ and <12.0	0.0342	0.0239	0.0104
Chest	12.0≤ and <14.5	0.0375	0.0282	0.0092
Chest	14.5≤ and <16.0	0.0394	0.0308	0.0085

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$$\Delta kW_{peak} = \Delta kWh * \text{Summer Peak Demand Factor}$$

Table 6 – Average Demand Savings (kW)

Freezer Type	Capacity Range (ft3)	ΔkW Peak
Upright	7.75≤ and <12.0	0.0198
Upright	12.0≤ and <14.5	0.0183
Upright	14.5≤ and <16.0	0.0174
Chest	7.75≤ and <12.0	0.0120
Chest	12.0≤ and <14.5	0.0107
Chest	14.5≤ and <16.0	0.0099

End Use Load Profile

PSP-Consumer-Residential-Freezers

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01321%	0.01131%	0.01403%	0.01142%

Effective Useful Life (EUL)

Measure	EUL (years)
Energy Star® Freezer	12

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Feb. 2008
1	Updated using 2007 Great Refrigerator Roundup Program (GRRP) Report Data	May 2008
2	Updated using 2008 GRRP Report Data	Dec. 2009
3	Updated using 2009 GRRP Report Data	Dec. 2010
4	Updated with PY2016 HAP Program Evaluation	Jul. 2017
5	Updated with PY2017 HAP Program Evaluation	Oct. 2018
6	Updated with PY2019 HAP Program Evaluation	May 2020
7	Added 7.75-12 cubic foot measure	Nov. 2021
8	Program performance team decided not to proceed with updated fridge assumptions due to lower savings	Jan. 2024
9	Updated by Resource Innovations	Jan. 2025

Energy Star® Refrigerator

Measure Description

Energy Efficient Equipment Description

Residential Energy Star certified refrigerators in the following categories:

Refrigerator Replacement (ENERGY STAR Qualified 15.5 ≤ and <16.9 cu ft)

Refrigerator Replacement (ENERGY STAR Qualified 17.0≤ and <18.4 cu ft)

Refrigerator Replacement (ENERGY STAR Qualified 12.5≤ and <15.5 cu ft)

Refrigerator Replacement (ENERGY STAR Qualified 10.0 - <12.5 cu ft)

Base Equipment Description

Early replacement of existing residential refrigerator.

Code, Standards and Regulations

Both Canada's Energy Efficiency Regulations[1] and Ontario regulation 404/12[2] state residential refrigerators or combination refrigerator-freezer having compressor-cycled automatic defrost system with a maximum capacity of 1,100 L (39 ft^3) and manufactured on or after September 15, 2014 must not exceed the maximum annual energy consumption limits.

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[1] Canada's Energy Efficiency Standard for Refrigerators https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6877

[2] Ontario Regulation 404/12 Energy and Water Efficiency – Appliance and Products https://www.ontario.ca/laws/regulation/120404

Table 1 - Energy performance standard for Refrigerator[3]

Product Class	Baseline Maximum Energy Usage, UEC_{base} (kWh/yr)	ENERGY STAR Maximum Energy Usage (kWh/yr)
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker	8.07*AV+233.7	7.26*AV + 210.3

Resource Savings

Measure Assumptions

Base Measure Assumptions

Early replacement of existing unit assumes annual unit energy consumption (UECexist) for one third of effective useful life (EUL). UECexist is calculated based on Illinois TRM v13 Volume 3 Section 5.1.8 based on the average size of the refrigerators.

UEC_{exist} is unit annual energy consumption of existing operational refrigerator[4]

UEC_{exist}= [83.32 + (Age * 3.68) + (Pre-1990 * 485.04) + (Size*27.15) + (Side-by-side * 406.78) + (Proportion of Primary Appliances * 161.86)

UEC_{base} is average unit annual energy consumption of baseline unit meeting Canada's energy efficiency regulations[5]

UEC_{base} = 8.07*AV+233.7

The new baseline (UEC_{base}) meeting Canada and Ontario energy efficiency standard for the remainder of EUL. The average annual energy consumption UEC_{exist} and UEC_{base} are summarized below based on refrigerator types and their volumes:

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep. 20, 2024, section 5.1.6
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep. 20, 2024, Section 5.1.8
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[5] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep. 20, 2024, section 5.1.6
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Table 2 – Baseline Unit Energy Consumption (kWh/yr)

Product Class	**Average Volume (cu ft)**	**UEC_{exist}[6] (kWh/yr)**	**UEC_{base} (kWh/yr)**
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (10.0 ≤ and < 12.5 cu ft)	11.25	587.42	347.37
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (12.5≤ and <15.5 cu ft)	14.00	662.08	375.15
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (15.5 ≤ and < 17.0 cu ft)	16.25	723.17	397.88
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (17.0 ≤ and < 18.4 cu ft)	17.70	762.54	412.53

AV=fresh volume+1.63*freezer volume (assuming 0.6 fresh and 0.4 freezer volume)

Energy Efficient Measure Assumptions

Annual Energy Consumption of the conservation measure (kWh/yr)ee = UECee = 7.26*AV + 210.3

The average annual energy consumptions of the conservation measure (UEC_{ee}) based on the refrigerator volumes are summarized in the table below.

Table 3 – Energy Efficient Unit Energy Consumption (kWh/yr)

Conservation Measure	**UEC_{ee} (kWh/yr)**
Energy Star Qualified 10.0 ≤ and < 12.5 cu ft	312.56
Energy Star Qualified 12.5 ≤ and < 15.5 cu ft	337.55
Energy Star Qualified 15.5 ≤ and < 17 cu ft	358.00
Energy Star Qualified 17 ≤ and < 18.4 cu ft	371.18

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[6] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep. 20, 2024, Section 5.1.8
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Energy and Demand Savings

Energy and Connected Demand Savings

Annual energy consumption of the base measure, kWhbase = (UECexist x %EREP) + (UECbase x %REMAIN)

where: %EREP - percentage of EUL of existing operational unit; assume 33%

%REMAIN - percentage of EUL of a base/standard unit (1 - %EREP); assume 67%

Annual energy consumption of the conservation measure, $kWh_{ee} = UEC_{ee} = 7.26*AV + 210.3$

Annual Energy Savings, $\Delta kWh = kWh_{base} - kWh_{ee}$

Average Demand Savings, ΔkW = Annual Energy Savings, ΔkWh / 8760

Table 4 – Annual Energy and Connected Demand Savings (kWh/yr)

Product Class	$(kWh/yr)_{base}$	$(kWh/yr)_{ee}$	ΔkWh	ΔkW
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (10.0 ≤ and < 12.5 cu ft)	312.56	347.37	114.03	0.0130
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (12.5≤ and <15.5 cu ft)	337.55	375.15	132.28	0.0151
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (15.5 ≤ and < 17.0 cu ft)	358.00	397.88	147.22	0.0168
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (17.0 ≤ and < 18.4 cu ft)	371.18	412.53	156.85	0.0179

Lifetime Energy Savings (kWh) = Annual Energy Savings, ΔkWh x EUL (yr)

Summer Peak Demand Savings

Summer peak demand savings (ΔkW_{peak}) is calculated by multiplying the Annual Energy Savings (ΔkWh) with the Summer Peak Demand Factor (SPDF) using an End Use Load Profile (see below).

$\Delta kW_{peak} = \Delta kWh * \text{Summer Peak Demand Factor} = \Delta kWh * 0.01344\%$

Table 5 – Peak Demand Savings (kW)

Product Class	ΔkW_{peak}
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (10.0 ≤ and < 12.5 cu ft)	0.0130
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (12.5≤ and <15.5 cu ft)	0.0151
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (15.5 ≤ and < 17.0 cu ft)	0.0168
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (17.0 ≤ and < 18.4 cu ft)	0.0179

End Use Load Profile

PSP-Consumer-Residential-Refrigerators

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01344%	0.01254%	0.01474%	0.01299%

Effective Useful Life (EUL)

Measure	EUL (years)
Energy Star® Freezer	15[7]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Feb. 2008
1	Updated using 2007 Great Refrigerator Roundup Program (GRRP) Report Data	May 2008

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[7] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep. 20, 2024, section 5.1.6 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

2	Updated using 2008 GRRP Report Data	Dec. 2009
3	Updated using 2009 GRRP Report Data	Dec. 2010
4	Updated with PY2016 HAP Program Evaluation	July 2017
5	Updated with PY2017 HAP Program Evaluation	Oct. 2018
6	Updated with PY2019 HAP Program Evaluation	May 2020
7	Added 7.75-12 cubic foot measure	Nov. 2021
8	Program performance team decided not to proceed with updated refrigerator assumptions due to lower savings	Jan. 2024
9	Updated by Resource Innovations	Jan. 2025

Efficient Faucet Aerators

Kitchen and Bathroom

Measure Description

Energy Efficient Equipment Description

Low-flow faucet aerators for household kitchen or bathroom fixtures with electric domestic hot water.

Base Equipment Description

Household kitchen or bathroom fixtures equipped with inefficient or no faucet aerators utilizing electric hot water.

Code, Standards and Regulations

The flow rates of fittings that supply water to a fixture shall not exceed the maximum flow rates of 8.35 L/min for both kitchen and bathroom faucets.[1]

Resource Savings

Measure Assumptions[2]

GPM_{base} – Average flow rate of the baseline faucet, gallons per minute

GPM_{eff} - Average flow rate of the efficient low-flow faucet, gallons per minute

Table 1 – Average Flow Rates (Gallons per Minute)

Faucet Type	**GPM_{base}**	**GPM_{eff}**
Kitchen	2.21	1.50
Bathroom	1.51	1.00

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[1] 2012 Ontario Building Code, 7.6.4. Water Efficiency Table 7.6.4.1 Maximum Flow Rates for Water Supply Fittings https://www.buildingcode.online/1139.html

[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Unknown	1.86	1.25

L - Average daily length faucet use per capita, minutes/person/day, see Table 2

Table 2 – Average Daily Length Faucet Use (Minutes/Person/Day)

Faucet Type/Building Type	Average Daily Length
Kitchen	4.5
Bathroom	1.6
Unknown Location - Single Family Except Mobile Homes	9.0
Unknown Location - Multifamily and Mobile Homes	6.9
Unknown Location - Unknown Building Type	8.3

Household - Average number of people per household; assume 2.76 for single family and 2.3 for multifamily

DF – Drain factor, %; assume 75% for kitchen and 90% for bathroom; if unknown, assume 79.5%

FPH - Number of faucets per Household, see Table 3

365.25 – Number of days per year

Table 3 – Number of Faucets per Household

Faucet Type/Building Type	FPH
Kitchen	1.00
Bathroom - Single Family Except Mobile Homes	2.83
Bathroom - Multifamily and Mobile Homes	1.50
Unknown Location - Single Family Except Mobile Homes	3.83
Unknown Location - Multifamily and Mobile Homes	2.50
Unknown Location - Unknown Building Type	3.42

$EPG_{electric}$ - Energy per gallon of water used by a faucet supplied by an electric water heater, kWh/gallon

$EPG_{electric}$ = Specific Weight (8.33 lbs/gallon) x Heat Capacity (1.0 Btu/lb-°F) x (T_{mixed} – T_{supply}) / (Electric Water Heat Recovery Efficiency (98%) x 3412 Btu/kWh)

where: T_{mixed} – assumed temperature of mixed water, °F

T_{supply} – assumed temperature of water entering the house, assume 55.4°F

Table 4 – Energy per Gallon of Water by Electric Water Heater Faucet (kWh/Gallon)

Faucet Type	T_{mixed}	$EPG_{electric}$
Kitchen	93	0.0937
Bathroom	86	0.0762
Unknown	91	0.0887

Hours – Annual electric domestic hot water recovery hours per faucet

Hours = [GPM_{base} x L x (Household/FPH) x 365.25 x DF x %Hot Water]/GPH

Where: %Hot Water – proportion of hot water mixed with supply water

GPH – gallons per hour recovery of electric water heater, assume 26.1

Table 5 – Annual Electric Domestic Hot Water Recovery Hours per Faucet

Faucet Type	Building Type	%Hot Water	Hours
Kitchen	Single	0.582	167.36
Kitchen	Multi-Family	0.582	139.47
Bathroom	Single	0.474	14.02
Bathroom	Multi-Family	0.474	22.04
Unknown	Single	0.551	73.79
Unknown	Multi-Family	0.551	72.23

Energy and Demand Savings

Energy Savings[3]

Annual Energy Savings (kWh/yr) = (GPM_{base} - GPM_{eff}) x L x Household x 365.25 x (DF/FPH) x $EPG_{electric}$

Table 6 – Annual Energy Savings (kWh/year)

Faucet Type	Single-Family	Multi-Family
Kitchen	224.9	187.5
Bathroom	19.8	31.1

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Connected Demand Savings

Annual Demand Savings = Annual Energy Savings (kWh/yr)/Hours

Table 7 – Annual Demand Savings (kW)

Faucet Type	Single-Family	Multi-Family
Kitchen	1.34	1.34
Bathroom	1.41	1.41

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$$\Delta kW_{peak} = \Delta kWh * \text{Summer Peak Demand Factor}$$

Table 8 – Summer PeakDemand Savings (kW)

Faucet Type	Single-Family	Multi-Family
Kitchen	1.34	1.34
Bathroom	1.41	1.41

End Use Load Profile

PSP-Consumer-Residential-Domestic_Hot_Water

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01033%	0.01592%	0.01099%	0.01603%

Effective Useful Life (EUL)

Measure	EUL (years)
Kitchen and Bathroom Aerators	12[4]

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[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Feb. 2008
1	Updated with 2008 SCDI PSB Final Report	Nov. 2009
2	Updated based on PY2016 Direct Install and separated savings between kitchen and bathroom	July 2017
3	Updated with 2017 Consumer HAP Program Evaluation	Aug. 2018
4	Updated based on 2019 Consumer HAP Program Evaluation	May 2020
5	Updated reference and formatting	Nov. 2023
6	Updated by Resource Innovations	Jan. 2025

Hot Water Pipe Wrap (Per Foot)

Measure Description

Energy Efficient Equipment Description

Residential electric hot water tank pipe with ½” or 3/4” insulation per foot

Base Equipment Description

Residential electric hot water tank pipe (½” or ¾” diameter) without insulation.

Code, Standards and Regulations

The insulation increases the heat loss coefficient (R-value) by a minimum of 3 (hr-°F-ft)/Btu)[1].

Resource Savings

Measure Assumptions

R_{exist} – Pipe heat loss coefficient of uninsulated pipe, hr-°F-ft/Btu; assume 1.0

R_{new} – Pipe heat loss coefficient of insulated pipe, hr-°F-ft/Btu; assume 3.5

$L_{effective}$ – Effective length of the pipe covered by insulation from the water heating source; assume 1 foot if horizontal and a horizontal to vertical adjustment factor (α) if vertical

C_{inside} – Inside circumference of the pipe, ft; see Table 1

Table 1 – Inside Circumference for Different Pipe Size and Type

Pipe Size (in)	Copper	PEX	α (Copper)	α (PEX)
½	0.1427	0.1270	0.67	0.73
¾	0.2055	0.1783	0.72	0.77

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

HOU – Annual operating hours of the hot water pipe; assume 8760 hrs/yr

ΔT – Temperature difference between supplied water and outside air temperature; assume 60°F

ηDHW - Recovery efficiency of electric hot water heater; assume 98%

3412 – Conversion from Btu to kWh

Energy and Demand Savings

Energy Savings[2]

Annual Energy Savings (kWh/yr) = $[\ (1/R_{exist} - 1/R_{new}) \times C_{inside} \times L_{effective} \times \Delta T \times 8760\ ]/ (\eta DHW \times 3412)$

Table 2 – Annual Energy Savings for Different Pipe Configurations (kWh/yr)

Pipe Size	Pipe Type	Pipe Orientation	Annual Energy Savings
½	Copper	Horizontal	16.8
½	Copper	Vertical	11.3
½	PEX	Horizontal	15.0
½	PEX	Vertical	10.9
½	**Unknown**	**Unknown**	**13.5**
¾	Copper	Horizontal	24.2
¾	Copper	Vertical	17.4
¾	PEX	Horizontal	21.0
¾	PEX	Vertical	16.2
¾	**Unknown**	**Unknown**	**19.7**

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Connected Demand Savings = Annual Energy Savings / 8760

Table 3 – Connected Demand Savings for Different Pipe Configurations (kW)

Pipe Size	Pipe Type	Pipe Orientation	Demand Savings
½	Copper	Horizontal	0.0019
½	Copper	Vertical	0.0013
½	PEX	Horizontal	0.0017
½	PEX	Vertical	0.0012
½	**Unknown**	**Unknown**	**0.0015**

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

¾	Copper	Horizontal	0.0028
¾	Copper	Vertical	0.0020
¾	PEX	Horizontal	0.0024
¾	PEX	Vertical	0.0018
¾	**Unknown**	**Unknown**	**0.0023**

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkW_{peak} = ΔkWh * Summer Peak Demand Factor

Table 4 – Summer Peak Demand Savings for Different Pipe Configurations (kW)

Pipe Size	Pipe Type	Pipe Orientation	Peak Demand Savings
½	Copper	Horizontal	0.00174
½	Copper	Vertical	0.00116
½	PEX	Horizontal	0.00155
½	PEX	Vertical	0.00113
½	**Unknown**	**Unknown**	**0.00139**
¾	Copper	Horizontal	0.00250
¾	Copper	Vertical	0.00180
¾	PEX	Horizontal	0.00217
¾	PEX	Vertical	0.00167
¾	**Unknown**	**Unknown**	**0.00204**

End Use Load Profile

PSP-Consumer-Residential-Domestic_Hot_Water

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01033%	0.01592%	0.01099%	0.01603%

Effective Useful Life (EUL)

Measure	EUL (years)
Pipe Wrap	12[3]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Feb. 2008
1	Adjusted to 3 from 6 feet of pipe insulation	July 2008
2	Updated based on PY2016 Consumer Program Evaluation	July 2017
3	Updated based on PY2017 HAP Program Evaluation	Nov. 2018
4	Updated based on PY2019 HAP Program Evaluation	May 2020
5	Updated references and formatting	Nov. 2023
6	Updated by Resource Innovations	Jan. 2025

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Hot Water Tank Wrap

Measure Description

Energy Efficient Equipment Description

Add blanket of R6 to electric water heater to achieve R-18 insulation[1]

Base Equipment Description

Typical uninsulated electric water heater without insulation blanket

Code, Standards and Regulations

Ontario Regulation O.Reg. 509/18 establishes efficiency standards for water heaters based on type, input power rating, storage tank size, and year of manufacture. For a typical electric water heater with a storage capacity ranging from 50 liters (13 US gallons) to 454 liters (120 US gallons) manufactured on or after April 16, 2015, the following maximum standby power loss requirements must be met[2]:

Water Heater Class	Capacity Range (Liters)	Maximum Standby Power Loss (W)
Water Heaters with bottom inlet	≥50 but≤ 270	0.2V*+40
Water Heaters with bottom inlet	>270 and≤ 454	0.472V-33.5
Water Heaters with top inlet	≥50 and <160	0.2V+35
Water Heaters with top inlet	≥160 and <270	0.2V+25
Water Heaters with top inlet	≥270 and ≤290	0.472V-48.5
Water Heaters with top inlet	>290 and≤ 454	0.472V-38.5

*V is the rated storage capacity in litres.

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[1] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs V4.1, Residential, Hot Water, Water Heater Jacket Insulation
https://mn.gov/commerce-stat/trm/releases/4.1.pdf

[2] Ontario Regulation O Reg. 509/18: Energy And Water Efficiency - Appliances And Products, Schedule 2: Water Heaters and Other Water Heating Equipment, Section 10. Water Heater, Electric, Storage, 50 L to 454 L and with an Input Rating of not more than 12 kW, Section iv.
O. Reg. 509/18 ENERGY AND WATER EFFICIENCY - APPLIANCES AND PRODUCTS | ontario.ca

Resource Savings

Measure Assumptions

Base Measure Assumptions

Electric water heater without insulation blanket.

Energy Efficient Measure Assumptions

Insulation blanket to achieve a total insulation value of R-18[3]

Energy and Demand Savings

Energy Savings[4]

Annual Energy Consumption $(kWh/yr)_{base} = [\ (U_{base} \times A_{base}) \times (T_{set} - T_{amb}) \times HOU\ ] / (3412 \times \eta DHW)$

Annual Energy Consumption $(kWh/yr)_{ee} = [\ (U_{insul} \times A_{insul}) \times (T_{set} - T_{amb}) \times HOU\ ] / (3412 \times \eta DHW)$

where: U_{base} - heat transfer coefficient of water heater without insulation; assume 0.0833 Btu/h-°F-ft^2

U_{insul} - heat transfer coefficient of water heater with insulation; assume 0.0555 Btu/h-°F-ft^2

A_{base} - surface area of tank before insulation; assume 24.99 ft^2

A_{insul} - surface area of tank after insulation; assume 27.06 ft^2

T_{set} - set point of hot water heater; assume 120°F

T_{amb} – ambient temperature; assume 60°F

HOU – hours of use per year; assume 8760

ηDHW - recovery efficiency of electric hot water heater; assume 98%

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[3] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs V4.1, Residential, Hot Water, Water Heater Jacket Insulation
https://mn.gov/commerce-stat/trm/releases/4.1.pdf

[4] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs V4.1, Residential, Hot Water, Water Heater Jacket Insulation
https://mn.gov/commerce-stat/trm/releases/4.1.pdf

Annual Energy Consumption $(kWh/yr)_{base}$ = [(0.0833 x 24.99) x (120 – 60) x 8760] / (3412 x 0.98) = 327.44

Annual Energy Consumption $(kWh/yr)_{ee}$ = [(0.0555 x 27.06) x (120 – 60) x 8760] / (3412 x 0.98) = 236.23

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{ee}$

Annual Energy Savings (kWh/yr) = 327.34 – 236.31 = 91.04 kWh

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Connected Demand Savings, ΔkW = (Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{ee}$) /HOU = (327.34 – 236.31)/8760 = 0.010 kW

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkW_{peak} = ΔkWh * Summer Peak Demand Factor

ΔkW_{peak} = 91.21 x 0.01236% = 0.0113 kW

End Use Load Profile

PSP-Consumer-Residential-Water_Heater_Blanket

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.01236%	0.01845%	0.01672%	0.02228%

Effective Useful Life (EUL)

Measure	EUL (years)
Water Heater Blanket	7[5]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Sep. 2010
1	Update based on PY2016 Consumer HAP Program Evaluation	July 2017
2	Update based on PY2017 Consumer Program Evaluation	Oct. 2018
3	Update based on PY2019 HAP Program Evaluation	May 2020
4	Updated references and formatting	Nov. 2023
5	Updated EM&V Peak Definition and Peak Demand Savings	Jan. 2025

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[5] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs V4.1, Residential, Hot Water, Water Heater Jacket Insulation
https://mn.gov/commerce-stat/trm/releases/4.1.pdf

Low-Flow Showerhead

Fixed or Handheld

Measure Description

Energy Efficient Equipment Description

Fixed or handheld low-flow showerheads using electric domestic hot water, rated at least 0.5 GPM lower than existing showerhead

Base Equipment Description

Standard showerheads meeting current Ontario Building Code and using electric domestic hot water

Code, Standards and Regulations

2024 Ontario Building Code states that the maximum showerhead flowrate shall not exceed 7.6 L/min (2.0 GPM) at 550 kPa test pressure.[1]

Resource Savings

Measure Assumptions[2]

GPM_{base} – Average flow rate of the baseline showerhead, gallons per minute; assume 2.0 (7.6 L/min) if unknown

GPM_{eff} - Average flow rate of the efficient showerhead, gallons per minute; if the flow rate is unknown, assume a flow rate of 0.5 GPM less than the existing rate for handheld fixtures, and 0.75 GPM less for standard showerheads. If the existing rate is also unknown, use an efficient flow rate of 1.5 GPM (5.7 L/min) for handheld and 1.25 GPM (4.7 L/min) for standard fixtures

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[1] O Reg. 332/12: Ontario Building Code Act, Part 7: Plumbing, Section 7.6.4.1. Potable Water Systems, Water Efficiency, Water Supply Fittings, Table 7.6.4.1. Maximum Flow Rates for Water Supply Fittings.

[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Section 5.4.5 Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

L - Average shower length, minutes; assume 7.8 min

Household - Average number of people per household; assume 2.76 for single family and 2.3 for multifamily

SPCD – No. of showers per person per day; assume 0.6

SPH – No. of showerheads per household; assume 1.79 for single-family except mobile homes, 1.3 for multifamily and mobile homes and 1.64 if unknown

365.25 – Number of days per year

$EPG_{electric}$ - Energy per gallon of water used by a showerhead supplied by an electric water heater, kWh/gallon; assume 0.1253

$EPG_{electric}$ = Specific Weight (8.33 lbs/gallon) x Heat Capacity (1.0 Btu/lb-°F) x (T_{shower} – T_{supply}) / (Electric Water Heat Recovery Efficiency (98%) x 3412 Btu/kWh)

where: T_{shower} – assumed temperature of the shower, assume 101°F

T_{supply} – assumed temperature of water entering the house, assume 50.7°F

Hours – Annual electric domestic hot water recovery hours per faucet; assume 262 hours for single family and 219 for multifamily

Hours = GPM_{base} x L x Household x SPCD x 365.25 x %Hot Water]/GPH

where: %Hot Water – proportion of hot water mixed with supply water, assume

72.6%

GPH – gallons per hour recovery of electric water heater, assume 26.1

Energy and Demand Savings

Energy Savings[3]

Annual Energy Savings (kWh/yr) = (GPM_{base} - GPM_{eff}) x L x Household x (SPCD/SPH) x 365.25 x $EPG_{electric}$

Table 1 – Annual Energy Savings (kWh/year)

Showerhead Type	Single-Family	Multi-Family
Handheld	167.7	192.4

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Standard	250.3	287.1

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Annual Demand Savings = Annual Energy Savings (kWh/yr)/Hours

Table 2 – Annual Demand Savings (kW)

Showerhead Type	Single-Family	Multi-Family
Handheld	0.639	0.880
Standard	0.954	1.313

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kW_{peak} = \Delta kWh * \text{Summer Peak Demand Factor}$

Table 3 – Summer Peak Demand Savings (kW)

Showerhead Type	Single-Family	Multi-Family
Handheld	0.017	0.020
Standard	0.026	0.030

End Use Load Profile

PSP-Consumer-Residential-Domestic_Hot_Water

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01033%	0.01592%	0.01099%	0.01603%

Effective Useful Life (EUL)

Measure	EUL (years)
Low Flow Showerhead	10[4]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	May 2008
1	Updated with PY2016 Consumer Program Evaluation	July 2017
2	Updated with PY2017 HAP Program Evaluation	Oct. 2018
3	Updated based on 2019 HAP Program Evaluation	May 2020
4	Evaluation Team Subsheet and MAL Review	Nov. 2023
5	Updated by Resource Innovations	Jan. 2025

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[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Energy Star® Dehumidifier

Measure Description

Energy Efficient Equipment Description

Residential Energy Star® certified portable dehumidifiers in the following categories:

- Dehumidifier Replacement (ENERGY STAR Qualified ≤ 11.83 L/day)
- Dehumidifier Replacement (ENERGY STAR Qualified >11.83 - <23.65 L/day)
- Dehumidifier Replacement (ENERGY STAR Qualified ≥23.65 - <35.48 L/day)

Base Equipment Description

Residential non-Energy Star portable dehumidifiers.

Code, Standards and Regulations

The new dehumidifier must adhere to the minimum integrated energy factor (IEF) specified by ENERGY STAR v5.0, effective October 30, 2023.[1] The existing unit complies with Canada's Energy Efficiency Regulations for products manufactured on or after June 13, 2019.[2]

Table 1 – Energy Performance Standard for Portable Dehumidifiers

Water Removal Capacity (L/day)	Energy Star V5.0 IEF (L/kWh)	Canada's Energy Efficiency Regulations IEF (L/kWh)
≤ 11.83	1.57	1.30
≥ 11.83 and < 23.65	1.80	1.60
≥ 23.65 and < 35.48	3.30	2.80

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[1] NRCan Canada's Energy Star Simple Savings Calculator V18.1 https://oee.nrcan.gc.ca/residential/business/energystar/procurement/calculator.cfm

[2] Canada's Energy Efficiency Regulations, Dehumidifiers (portable and whole-home) https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/dehumidifiers-portable-and-whole-home/6889

Resource Savings

Measure Assumptions

CAPY – Average capacity of the dehumidifier per day, L/day

L/kWh – Amount of liters of water consumed by the unit per kWh

Table 2 – Energy Factors for Portable Dehumidifiers (L/kWh)

Water Removal Capacity (L/day)	**$(L/kWh)_{base}$**	**$(L/kWh)_{eff}$**
≤ 11.83	1.3	1.57
≥ 11.83 and < 23.65	1.6	1.80
≥ 23.65 and < 35.48	2.8	3.30

HOU – operation hours of dehumidifiers, assume 2200 hours[3]

Energy and Demand Savings

Energy Savings[3]

Annual Energy Consumption $(kWh/yr)_{base}$ = CAPY x (day/24 hours) x HOU x $(1/L/kWh_{base})$

Annual Energy Consumption $(kWh/yr)_{eff}$ = CAPY x (day/24 hours) x HOU x $(1/L/kWh_{ee})$

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $kWh/yr)_{eff}$

Table 3 – Annual Energy Savings (kWh/yr)

Water Removal Capacity (L/day)	**Average Dehumidifier capacity (L/day)**	**Annual Energy $Consumption_{base}$**	**Annual Energy $Consumption_{eff}$**	**Annual Energy Savings (kWh/yr)**
≤ 11.83 L/day	10.31	727.1	602	125.1
≥ 11.83 and < 23.65 L/day	20.39	1,168.00	1,038.20	129.8
≥ 23.65 and < 35.48 L/day	29.56	967.8	821.2	146.6

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Demand Savings (kW) = CAPY x (day/24 hours) x [$(1/L/kWh_{base})$ - $(1/L/kWh_{ee})$]

Table 4 – Connected Demand Savings (kW)

Water Removal Capacity (L/day)	$Wattage_{base}$ (kW)	$Wattage_{ee}$ (kW)	Connected Demand Savings, ΔkW (kW)
≤ 11.83 L/day	0.33	0.274	0.057
≥ 11.83 and < 23.65 L/day	0.531	0.472	0.059
≥ 23.65 and < 35.48 L/day	0.44	0.373	0.067

Summer Peak Demand Savings

Summer peak demand savings ΔkWpeak are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkWpeak = ΔkWh * Summer Peak Demand Factor

Table 5 – Summer Peak Demand Savings (kW)

Water Removal Capacity (L/day)	Summer Peak Demand Savings (ΔkW_{peak})
≤ 11.83 L/day	0.033
≥ 11.83 and < 23.65 L/day	0.034
≥ 23.65 and < 35.48 L/day	0.038

End Use Load Profile

PSP-Consumer-Residential-Dehumidifiers

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.02620%	0.01034%	0.06070%	0.01080%

Effective Useful Life (EUL)

Measure	EUL (years)
Dehumidifier	12[4]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Oct. 2008
1	Updated using 2008 EKC Power Savings Event, Keep Cool Pilot and Rewards for Recycling Programs Evaluation Report	Sep. 2009
2	Updated based on PY2016 HAP Program Evaluation	July 2017
3	Updated based on PY2017 HAP Program Evaluation	Oct. 2018
4	Updated with PY2019 HAP Program Evaluation	May 2020
5	Updated references and formatting	Nov. 2023
6	Updated by Resource Innovations	Jan. 2025

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[4] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Energy Star® Room Air-Conditioner

Measure Description

Energy Efficient Equipment Description

Residential Energy Star® certified room air conditioner that meets ENERGY STAR version 5.0, which is effective October 30th 2023, or CEE Tier 2, which is effective May 17th 2022, minimum qualifying efficiency specifications in the following categories:

- Energy Star® or CEE Tier 2 Qualified 6,000 - 7,999 BTU/hr
- Energy Star® or CEE Tier 2 Qualified 8,000 - 9,999 BTU/hr
- Energy Star® or CEE Tier 2 Qualified 10,000 - 12,000 BTU/hr

Base Equipment Description

Early replacement of existing room air conditioner meeting Canada’s energy efficiency standard effective June 1st 2024.

Code, Standards and Regulations

The new air conditioner must meet the following minimum combined energy efficiency ratio (CEER)* specified by ENERGY STAR v5.0, effective October 30th 2023, or by CEE Tier 2, effective May 17th 2022. The existing unit meets Canada’s Energy Efficiency Regulations effective June 1st 2024:

Table 1 – Energy performance standard for room air conditioners[1,2,3]

Product type**	Cooling capacity category (Btu/h)	Canada's Energy Efficiency Regulations CEER (Btuh/W) - With louvered sides	Canada's Energy Efficiency Regulations CEER (Btuh/W) - Without louvered sides	ENERGY STAR V5.0 CEER (Btuh/W) - With louvered sides	ENERGY STAR V5.0 CEER (Btuh/W) - Without louvered sides	CEE Tier 2 CEER (Btuh/W)
Without reverse cycle	< 6,000	≥11.0	≥ 10.0	≥ 13.1	≥ 12.8	≥ 14.85
Without reverse cycle	≥ 6,000 but < 8,000	≥ 11.0	≥ 10.0	≥ 13.7	≥ 12.8	≥ 14.85
Without reverse cycle	≥ 8,000 but < 11,000	≥ 10.9	≥ 9.6	≥ 14.7	≥ 13.0	≥ 14.72
Without reverse cycle	≥ 11,000 but < 14,000	≥ 10.9	≥ 9.5	≥ 14.7	≥ 12.8	≥ 14.72
Without reverse cycle	≥ 14,000 but < 20,000	≥ 10.7	≥ 9.3	≥ 14.4	≥ 12.6	≥ 14.45
Without reverse cycle	≥ 20,000 but < 28,000	≥ 9.4	≥ 9.4	≥ 12.7	≥ 12.7	≥ 12.69
Without reverse cycle	≥28,000	≥ 9.0	≥ 9.4	≥ 12.2	≥ 12.7	≥ 12.15
With reverse cycle	< 14,000	≥ 9.8	≥ 9.3	N/A	≥ 12.6	N/A
With reverse cycle	= 14,000	≥ 9.8	≥ 8.7	N/A	≥ 11.7	N/A
With reverse cycle	> 14,000 but < 20,000	≥ 9.8	≥ 8.7	≥ 13.2	N/A	N/A
With reverse cycle	≥20,000	≥ 9.3	≥ 8.7	≥ 12.6	N/A	N/A
Casement only	Casement only	≥ 9.5	≥ 9.5	≥ 12.8	≥ 12.8	N/A

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[1] Canada's Energy Efficiency Regulations for Room Air Conditioners https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/room-air-conditioners/6867

[2] ENERGY STAR Room Air Conditioners Key Product Criteria, Effective October 30th, 2023 https://www.energystar.gov/products/room_air_conditioners/key_product_criteria

[3] CEE Room Air Conditioner Specifications, effective May 17th, 2022 https://cee1.org/images/pdf/CEE_RoomAC_Specification_17May2022.pdf

Casement slider	Casement slider	≥ 9.5	≥ 9.5	≥ 12.8	≥ 12.8	N/A

** Window-mounted units have louvered sides, whereas through-the-wall units do not.

CEER is a combined energy efficiency ratio for room air conditioners including idle energy consumption when the unit is not running, but power is on. (CEER = EER/1.01).

Resource Savings

Measure Assumptions

Base Measure Assumptions

Early replacement of an inefficient unit, whether it's already in the home or being purchased from the secondary market. The baseline assumption is a room air conditioning unit that complies with the Federal efficiency standards effective June 1, 2014.

Table 2 – Baseline energy efficiency ratio[4]

Product Type	**Cooling Capacity Category (Btu/h)**	**CEER$_{base}$ (Btuh/W) With Louvered Sides**	**CEER$_{base}$ (Btuh/W) Without Louvered Sides**
Without reverse cycle	≥ 6,000 but < 8,000	11	10
Without reverse cycle	≥ 8,000 but < 10,000	10.9	9.6
Without reverse cycle	≥ 10,000 but < 11,000	10.9	9.6
Without reverse cycle	≥ 11,000 but ≤ 12,000	10.9	9.5
With reverse cycle	≥ 6,000 but ≤ 12,000	9.8	9.3
Casement only	Casement only	9.5	9.5
Casement slider	Casement slider	10.4	10.4

Energy Efficient Measure Assumptions

Energy Star or Tier 2 qualified room air conditioners meeting the following Energy Star or CEE Tier 2 efficiency requirement:

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[4] Canada’s Energy Efficiency Regulations for Room Air Conditioners https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/room-air-conditioners/6867

Table 3 – Efficient Case Energy Efficiency Ratio[5,6]

Product Type	**Cooling Capacity Category (Btu/h)**	**Average Cooling Capacity[7] (Btu/h)**	**ENERGY STAR V5.0 CEERee (Btuh/W) - With Louvered Sides**	**ENERGY STAR V5.0 CEERee (Btuh/W) - Without Louvered Sides**	**CEE Tier 2 CEERee (Btuh/W)**
Without reverse cycle	≥ 6,000 but < 8,000	6,018	13.7	12.8	14.85
Without reverse cycle	≥ 8,000 but < 10,000	8,010	14.7	13	14.72
Without reverse cycle	≥ 10,000 but < 11,000	10,024	14.7	13	14.72
Without reverse cycle	≥ 11,000 but ≤ 12,000	11,997	14.7	12.8	14.72
With reverse cycle	≥ 6,000 but < 8,000	7,000	N/A	12.6	N/A
With reverse cycle	≥ 8,000 but < 10,000	8,561	N/A	12.6	N/A
With reverse cycle	≥ 10,000 but < 12,000	11,115	N/A	12.6	N/A
Casement only	Casement only	8,000	12.8	12.8	N/A
Casement slider	Casement slider	8,000	14	14	N/A

Table 4 – Cooling FLH[8]

Climate City Zone	**Cooling Full Load Hours**	**Weighting Factor**
Barrie	563	3%
Hamilton	671	6%
Ottawa	706	19%
Peterborough	607	2%
Thunder Bay	402	2%

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[5] ENERGY STAR Room Air Conditioners Key Product Criteria, Effective October 30th, 2023 https://www.energystar.gov/products/room_air_conditioners/key_product_criteria

[6] CEE Room Air Conditioner Specifications, effective May 17th, 2022 https://cee1.org/images/pdf/CEE_RoomAC_Specification_17May2022.pdf

[7] Evaluation of 2017 Save on Energy Residential Province Wide Program – HAP Workbook Room ACs, Cadmus, Oct 2018

[8] Effective Full Load Hours, Sourced from Resource Innovations report to IESO, Oct. 2024

Timmins	391	1%
Toronto	679	55%
Windsor	1008	5%
Sudbury	504	2%
London	750	7%
Unknown	690	
Calibration factor from Central AC to Room AC	50%	Assuming 50% on/off operation
Calibrated for Room AC FLH	345	

Energy and Demand Savings

Energy Savings[9]

$\Delta kWh = FLH_{RoomAC} \times Btu/h \times (1/CEER_{base} - 1/CEER_{ee})/1000$

FLH_{RoomAC} (hrs/yr) = Full Load Hours of room air conditioning unit (See table 4)[10]

EER_{base} (Btuh/W) = Efficiency of existing / baseline unit (If unknown, see table 2)[11]

Factor to convert EER to CEER (CEER includes standby and off power consumption) = 1.01

$CEER_{ee}$ (Btuh/W) = Combined Efficiency of energy star unit (If unknown, see table 3)

Table 5 – Energy Savings Per Cooling Capacity Category

Cooling Capacity Category (Btu/h)	kWh_{base}	kWh_{ee}	ΔkWh
≥ 6,000 but < 8,000	218.7	168.5	50.2
≥ 8,000 but < 10,000	286.3	211.7	74.7
≥ 10,000 but < 12,000	381.0	282.1	98.9

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[9] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep 20, 2024, Section 5.1.7 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

[10] Effective Full Load Hours, Sourced from Resource Innovations report to IESO, Oct. 2024

[11] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep 20, 2024, Section 5.1.7 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Connected Demand Savings[12]

Demand Savings (ΔkW) = Base Measure Wattage – Conservation Measure Wattage

$= \text{Btu/h} \times (1/(\text{CEER}_{base} \text{ x } 1.01) - 1/(\text{CEER}_{ee} \text{ x } 1.01))/1000$

Table 6 – Average Connected Demand Savings (ΔkWh)

Cooling Capacity Category (Btu/h)	kW_{base}	kW_{ee}	ΔkW
≥ 6,000 but < 8,000	0.628	0.483	0.144
≥ 8,000 but < 10,000	0.822	0.607	0.214
≥ 10,000 but < 12,000	1.094	0.810	0.284

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below)

$\Delta kW_{peak} = \Delta kWh * SPDF$

Table 7 – Summer Peak Demand Savings (kW)

Cooling Capacity Category (Btu/h)	Summer Peak Demand Savings (kW)
≥ 6,000 but < 8,000	0.0230
≥ 8,000 but < 10,000	0.0342
≥ 10,000 but < 12,000	0.0453

End Use Load Profile

EM&V-Residential-AC_Cooling

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.04576%	0.00000%	0.00000%	0.00000%

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[12] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep 20, 2024, Section 5.1.7
https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Effective Useful Life (EUL)

Measure	EUL (years)
Energy Star Room Air Conditioner	12 [13]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Feb. 2008
1	Updated using 2007 Great Refrigerator Roundup Program (GRRP) Report Data	May 2008
2	Updated using 2008 Impact Evaluation of Spring EKC Report Data	Oct. 2008
3	Updated using 2008 EKC Power Savings Event, Keep Cool Pilot and Rewards for Recycling Programs Evaluation Report	Sep. 2008
4	Updated with PY2017 HAP Program Evaluation	Oct. 2018
5	Updated with PY2019 HAP Program Evaluation	May 2020
6	Updated reference and formatting	Nov. 2023
7	Updated by Resource Innovations	Jan. 2025

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[13] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep 20, 2024, Section 5.1.7 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Line Voltage Smart Thermostat

Baseboard Heaters

Measure Description

Energy Efficient Equipment Description

Wi-Fi-enabled smart line-voltage thermostat for electric baseboard heating that has the ability to automatically adjust temperature settings based on observed occupancy patterns.

Base Equipment Description

Electric baseboard heating with non-programmable or programmable thermostats.

Code, Standards and Regulations

Smart line-voltage thermostats sold in Canada must comply with CSA-C828-19[1] and FCC Safety Standards and must bear CSA and FCC certifications. The installation of the smart line-voltage thermostat must be performed by a licensed electrician.

Resource Savings

Measure Assumptions

Base Measure Assumptions

Electric baseboard heating with mixed programmable and non-programmable thermostat.

Energy Efficient Measure Assumptions

CSA-certified Wi-Fi-enabled line-voltage smart thermostat installed for baseboard heaters, featuring temperature settings based on occupancy sensing and remote access.

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[1] CSA-C828-19 Performance requirements for line voltage thermostats used with individual room electric space heating devices: https://www.csagroup.org/store/product/CSA%20C828%3A19/

Energy and Demand Savings

Energy Savings

$\Delta kWh_{savings}$ = ((kBTU/h)$_{out}$ /unit × 1/HSPF x $EFLH_{heating}$ x $ESF_{heating}$)/N

Where: Output electric heating capacity per residence, (kBTU/h)$_{out}$ /unit = Actual (If the value is unknown, assume 36)[2]

Heating seasonal performance factor, HSPF = 3.412 (Electric baseboard heaters have a COP of 1 or an HSPF of 1 x 3.412)

Heating equivalent full-load hours, $EFLH_{heating}$ (hrs/yr)[3] = 1811 hours

Energy savings factor for programmable Thermostat, $ESF_{heating}$[4]= 2.0%

Energy savings factor, $ESF_{heating}$[5]= 8.0%

% of Manual Thermostat[6] = 43%

Number of thermostats per residence, N = Actual (If unknown, assume 3)[7]

$kWh_{Savings}$ per thermostat (for non-thermostat in baseline) = [(36 /3.412) × 1811 × 8.0%]/ 3 = 510 kWh

$kWh_{Savings}$ per thermostat (for programmable thermostat in baseline) = [(36 /3.412) × 1811 × (8.0% - 2.0%)]/ 3 = 382 kWh

$kWh_{savings}$ = kWh Savings/thermostat for non-thermostat in baseline x % of Manual Thermostat - kWh Savings/thermostat for programmable thermostat in baseline × (1- % of Manual Thermostat) = 510 × 43% – 382 × (1- 43%) = 437 kWh

Connected Demand Savings

No connected demand savings for this measure.

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[2] IESO EAP reporting results 2021-2023 for number of Baseboard heaters and size of the heating system

[3] Effective Full Load Hours, Sourced from Resource Innovations report to IESO, Oct. 2024

[4] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Residential, Multi-Family, and Commercial/Industrial Measures, Version 11, October 6, 2023, HVAC - Control, Connected Thermostat https://dps.ny.gov/system/files/documents/2023/12/nys-trm-v11_filing.pdf

[5] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs Version - Residential, Multi-Family, and Commercial/Industrial Measures, Version 11, October 6, 2023, HVAC - Control, Connected Thermostat https://dps.ny.gov/system/files/documents/2023/12/nys-trm-v11_filing.pdf

[6] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures, Final, Sep. 20, 2024, Section 5.3.16, Advanced Thermostats

[7] IESO EAP reporting results 2021-2023 for number of Baseboard heaters and size of the heating system

Summer Peak Demand Savings

Summer peak demand savings, ΔkW_{peak} is calculated by multiplying the Annual Energy Savings $kWh_{savings}$ with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kW_{peak} = kWh_{savings} * \text{Summer Peak Demand Factor}$

$\Delta kW_{peak} = 437 \text{ x } 0.00090\% = 0.00393 \text{ kW}$

End Use Load Profile

PSP-Consumer-Residential-Forced_Air_Central_HeatingEM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.00090%	0.02600%	0.00086%	0.03600%

Effective Useful Life (EUL)

Measure	**EUL (years)**
Smart Line Voltage Thermostat	11[8]

Revision History

Revision #	**Description/Comment**	**Date Revised**
0	Created in Measures & Assumptions List	Dec. 2019
1	Updated Measure Incremental Cost	May 2020
2	Updated references and formatting	Nov. 2023
3	Updated by Resource Innovations	Jan. 2025

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[8] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Residential, Multi-Family, and Commercial/Industrial Measures, Version 11, October 6, 2023, HVAC - Control, Connected Thermostat https://dps.ny.gov/system/files/documents/2023/12/nys-trm-v11_filing.pdf

Low Voltage Smart Thermostat

Measure Description

Energy Efficient Equipment Description

Wi-Fi-enabled smart low-voltage thermostat for electric heating and cooling, with or without central-air conditioning that automatically adjusts temperature settings based on observed occupancy patterns.

Base Equipment Description

Combined traditional manual and programmable thermostat for electric heating and cooling.

Code, Standards and Regulations

The Office of Energy Efficiency of Natural Resources Canada (NRCan) has listed the Energy Star® specification for connected thermostats. The smart thermostat or connected thermostat is defined as a device that controls HVAC equipment to regulate the temperature of the room or space in which it is installed and has the ability to communicate with sources external to the HVAC system. A smart thermostat must meet the specific device and energy savings criteria to be ENERGY STAR® qualified (effective on December 23, 2016).[1]

Table 1 - Smart Thermostat Device Criteria[2]

Parameter	Performance Requirement
Static temperature accuracy	≤ ± 2.0 °F
Network standby average power consumption	≤ 3.0 W average

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[1] ENERGYSTAR® Program Requirements For Connected Thermostat Products: https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Program%20Requirements%20for%20Connected%20Thermostats%20Version%201.0.pdf

[2] ENERGYSTAR® Program Requirements For Connected Thermostat Products: https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Program%20Requirements%20for%20Connected%20Thermostats%20Version%201.0.pdf

Time to enter network standby after user interaction (on device, remote or occupancy detection)	≤ 5.0 minutes

Table 2 - Smart Thermostat Energy Saving Criteria[3]

Metric	Statistical Measure	Performance Requirement
Annual % run time reduction, heating (HS)	Lower 95% confidence limit of weighted national average	≥ 8%
Annual % run time reduction, heating (HS)	Weighted national average of 20th percentiles	≥ 4%
Annual % run time reduction, cooling (CS)	Lower 95% confidence limit of weighted national average	≥ 10%
Annual % run time reduction, cooling (CS)	Weighted national average of 20th percentiles	≥ 5%
Average resistance heat utilization for heat pump installations (RU)	National mean in 5 °F outdoor temperature bins from 0 to 60 °F	Reporting requirement

Resource Savings

Measure Assumptions

Base Measure Assumptions

Electric furnace or heat pump with central air-conditioning (CAC) equipped with either a programmable or non-programmable thermostat.

Energy Efficient Measure Assumptions

Energy Star qualified Wi-Fi-enabled low-voltage smart thermostat for electric furnace or heat pump with or without central air-conditioning (CAC), featuring temperature settings based on occupancy sensing and remote access.

Energy and Demand Savings

Energy Savings

$$\text{Annual Energy Savings (kWh/yr)}_{\text{cooling}} = \text{tons/unit} \times 12/\text{Eff}_{\text{cooling}} \times \text{EFLH}_{\text{cooling}} \times \text{ESF}_{\text{cooling}}$$

$$\text{Annual Energy Savings (kWh/yr)}_{\text{heating}} = (\text{kBTU/h})_{\text{out}}\ /\text{unit} \times 1/\text{HSPF} \times \text{EFLH}_{\text{heating}} \times \text{ESF}_{\text{heating}}$$

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[3] ENERGYSTAR® Program Requirements For Connected Thermostat Products: https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Program%20Requirements%20for%20Connected%20Thermostats%20Version%201.0.pdf

$\Delta MMBtu = (kBTU/h)_{out}$ /unit × 1/1000 × $EFLH_{heating}$ × $ESF_{heating}$

Annual Energy Savings[4] = Annual Energy Savings $(kWh/yr)_{cooling}$ + Annual Energy Savings $(kWh/yr)_{heating}$

= tons/unit x 12/$Eff_{cooling}$ × $EFLH_{cooling}$ × $ESF_{cooling}$ + $(kBTU/h)_{out}$ /unit × 1/HSPF × $EFLH_{heating}$ × $ESF_{heating}$

= 92.69 + 745.40 = 838.09 kWh

Where: Tons of air conditioning per residence, tons /unit = Actual (If the value is unknown, assume = 1.5)[5]

Seasonal average cooling energy efficiency, $Eff_{cooling}$ = Actual (If the value is unknown, assume 13.4)[6]

Cooling equivalent full-load hours, $EFLH_{cooling}$ = 690 hrs[7]

Cooling energy savings factor, $ESF_{cooling}$ = 10%[8]

Output electric heating capacity per residence, $(kBTU/h)_{out}$ /unit = Actual (If the value is unknown, assume 36 kBTU /hr)[9]

Heating seasonal performance factor, HSPF = Actual (If the value is unknown, assume 6 Btu/wh)[10]

Heating equivalent full-load hours, $EFLH_{heating}$ = 1811 hrs[11]

Heating energy savings factor for programmable Thermostat, $ESF_{heating}$[12] = 2.0%

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[4] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs Version 11, Single and Multi-family Residential Measures, HVAC - Control, Connected Thermostat

[5] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs Version 11, Single and Multi-family Residential Measures, HVAC - Control, Connected Thermostat

[6] https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/split-system-central-air-conditioners-and-heat-pumps/6895

[7] Effective Full Load Hours, Sourced from Resource Innovations report to IESO, Oct. 2024

[8] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs Version 11, Single and Multi-family Residential Measures, HVAC - Control, Connected Thermostat

[9] IESO EAP reporting results 2021-2023 for number of Baseboard heaters and size of the heating system

[10] https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/split-system-central-air-conditioners-and-heat-pumps/6895

[11] Effective Full Load Hours, Sourced from Resource Innovations report to IESO, Oct. 2024

[12] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs Version 11, Single and Multi-family Residential Measures, HVAC - Control, Connected Thermostat

Heating energy savings factor for Smart Thermostat, $ESF_{heating}$[13] = 8.0%

Blended heating energy savings factor considering 43% of the houses that have manual thermostat, $ESF_{heating}$[14] = 6.9%

Connected Demand Savings

No connected demand savings for this measure.

Summer Peak Demand Savings

Summer peak demand savings, ΔkW_{peak} is calculated by multiplying the Annual Energy Savings $(kWh/yr)_{cooling}$ with the Summer Peak Demand Factor using an End Use Load Profile (see below).

Annual Energy Savings $(kWh/yr)_{cooling}$ = tons/unit x 12/$Eff_{cooling}$ × $EFLH_{cooling}$ × $ESF_{cooling}$

= 92.69 kWh

ΔkW_{peak} = Annual Energy Savings $(kWh/yr)_{cooling}$ × Summer Peak Demand Factor

ΔkW_{peak} = 92.69 × 0.04576% = 0.04241 kW

End Use Load Profile

EM&V-Residential-Electric_Heating_and_Cooling

PSP-Consumer-Residential-AC_Central

EM&V Peak Definition

Load Profile	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
EM&V-Residential-Electric_Heating_and_Cooling	0.02323%	0.01303%	0.01755%	0.01755%
PSP-Consumer-Residential-AC_Central	0.04576%	0.00000%	0.12185%	0.00000%

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[13] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs Version 11, Single and Multi-family Residential Measures, HVAC - Control, Connected Thermostat

[14] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 13.0 Volume 3: Residential Measures, Section 5.3.16 Advanced Thermostats

Effective Useful Life (EUL)

Measure	EUL (years)
Smart Line Voltage Thermostat	11[15]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Dec. 2019
1	Updated Measure Incremental Cost	May 2020
2	Updated references and formatting	Nov. 2023
3	Updated by Resource Innovations	Jan. 2025

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[15] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs Version 11, Single and Multi-family Residential Measures, HVAC - Control, Connected Thermostat

Programmable Thermostat

Baseboard Heaters

Measure Description

Energy Efficient Equipment Description

Electric baseboard heater equipped with a line voltage programmable thermostat that features temperature setback capability

Base Equipment Description

Baseboard heater without a programmable thermostat for overnight temperature setback

Code, Standards and Regulations

Programmable thermostats must meet the CAN/CSA C828-19 Standards.[1] Programmable thermostats are no longer listed as Energy Star certified products.

Resource Savings

Measure Assumptions

kBTu/h – Output heating capacity per residence; assume 36 if unknown[2]

HSPF – Heating seasonal performance factor, Btu/WH; assume 3.412

EFLH – Heating equivalent full-load hours, see Table 1

ESF – Energy savings factor for heating; assume 2%[3]

N - Number of thermostats per residence; assume 3 if unknown

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[1] Performance requirements for line voltage thermostats used with individual room electric space heating devices https://www.csagroup.org/store/product/CSA%20C828%3A19/

[2] IESO EAP reporting results 2021-2023 for number of baseboard heaters and size of the heating system

[3] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 11 (effective Jan. 1, 2024), Programmable Setback https://dps.ny.gov/system/files/documents/2023/12/nys-trm-v11_filing.pdf

Table 1 – Heating Equivalent Full-Load Hours[4]

Climate City Zone	EFLH	Weighting Factor
Barrie	1939	3%
Hamilton	1902	6%
Ottawa	2129	19%
Peterborough	1896	2%
Thunder Bay	2308	2%
Timmins	2557	1%
Toronto	1678	55%
Windsor	1529	5%
Sudbury	2210	2%
London	1715	7%
Unknown	1811	

Energy and Demand Savings

Energy Savings

Annual Energy Savings (kWh/yr) = (kBtu/h x 1/HSPF x $EFLH_{heating}$ x $ESF_{heating}$)/N

Annual Energy Savings (kWh/yr) = (36 x (1/3.412) x 1811 x 0.02)/3 = 127.4

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There is no connected demand savings for this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkW_{peak} = ΔkWh * Summer Peak Demand Factor

ΔkW_{peak} = 127.46 x 0.0009% = 0.0011 kW

End Use Load Profile

PSP-Consumer-Residential-Forced_Air_Central_Heating

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[4] Effective Full Load Hours, Sourced from Resource Innovations report to IESO, Oct. 2024

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.00090%	0.02600%	0.00086%	0.03600%

Effective Useful Life (EUL)

Measure	EUL (years)
Programmable Thermostat for Baseboard Heaters	11[5]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Feb. 2008
1	Update from 2007 EKC Program Final Evaluation Report	May 2008
2	Update from 2008 EKC Power Savings Event, Keep Cool Pilot and Rewards for Recycling Programs Evaluation Report	Oct. 2009
3	Updated from PY2016 Consumer RNC Program Evaluation	July 2017
4	Updated from PY2017 Consumer Program Evaluation	Nov. 2018
5	Updated to Apply Discrete Savings for Detached, Attached or Row House, and Multifamily using Program Tracking Data	May 2020
6	Updated formatting	Nov. 2023
7	Updated by Resource Innovations	Jan. 2025

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[5] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 11 (effective Jan. 1, 2024), Programmable Setback https://dps.ny.gov/system/files/documents/2023/12/nys-trm-v11_filing.pdf

ENERGY STAR® LED Lights

Measure Description

Energy Efficient Equipment Description

Residential Energy Star certified **LED lights** in the following categories:

- ≤ 16 W Energy Star Qualified LED PAR30 & PAR38 (≥ 600 Lumen)
- ≤ 6 W Energy Star Qualified LED MR 16 / PAR 16 (≥ 250 Lumen)
- ≤ 11 W Energy Star Qualified LED A Shape (60W) (≥ 600 Lumen)
- ≤ 14 W Energy Star Qualified LED A Shape (75W) (≥ 800 Lumen)
- ≤ 23 W Energy Star Qualified LED A Shape (100W) (≥ 1600 Lumen)
- ≤ 23 W Energy Star LED Wet Location Rated PAR lamp (≥ 1100 Lumen)

Base Equipment Description

Weighted average of general purpose incandescent and halogen bulbs

Code, Standards and Regulations

All general purpose incandescent lightbulbs manufactured on or after December 31, 2014 are subject to Canada's Energy Efficiency Regulations, which set a max allowable wattage based on lumens:[1]

Standard Lumen Range	Maximum Wattage	Modified Lumen Range	Maximum Wattage New Standard
310 – 749	40	232 -562	29
750 – 1049	60	563 -787	43
1050 – 1489	75	788 -1,117	53
1,490 – 2,600	100	1,118 -1,950	72

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[1] NRCan Compliance Standard SOR/2013-260, General Purpose Lightbulb Regulations Online. http://www.nrcan.gc.ca/energy/regulations-codes-standards/12342

Resource Savings

Measure Assumptions

Base Measure Assumptions

Mixture of general purpose incandescent and halogen bulbs and proxy of specialty lamps based on US EISA standards[2] with the following average lumens and base wattages[3,4]:

Table 1 – Baseline Wattage Assumptions

Baseline Wattage Category	Average Lumens	Average Base Wattages
General Purpose Bulbs	835	43.00
General Purpose Bulbs	870	43.00
General Purpose Bulbs	1642	72.00
R, PAR, ER, BR, BPAR, or similar bulb shapes, with diameter >2.5"	428	40.00
R, PAR, ER, BR, BPAR, or similar bulb shapes, with diameter >2.5"	532	40.00
R, PAR, ER, BR, BPAR, or similar bulb shapes, with diameter >2.5"	637	50.00
R, PAR, ER, BR, BPAR, or similar bulb shapes, with diameter >2.5"	1045	65.00
R, PAR, ER, BR, BPAR, or similar bulb shapes, with diameter >2.5"	1257	65.00
R, PAR, ER, BR, BPAR, or similar bulb shapes, with diameter >2.5"	1310	65.00
Other	709	45.00
Other	1198	65.00

Energy Efficient Measure Assumptions

Efficient measure wattages and lumens are derived based on bulb type, minimum lumens, maximum wattage as per the Energy Star Qualified Products List[5]:

Table 2 - Efficient Wattage Assumptions

Measure Name	Average Lumens	Efficient Measure Wattages
≤16W Energy Star Qualified LED PAR 30 & PAR 38	1045	13.51
≤6W Energy Star Qualified LED MR 16 / PAR 16	428	5.59
≤11W Energy Star Qualified LED A Shape	835	9.40
≤14W Energy Star Qualified LED A Shape	870	9.74

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[2] There is no Canadian standard for lamps.

[3] Evaluation of 2017 Save on Energy Residential Province Wide Programs – HAP Lighting Workbook, Cadmus, Oct 2018.

[4] Evaluation of 2019 Save on Energy Residential Province Wide Programs – HAP TRM Adjustments Workbook, NMR Group, 2020.

[5] Energy Star Qualified Product List https://www.energystar.gov/productfinder/product/certified-light-bulbs/results

≤23W Energy Star Qualified LED A Shape	1642	16.01
Energy Star LED Wet Location Rated PAR lamp ≤ 23W	1257	16.42

Assumed Hours of Operation

Table 3 – Average Daily Operating Hours (HOU) Assumption

Measure	**HOU (hrs/day)**
≤16W Energy Star Qualified LED PAR 30 & PAR 38	2.7
≤6W Energy Star Qualified LED MR 16 / PAR 16	2.7
≤11W Energy Star Qualified LED A Shape	3.0
≤14W Energy Star Qualified LED A Shape	3.0
≤23W Energy Star Qualified LED A Shape	3.0
Energy Star LED Wet Location Rated PAR lamp ≤23W	2.7

Energy and Demand Savings

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{ee}$ = Efficient Measure Wattage x Operating Hours

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{ee}$

Table 4 – Annual Energy Savings (kWh/yr)

Measure	**kWh_{base}**	**kWh_{ee}**	**∆kWh**
≤16W Energy Star Qualified LED PAR 30 & PAR 38	64.06	13.31	50.74
≤6W Energy Star Qualified LED MR 16 / PAR 16	39.42	5.51	33.91
≤11W Energy Star Qualified LED A Shape	47.09	10.29	36.79
≤14W Energy Star Qualified LED A Shape	47.09	10.67	36.42
≤23W Energy Star Qualified LED A Shape	78.84	17.53	61.31
Energy Star LED Wet Location Rated PAR lamp ≤23W	64.06	16.18	47.88

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Table 5 – Connected Demand Savings (kW)

Measure	kW_{base}	kW_{ee}	ΔkW
≤16W Energy Star Qualified LED PAR 30 & PAR 38	0.0650	0.0135	0.0515
≤6W Energy Star Qualified LED MR 16 / PAR 16	0.0400	0.0056	0.0344
≤11W Energy Star Qualified LED A Shape	0.0430	0.0094	0.0336
≤14W Energy Star Qualified LED A Shape	0.0430	0.0097	0.0333
≤23W Energy Star Qualified LED A Shape	0.0720	0.0160	0.0560
Energy Star LED Wet Location Rated PAR lamp ≤23W	0.0650	0.0164	0.0486

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$\Delta kW_{peak} = \Delta kWh * \text{Summer Peak Demand Factor}$

Table 6 – Summer Peak Demand Savings (kW)

Measure	Summer Peak Demand Savings
≤16W Energy Star Qualified LED PAR 30 & PAR 38	0.0076
≤6W Energy Star Qualified LED MR 16 / PAR 16	0.0051
≤11W Energy Star Qualified LED A Shape	0.0055
≤14W Energy Star Qualified LED A Shape	0.0055
≤23W Energy Star Qualified LED A Shape	0.0092
Energy Star LED Wet Location Rated PAR lamp ≤23W	0.0072

End Use Load Profile

EM&V-Residential-Lighting_Interior

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01502%	0.02875%	0.03066%	0.03066%

Effective Useful Life (EUL)

EUL is estimated to be 14 years for residential LEDs derived by dividing the minimum 15,000 hours rated life (Energy Star®) by the assumed annual HOUs.

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Feb. 2008
1	Updated using 2007 Great Refrigerator Roundup Program (GRRP) Report Data	May 2008
2	Updated using 2008 GRRP Report Data	Dec. 2009
3	Updated using 2009 GRRP Report Data	Dec. 2010
4	Updated with PY2016 HAP Program Evaluation	July 2017
5	Updated with PY2017 HAP Program Evaluation	Oct. 2018
6	Updated with PY2019 HAP Program Evaluation	May 2020
7	Updated references and formatting	Nov. 2023
8	Updated summer peak demand savings due to changes in summer peak demand definition	Jan. 2025

LED Nightlight

Measure Description

Energy Efficient Equipment Description

LED nightlight – installed in a residential location

Base Equipment Description

Incandescent or halogen nightlight

Code, Standards and Regulations

No applicable codes and standards for nightlights

Resource Savings

Measure Assumptions[1]

Base Measure Assumptions

7W incandescent or halogen nightlight

Energy Efficient Measure Assumptions

0.3W LED nightlight

Assumed Hours of Operation

HOU - 4,380 hrs/yr

Energy and Demand Savings

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Vol. 3, Section 5.5.11 Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

Energy Savings

Annual Energy Consumption $(kWh/yr)_{base}$ = Base Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{base}$ = 7W x 4380 hrs/yr x kWh/1000Wh

= 30.66 kWh/yr

Annual Energy Consumption $(kWh/yr)_{ee}$ = Efficient Measure Wattage x Operating Hours

Annual Energy Consumption $(kWh/yr)_{ee}$ = 0.3W x 4380 hrs/yr x kWh/1000Wh

= 1.31 kWh/yr

Annual Energy Savings (kWh/yr) = Annual Energy Consumption $(kWh/yr)_{base}$ - Annual Energy Consumption $(kWh/yr)_{ee}$

Annual Energy Savings (kWh/yr) = 30.66 kWh/yr – 1.31 kWh/yr = 29.35 kWh/yr

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

Demand Savings (kW) = Base Measure Wattage – Conservation Measure Wattage

Demand Savings (kW) = (7 Watt– 0.3 Watt) / 1000 = 0.0067 kW

Summer Peak Demand Savings

No peak demand savings since this measure is used during nighttime.

End Use Load Profile

EM&V-Residential-Lighting_Interior

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	**Winter Peak Demand (kW/kWh)**	**Alternative Summer Peak Demand (kW/kWh)**	**Alternative Winter Peak Demand (kW/kWh)**
0.01502%	0.02875%	0.03066%	0.03066%

Effective Useful Life (EUL)

Measure	EUL (years)
LED Nightlight	8[2]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Sep. 2020
1	Updated reference and formatting	Nov. 2023
2	Updated summer peak demand savings due to changes in summer peak demand definition	Jan. 2025

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0 Sep 20, 2024 https://www.icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency

HEAVY DUTY PLUG-IN TIMERS

Car Block Heater

Measure Description

Energy Efficient Equipment Description

Heavy duty plug-in timer on car block heater to reduce operation time

Base Equipment Description

No timer on the car block heater

Code, Standards and Regulations

The timers and time switches sold in Canada shall meet CSA E730-2-7-94 (R2013) Standard.

Resource Savings

Measure Assumptions[1]

P – average power (kW) of the equipment that are to be controlled by the plug-in timer; assume 0.511 kW

HOU_{base} - base average daily operating hours before installing the plug-in timer; assume 10.1 hrs/day

HOU_{ee} – efficient measure average daily operating hours after installing the plug-in timer; assume 3.7 hrs/day

Days - number of days per year the equipment operates; assume 73 days/yr

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[1] PY2017 Block Heater Timer Pilot Impact and Process Evaluation, Cadmus, Nov 15 2018.

Energy and Demand Savings

Energy Savings[2]

Annual Energy Consumption $(kWh/yr)_{base}$ = P x HOU_{base} x Days

Annual Energy Consumption $(kWh/yr)_{ee}$ = P x HOU_{ee} x Days

Annual Energy Savings (kWh/yr) = P x Days x (HOU_{base} – HOU_{ee})

Annual Energy Savings (kWh/yr) = 0.511 x 73 x (10.1 – 3.7) = 238.7

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

There is no connected demand savings for this measure.

Summer Peak Demand Savings

There is no summer peak demand savings for this measure.

End Use Load Profile

EM&V-Residential-Car_Block_Heater_North_Ontario

EM&V-Residential-Car_Block_Heater_South_Ontario

EM&V Peak Definition

Load Profile	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
North_Ontario	0.00000%	0.01287%	0.07172%	0.07172%
South_Ontario	0.00000%	0.01621%	0.36691%	0.36691%

Effective Useful Life (EUL)

Measure	EUL (years)
Block Heater Timer	10[3]

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[2] 2023 Wisconsin Focus on Energy Technical Reference Manual https://focusonenergy.com/evaluation-reports/2023-wisconsin-focus-on-energy-technical-reference-manual

[3] PY2017 Block Heater Timer Pilot Impact and Process Evaluation, Cadmus, Nov 15 2018.

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Oct. 2008
1	Updated from 2007 Every Kilowatt Counts (EKC) Power Saving Event (PSE), Keep Cool Pilot & Rewards for Recycling (R4R) programs	Oct. 2009
2	Updated based on PY2017 Consumer Instant Discount Program Evaluation	Dec. 2018
3	Updated based on PY2019 HAP Program Evaluation	May 2020
4	Updated references and formatting	Nov. 2023
5	Updated by Resource Innovations	Jan. 2025

Indoor Clothes Drying Rack/Outdoor Retractable Clothesline Kit

Measure Description

Energy Efficient Equipment Description

Retractable clothesline or drying rack for indoor or outdoor use

Base Equipment Description

Conventional electric and gas clothes dryer

Code, Standards and Regulations

Ontario Regulation 97/08 under the Energy Conservation Leadership Act allows clotheslines in certain circumstances where they might not otherwise be allowed by the municipal by-law or condominium by-law. The regulation overrides any such prohibitions.

Resource Savings

Measure Assumptions

Base Measure Assumptions[1]

Conventional electric clothes dryer with average 5.4 loads per week or 283 loads per year

Energy Efficient Measure Assumptions

Retractable clothesline or drying rack displacing equivalent 0.96 dryer loads per week or 50 loads per year.[2]

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[1] Energy Use in Canada: Publications | Natural Resources Canada

[2] "Evaluation of 2017 Clothesline Instant Savings Program Evaluation" , Cadmus, Oct 2018

Energy and Demand Savings

Energy Savings[3,4,5,6, 7]

Annual energy consumption of the base measure (kWh/yr)$_{b,ele}$ = Σ [{(W$_{ele}$ x L$_{b}$ x 52)/CEF$_{b}$) x %distr] x %$_{ele}$

Annual energy consumption of conservation measure (kWh/yr)$_{ee,ele}$ = [(W$_{ele}$ x (L$_{b}$-L$_{e)}$ x 52)/CEF$_{e}$} x %distr x %$_{ele}$

Where: W$_{ele}$ - average weight of clothes per electric dryer load, lb/load

L$_{b}$ - Average number of loads dried per week using dryer with base measure = 5.4 loads/week

L$_{ee}$ - Average number of equivalent loads dried per week using clothesline with conservation measure = 0.96 loads/week

CEF$_{b}$ - average combined energy factor of electric dryers, lb/kWh

CEF$_{e}$ - average combined energy factor of electric dryers, lb/kWh

%distr - distribution rate of different types of electric dryer

%$_{ele}$ – saturation rate of electric dryer, assume 75%

52 – number of weeks per year

Table 1 - Average weight of clothes per electric dryer load and average combined energy factor of electric dryers[8]

Type of Electric Dryers	**W$_{ele}$**	**CEF$_{b}$**	**CEF$_{e}$**
Ventless or Vented Standard (≥4.4 cu.ft.), Electric (240V)	8.45	3.11	3.11

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

[4] Massachusetts Department of Public Utilities eTRM, 2019-2021 Plan TRM https://etrm.anbetrack.com/#/workarea/home?token=6d6c45766e692f527044

[5] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, Version 7, Jan 2020 https://dps.ny.gov/system/files/documents/2022/11/technical-resource-manual-version-7-filed-april-15-2019-effective-january-1-2020.pdf

[6] US Energy Star appliances Calculator https://www.energystar.gov/products/clothes_dryers

[7] 2. NRCan, ENERGY STAR Simple Savings Calculator – Clothes Dryers http://oee.nrcan.gc.ca/residential/business/energystar/procurement/programfiles/download.cfm

[8] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Volume 3: Residential Measures IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Ventless or Vented Compact (<4.4 cu.ft.), Electric (120V)	3.00	3.01	3.01
Vented Compact (<4.4 cu.ft.), Electric (240V)	3.00	2.73	2.73
Ventless Compact (<4.4 cu.ft.), Electric (240V)	3.00	2.13	2.13

Table 2 -Distribution of electric dryers[9]

Type of Electric Dryers	%distr
Ventless or Vented Standard (≥4.4 cu.ft.), Electric (240V)	85%
Ventless or Vented Compact (<4.4 cu.ft.), Electric (120V)[9]	6%
Vented Compact (<4.4 cu.ft.), Electric (240V)	3%
Ventless Compact (<4.4 cu.ft.), Electric (240V)	6%

Annual electricity savings, ΔkWh = Annual energy consumption of the base measure $(kWh/yr)_{b,ele}$ - Annual energy consumption of the conservation measure $(kWh/yr)_{ee,ele}$

Table 3 – Annual Electricity Savings (kWh/yr)

Dryers	kWh_b	kWh_{ee}	ΔkWh
Electric Dryers	525.1	431.8	93.35

Lifetime Energy Savings (kWh) = ΔkWh x EUL (yr)

Connected Demand Savings

No connected demand savings for this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkW_{peak} = ΔkWh * Summer Peak Demand Factor

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[9] EERE - Compliance Certification Database. Clothes Dryers - Appendices D1 and D2 https://www.regulations.doe.gov/certification-data/CCMS-4-Clothes_Dryers_-_Appendices_D1_and_D2.html#q=Product_Group_s%3A%22Clothes%20Dryers%20-%20Appendices%20D1%20and%20D2%22

$\Delta kW_{peak} = 93.35 \times 0.01368\% = 0.01277\ kW$

End Use Load Profile

PSP-Consumer-Residential-Clothes_Dryers

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.01368%	0.01625%	0.01974%	0.01802%

Effective Useful Life (EUL)

Measure	EUL (years)
Clothesline	16[10]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Oct. 2008
1	Updated input assumptions based on EKC Spring 2009 Program Evaluation	Nov. 2010
2	Updated based on PY2016 Consumer Program Evaluation	Aug. 2017
3	Updated based on PY2017 Clothesline Instant Saving Program Evaluation	Nov. 2018
4	Updates based on PY2019 HAP Program Evaluation	Sep. 2020
5	Updated formatting and other references	Nov. 2023
6	Updated by Resource Innovations	Jan. 2025

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[10] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, Version 7, Jan 2020 https://dps.ny.gov/system/files/documents/2022/11/technical-resource-manual-version-7-filed-april-15-2019-effective-january-1-2020.pdf

Tier 2 Advanced Power Strip

Measure Description

Energy Efficient Equipment Description

Home entertainment controlled with Tier 2 Advance Power Strips (APS)

Base Equipment Description

Home entertainment equipment with no power strip (wall socket) or standard power strip that does not control loads of connected equipment

Code, Standards and Regulations

Power bars are subject to Canada's Energy Efficiency Regulations, which set a maximum allowable wattage in no-load mode:

Nominal nameplate output power	**Minimum average efficiency in active mode**
< 1 W	0.5 x Nameplate output
≥ 1 W and ≤ 51 W	0.09 x Nameplate output + 0.5
> 51 W	0.85

All external power supplies manufactured on or after July 1, 2010 must meet NRCan Compliance Standard CSA C381.1 or 10C.F.R Appendix Z.

Resource Savings

Measure Assumptions

Base Measure Assumptions

Conventional power strip or no power strip (wall socket).

Energy Efficient Measure

Tier 2 Advance Power Strips (APS) are multi-plug power strips achieve energy savings by turning off automatically the connected equipment through occupancy sensing and intelligent control strategies.

Energy and Demand Savings

Energy Savings[1]

Tier 2 APS savings with AV equipment as the connected equipment in a typical household is assumed as follows:

Home Connected Equipment	Annual Energy Savings (kWh/yr)
Entertainment Equipment	234

Connected Demand Savings

Annual hours that the connected system is not in use or is turned off, hrs_{off} = 8048 hours

Summer Peak Demand Savings

Summer peak demand savings ΔkWpeak are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

$$\Delta kWpeak = \Delta kWh * \text{Summer Peak Demand Factor}$$

$$\Delta kWpeak = 234 \text{ x } 0.00111\% = 0.0026 \text{ kW}$$

End Use Load Profile

PSP-Consumer-Residential-Power_Bar

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
0.00111%	0.00003%	0.00361%	0.00009%

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[1] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Residential, Multi-Family, and Commercial/Industrial Measures, Version 11, Issued Date - October 6, 2023, Advanced Power Strip, Page 61 - 64
https://dps.ny.gov/system/files/documents/2023/12/nys-trm-v11_filing.pdf

Effective Useful Life (EUL)

Measure	EUL (years)
Smart Power Strip	7[2]

Revision History

Revision #	Description/Comment	Date Revised
0	Created in Measures & Assumptions List	Dec. 2019
1	Updated based on PY2019 HAP Program Evaluation	May 2020
2	Updated references and formatting	Nov. 2023
3	Updated EM&V Peak Definition and References	Jan. 2025

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0 Volume 3: Residential Measures FINAL, Sep. 20, 2024, Section 5.2.2 – Tier 2 Advanced Power Strips
IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Residential Measures (Quasi-Prescriptive)

Air Source Heat Pump

Measure Description

Energy Efficient Equipment Description

Ducless Mini-split Air Source Heat Pump (ASHP) or Cold Climate Air Source Heat Pump (ccASHP) installed in residential single family homes.

Base Equipment Description

Base case equipment can be a fossil fuel fired furnace with air conditioning or an electric resistance heating system either with or without air conditioning or an existing air source heat pump.

Code, Standards and Regulations

Minimum efficiencies of ASHPs for sale in Canada are regulated by Canada's Energy Efficiency Act. Performance standards for ASHPs for sale in Ontario are outlined in O.Reg. 509/18.

Resource Savings

Measure Assumptions

Variable	Description	Value	Unit
$AFUE_{base}$	Baseline annual fuel utilization efficiency rating	See Table 1	%
HeatLoad	Full Load hours x Heating Capacity		Btu
FLH $ASHP_{heat}$	Full load hours of heat pump heating	See Table 2	hr
FLH $ASHP_{heat}$ Partial Displacement by Split System	Full load hours for a ductless minisplit HP providing supplemental heating to a limited space previously unserved or underserved by existing equipment.	See Table 3	hr

Capacity $ASHP_{heat}$	Heating output capacity of ASHP at 47°F	Actual (1 ton = 12,000Btu/hr)	Btu/hr
DuctlessSave	Factor used to adjust ducted heating or cooling load displaced by ductless systems that are not subject to losses from existing ductwork.	1	-
HSPF2_ee	Heating seasonal performance factor 2 of efficient ASHP; converted to HSPF2 if rating is in HSPF	Actual or program-defined minimum if unknown	kBtu/kWh
$DeratingHeat_{base}$	Baseline heating derating	0.1	
Cooling Load	Annual cooling load for the building FLH_cooling x Capacity_$ASHP_{cool}$		Btu
SEER2_base	Seasonal energy efficiency ratio of baseline unit	See Table 4	kBtu/kWh
SEER2_ee	Rated SEER of ENERGY STAR unit (kBtu/kWh); converted to SEER2 if rating is in SEER	Actual or program-defined minimum if unknown	kBtu/kWh
F_e	Furnace fan energy consumption as a percentage of annual fuel consumption	3.14% (Existing) 1.88% (New)	%
EER2_base	Energy efficiency ratio 2 of baseline unit	See Table 5	kBtu/kWh
Derating $Cool_{base}$	Baseline cooling derating	0.1	
FLH_cooling	Full load hours of air conditioning	See Table 2	hr
FLH_cooling Partial Displacement by Split System	Full load hours for a ductless mini split HP providing supplemental cooling to a limited space previously unserved or underserved by existing equipment.	See Table 3	hr
CF	Coincidence factor for summer peak demand	0.72	-
EER2_ee	Energy efficiency ratio of efficient ASHP	See Table 6	kBtu/hr / kW

Table 1 – Baseline Heating Efficiency Rating (%)[1]

Existing Heating System	$AFUE_{base}$	Note
Existing Gas Furnace	90%	Manufactured and sold in Ontario before June 30, 2020

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[1] O. Reg. 509/18: ENERGY AND WATER EFFICIENCY - APPLIANCES AND PRODUCTS - https://www.ontario.ca/laws/regulation/180509#BK13

New Gas Furnace	95%	Manufactured and sold in Ontario after July 1, 2020
Oil Furnace	83%	Manufactured and sold in Ontario after Jan 1, 2014
Unknown	89.33%	Average of fossil fuel efficiencies
Electric Resistance	100%	
Wood Furnace	80%	

Table 2 – Full Load Displacement – Single Technology

Climate Zone City	FLH_Electric Heat	FLH_ASHP	FLH_Gas Furnace	FLH_Cool
Barrie	1,939	2,320	1,790	563
Hamilton	1,902	2,273	1,682	671
Ottawa	2,129	2,412	1,907	706
Peterborough	1,896	2,540	1,709	607
Thunder Bay	2,308	2,253	2,166	402
Timmins	2,557	2,759	2,424	391
Toronto	1,678	2,148	1,513	679
Windsor	1,529	1,967	1,369	1,008
Armstrong	2,644	2,704	2,500	332
Peawanuck	3,520	3,695	3,442	144
Sudbury	2,210	2,502	2,064	504
London	1,715	2,170	1,539	750
Vineland	1,624	1,933	1,447	725
Wiarton	1,878	2,290	1,718	635

Table 3 – Part Load Displacement – Single Technology

Climate Zone City	FLH_Electric Heat	FLH_ASHP	FLH_Gas Furnace	FLH_Cool
Barrie	717	858	662	343
Hamilton	704	841	622	409
Ottawa	788	892	706	431
Peterborough	702	940	632	370
Thunder Bay	854	834	801	245

Timmins	946	1,021	897	239
Toronto	621	795	560	414
Windsor	566	728	507	615
Armstrong	978	1,000	925	203
Peawanuck	1,302	1,367	1,274	88
Sudbury	818	926	764	307
London	635	803	569	458
Vineland	601	715	535	442
Wiarton	695	847	636	387

Table 4 – Baseline Cooling Efficiency

Existing Cooling System	SEER2_base[2]	EER2_base[3]
ASHP – Standard sized	14.3	9.4
Central AC – Standard sized	14.3	10.6
Average	**14.3**	**10.0**

Table 5 – Minimum Efficiencies of Upgrade Case[4]

CEE Tier 1 - Technology	SEER2_ee	HSPF2_ee	EER2_ee
ASHP	15.2	6.6	10.0
ccASHP	15.2	6.6	10.0

Table 6 – Efficiencies of Energy Efficient Case[4]

Type	SEER2_ee	HSPF2_ee	EER2_ee
ASHP	20.8	7.2	12
ccASHP	22.4	8.1	12.8

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[2] https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/split-system-central-air-conditioners-and-heat-pumps/6895

[3] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 12.0, Volume 3: Residential Measures https://icc.illinois.gov/api/web-management/documents/downloads/public/il-trm-12/IL-TRM_Effective_010124_v12.0_Vol_3_Res_09222023_FINAL_clean.pdf

[4] NEEP Heat Pumps list average

Energy and Demand Savings

GasHeatReplaced	(HeatLoad/DuctlessSave * 1/$\text{AFUE}_{\text{base}}$) / 1,000,000
ASHP Site Heat Consumed	((HeatLoad * (1/(HSPF2_ee))) /1000 * 3412)/ 1,000,000
Baseline Cooling Consumption	((CoolingLoad/DuctlessSave * (1/(SEER2_base * (1 – DeratingCoolBase))))/1000 * 3412) / 1,000,000
Efficient Case Cooling Consumption	((CoolingLoad * 1/(SEER2_ee * (1 – DeratingCoolEff))))/1000 * 3412) / 1,000,000
Baseline furnace fan consumption	(HeatLoad_Disp/DuctlessSave * 1/AFUEbase * FeExist) / 1,000,000
Efficient Case furnace fan consumption	(HeatLoad_Disp/DuctlessSave * 1/AFUEbase * FeNew) / 1,000,000
Summer Coincident Peak Demand Savings	((Capacity_cooling/DuctlessSave * (1/(SEER2_base * (1 – $\text{DeratingCool}_{\text{Base}}$))) – (Capacity_cooling * 1/(SEER2_ee))) / 1000 * CF
ASHPSiteHeatingImpact	((HeatLoad_Disp/DuctlessSave * (1/($\text{HSPF2\_}_{\text{base}}$ * (1 – DeratingHeatBase)))) – (HeatLoad_Disp * 1/(HSPF2_ee * (1 – $\text{DeratingHeat}_{\text{Eff}}$)))) / 1000

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

See Algorithm on previous page.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below).

ΔkW_{peak} = ΔkWh * Summer Peak Demand Factor

End Use Load Profile

To be defined (custom)

EM&V Peak Definition

Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
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Effective Useful Life (EUL)

Measure	EUL (years)
ASHP	16[5]

Revision History

Revision #	Description/Comment	Date Revised
0	Developed by Resource Innovations	Jan. 2025

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[5] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 12.0, Volume 3: Residential Measures https://icc.illinois.gov/api/web-management/documents/downloads/public/il-trm-12/IL-TRM_Effective_010124_v12.0_Vol_3_Res_09222023_FINAL_clean.pdf

Attic Insulation

Measure Description

Energy Efficient Equipment Description

This measure includes the addition of blown cellulose or fiberglass batt insulation to the attic of a single family home. The minimum final attic insulation must be R-50.

Base Equipment Description

Existing attic with little or no insulation

Code, Standards and Regulations

The energy efficiency ratings for insulation in Ontario is regulated by the Ontario building code O. Reg. 163/24.

Resource Savings

Measure Assumptions

R_b (Btu/ft^2-°F-hr) - R-value of existing assemble and any existing insulation; Ontario Building Code began mandating minimum R-values in 2012. For houses built between 1975 and 2012, typical R-values for attic insulation range from R-12 to R-35; assume an average R-value of 25.

R_{ee} (Btu/ft^2-°F-hr) – R-value of new attic assembly (including all layers between inside air and outside air); assume R-value of 50

A_{attic} (ft^2) – Total area of insulated ceiling/attic

$Framing_{factor}$ (%) - Adjustment to account for area of framing; assume 7%

CDD (°F-day) - Cooling degree days depending on the location to the closest weather station; based on CWEC 2020 data, values are location-dependent. For unknown locations, a weighted average was calculated using population-based weighting factors from other locations; see Table 1

HDD (°F-day) – Heating degree days depending on the location to the closest weather station; based on CWEC 2020 data, values are location-dependent. For unknown locations, a weighted average was calculated using population-based weighting factors from other locations; see Table 1

Table 1 – Cooling and Heating Degree Days

Climate Zone City	**HDD 60°F**	**CDD 65°F**	**Weighing Factor**
Barrie	6742	475	3%
Hamilton	5840	549	6%
Ottawa	6743	561	19%
Peterborough	6488	528	2%
Thunder Bay	8410	319	2%
Timmins	9192	316	1%
Toronto	5173	457	55%
Windsor	4743	973	5%
Sudbury	7679	372	2%
London	5526	632	7%
Weighted Average	5716	516	

DUA (%) - Discretionary use adjustment (reflects the fact that people do not always operate their air conditioning when conditions may call for it); assume 75%[1]

η_{cool} (Btu/Whr) - Seasonal energy efficiency ratio of cooling system; see Table 2

η_{heat} (%) – Efficiency of heating system; see Table 2

Table 2 – System Efficiencies

System Type	η_{cool}	η_{heat}
Heat Pump	14.3	1.49
Resistance + AC	13.4	1.00
Oil	13.4	0.83
Natural Gas or Propane Furnace	13.4	0.95
Wood	13.4	0.80
Unknown	13.4	1.00

ADJ_{cool} (%) - Adjustment for cooling savings to account for inaccuracies in engineering algorithms; assume 114%

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[1] Energy Center of Wisconsin, May 2008 metering study; "Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research", p31.

ADJ_{heat} (%) - Adjustment for heating savings to account for inaccuracies in engineering algorithms; assume 63%

%Cool – Percent of homes that have cooling; assume 100% with cooling and 0% with no cooling; for unknown, assume 66%

24 – Hours/day

1000 – Converts Watthours to Kilowatthours

3412 – Converts Btu to kWh

Energy and Demand Savings

Energy Savings[2]

Annual Energy Savings $(kWh/yr)_{cooling}$ = [$(1/R_b – 1/R_{ee})$ x A_{attic} x (1 – $Framing_{factor}$) x 24 x CDD x DUA x ADJ_{cool} x %Cool] / (η_{cool} x 1000)

Annual Energy Savings $(kWh/yr)_{heating}$ = [$(1/R_b – 1/R_{ee})$ x A_{attic} x (1 – $Framing_{factor}$) x 24 x HDD x ADJ_{heat}] / (η_{heat} x 3412)

Annual Energy Savings (kWh/yr) = Annual Energy Savings $(kWh/yr)_{cooling}$ + Annual Energy Savings $(kWh/yr)_{heating}$

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

No connected demand savings for this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below). Alternative summer peak demand factor is used since the measure is weather sensitive.

ΔkW_{peak} = ΔkWh * Alternative Summer Peak Demand Factor

End Use Load Profile

EM&V-Residential-Electric_Heating_and_Cooling

PSP-Consumer-Residential-AC_Central

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Section 5.6.5 – Attic Insulation, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

EM&V Peak Definition

Load Profiles	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
EM&V-Residential-Electric_Heating_and_Cooling	0.02323%	0.01303%	0.01755%	0.01755%
PSP-Consumer-Residential-AC_Central	0.04576%	0.00000%	0.12185%	0.00000%

Effective Useful Life (EUL)

Measure	EUL (years)
Attic Insulation	20[3]

Revision History

Revision #	Description/Comment	Date Revised
0	Included as PY2017 HAP Program Fast Tool	Nov. 2018
1	Updated based on 2019 Consumer HAP Program Evaluation	May 2020
2	Updated reference and formatting	Nov. 2023
3	Updated by Resource Innovations	Jan. 2025

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[3] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Section 5.6.5 – Attic Insulation, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Basement Insulation

Measure Description

Energy Efficient Equipment Description

This measure includes the addition of blown cellulose or fiberglass batt insulation to the basement of a single family home. The minimum final attic insulation must be R-20.

Base Equipment Description

Existing basement with little or no insulation

Code, Standards and Regulations

The energy efficiency ratings for insulation in Ontario is regulated by the Ontario building code O. Reg. 163/24.

Resource Savings

Measure Assumptions

R_{added} (ft^2-°F-hr/Btu) - R-value of additional spray foam, rigid foam, or cavity insulation; assume 20

$R_{b,ag}$ (ft^2-°F-hr/Btu) - R-value of foundation wall above grade; Onatrio Building Code for houses built between 1975–2006 has introduced basic insulation standards, with basement wall R-values typically ranging from R-5 to R-12; assume an average R-value of 7.5

$R_{b,bg}$ (ft^2-°F-hr/Btu) - R-value of foundation wall below grade (including thermal resistance of the earth

$L_{basement\_wall\_total}$ (ft) - Length of basement wall around the entire insulated perimeter

$H_{basement\_wall\_ag}$ (ft) - Height of insulated basement wall above grade

$H_{basement\_wall\_total}$ (ft) - Total height of basement wall

$Framing_{factor}$ (%) - Adjustment to account for area of framing when cavity insulation is used; assume 25% if studs and cavity insulation; assume 0% if spray foam or external rigid foam

CDD (°F-day) - Cooling degree days depending on the location to the closest weather station; based on CWEC 2020 data, values are location-dependent. For unknown locations, a weighted average was calculated using population-based weighting factors from other locations; see Table 1

HDD (°F-day) – Heating degree days depending on the location to the closest weather station; based on CWEC 2020 data, values are location-dependent. For unknown locations, a weighted average was calculated using population-based weighting factors from other locations; see Table 1

Table 1 – Cooling and Heating Degree Days

Climate Zone City	HDD 60°F	CDD 65°F	Weighing Factor
Barrie	6742	475	3%
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Thunder Bay	8410	319	2%
Timmins	9192	316	1%
Toronto	5173	457	55%
Windsor	4743	973	5%
Sudbury	7679	372	2%
London	5526	632	7%
Weighted Average	5716	516	

DUA (%) - Discretionary use adjustment (reflects the fact that people do not always operate their air conditioning when conditions may call for it); assume 75%

η_{cool} (Btu/Whr) - Seasonal energy efficiency ratio of cooling system; see Table 2

η_{heat} (%) – Efficiency of heating system; see Table 2

Table 2 – System Efficiencies

System Type	η_{cool}	η_{heat}
Heat Pump	14.3	1.49
Resistance + AC	13.4	1.00
Oil	13.4	0.83
Natural Gas or Propane Furnace	13.4	0.95
Wood	13.4	0.80
Unknown	13.4	1.00

ADJ_{cool} (%) - Adjustment for cooling savings to account for inaccuracies in engineering algorithms; assume 114%

$ADJ_{heating}$ (%) - Adjustment for heating savings to account for inaccuracies in engineering algorithms; assume 63%

%Cool – Percent of homes that have cooling; assume 100% with cooling and 0% with no cooling; for unknown, assume 66%

24 – Hours/day

1000 – Converts Watthours to Kilowatthours

3412 – Converts Btu to kWh

Energy and Demand Savings

Energy Savings[1]

$\text{Annual Energy Savings (kWh/yr)}_{cooling} = [(1/R_{b,ag} – 1/(R_{added} + R_{b,ag})) \text{ x } L_{total\_basement\_wall} \text{ x } H_{basement\_wall\_ag} \text{ x } (1 – Framing_{factor}) \text{ x } 24 \text{ x CDD x DUA x } ADJ_{cool} \text{ x \%Cool}] / (\eta_{cool} \text{ x } 1000)$

$\text{Annual Energy Savings (kWh/yr)}_{heating} = \{[(1/R_{b,ag} – 1/(R_{added} + R_{b,ag})) \text{ x } L_{total\_basement\_wall} \text{ x } H_{basement\_wall\_ag})] + [(1/R_{b,bg} – 1/(R_{added} + R_{b,bg})) \text{ x } L_{basement\_wall\_total} \text{ x } (H_{basement\_wall\_total} – H_{basement\_wall\_ag}] \text{ x } (1 – Framing_{factor})] \text{ x } 24 \text{ x HDD x } ADJ_{basement\_heat}\} / (\eta_{heat} \text{ x } 3412)$

$\text{Annual Energy Savings (kWh/yr)} = \text{Annual Energy Savings (kWh/yr)}_{cooling} + \text{Annual Energy Savings (kWh/yr)}_{heating}$

Lifetime Energy Savings (kWh) = Annual Energy Savings (kWh/yr) x EUL (yr)

Connected Demand Savings

No connected demand savings for this measure.

Summer Peak Demand Savings

Summer peak demand savings ΔkW_{peak} are calculated by multiplying the Annual Energy Savings ΔkWh with the Summer Peak Demand Factor using an End Use Load Profile (see below). Alternative summer peak demand factor is used since the measure is weather sensitive.

$\Delta kW_{peak} = \Delta kWh * \text{Alternative Summer Peak Demand Factor}$

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[1] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Section 5.6.2 – Basement Sidewall Insulation, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

End Use Load Profile

EM&V-Residential-Electric_Heating_and_Cooling

PSP-Consumer-Residential-AC_Central

EM&V Peak Definition

Load Profiles	Summer Peak Demand (kW/kWh)	Winter Peak Demand (kW/kWh)	Alternative Summer Peak Demand (kW/kWh)	Alternative Winter Peak Demand (kW/kWh)
EM&V-Residential-Electric_Heating_and_Cooling	0.02323%	0.01303%	0.01755%	0.01755%
PSP-Consumer-Residential-AC_Central	0.04576%	0.00000%	0.12185%	0.00000%

Effective Useful Life (EUL)

Measure	EUL (years)
Attic Insulation	30[2]

Revision History

Revision #	Description/Comment	Date Revised
0	Included as PY2017 HAP Program Fast Tool	Nov. 2018
1	Updated based on 2019 Consumer HAP Program Evaluation	May 2020
2	Updated reference and formatting	Nov. 2023
3	Updated by Resource Innovations	Jan. 2025

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[2] 2025 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 13.0, Section 5.6.2 – Basement Sidewall Insulation, Sep 20, 2024 https://icc.illinois.gov/api/web-management/documents/downloads/public/IL-TRM_Effective_010125_v13.0_Vol_3_Res_09202024_FINAL.pdf

Appendices

Appendix A - Incremental Costs

Commercial & Industrial Measures (Prescriptive)

END_USE	CONSERVATION_MEASURE_NAME	DESCRIPTION	INCREMENTAL_LIFE_CYCLE_COST
Agribusiness	CREEP HEAT CONTROLLER	NEMA 4 or 4X. Must meet all applicable Code, standard, safety and regulatory requirements including CSA/UL/CUL	$666.00
Agribusiness	DAIRY ENERGY STAR WATER HEATER	Energy Star Electric Hot Water Tank >= 60 gal	$853.00
Agribusiness	DAIRY PLATE COOLER	Plate cooler to pre-cool milk prior to refrigeration	$3,098.00
Agribusiness	DOUBLE CREEP HEAT PAD	Up to 200W maximum	$95.00
Agribusiness	DUAL AND NATURAL EXHAUST VENTILATION SYSTEM	Chicken broilers	$27,000.00
Agribusiness	DUAL AND NATURAL EXHAUST VENTILATION SYSTEM	Dairy-tie stall, outside in summer	$12,000.00
Agribusiness	DUAL AND NATURAL EXHAUST VENTILATION SYSTEM	Dairy-tie stall, year-round housing	$12,000.00
Agribusiness	DUAL AND NATURAL EXHAUST VENTILATION SYSTEM	Egg layers	$18,000.00
Agribusiness	DUAL AND NATURAL EXHAUST VENTILATION SYSTEM	Greenhouse - Flowers	$10,250.00
Agribusiness	DUAL AND NATURAL EXHAUST VENTILATION SYSTEM	Swine - Breeding & Gestation	$5,500.00
Agribusiness	DUAL AND NATURAL EXHAUST VENTILATION SYSTEM	Swine - Growing & Finishing	$15,000.00
Agribusiness	DUAL AND NATURAL EXHAUST VENTILATION SYSTEM	Turkeys	$15,000.00
Agribusiness	ENGINE BLOCK HEATER TIMER	Plug-in timer that operates the heater only when outdoor temp drops below -3.8C	$13.76
Agribusiness	HIGH EFFICIENCY VENTILATION EXHAUST FANS	>= 18 to < 24" Fan	$202.00
Agribusiness	HIGH EFFICIENCY VENTILATION EXHAUST FANS	>= 24" to < 36" Fans	$202.00
Agribusiness	HIGH EFFICIENCY VENTILATION EXHAUST FANS	>= 36" to < 48" Fans	$202.00
Agribusiness	HIGH EFFICIENCY VENTILATION EXHAUST FANS	>= 48" Fans	$202.00
Agribusiness	HIGH TEMPERATURE CUTOUT THERMOSTAT	Operating range 24 to 40 Celsius	$124.00
Agribusiness	HIGH VOLUME LOW SPEED FAN	>= 10 ft to <11 ft, 1 HP	$1,293.00
Agribusiness	HIGH VOLUME LOW SPEED FAN	>= 11 ft to <19 ft, 1.5 HP	$2,962.00

Agribusiness	HIGH VOLUME LOW SPEED FAN	>= 19 ft to <=24 ft, 2 HP	$5,558.00
Agribusiness	LOW ENERGY LIVESTOCK WATERERS	300W maximum	$920.00
Agribusiness	MILK SCROLL COMPRESSOR	New scroll compressor for milk cooling with minimum EER of 12	$540.00
Agribusiness	PHOTOCELL AND TIMER FOR LIGHTING CONTROL	Timer to regulate on-off lighting schedule	$78.00
Agribusiness	SINGLE CREEP HEAT PAD	Up to 100W maximum	$70.00
Agribusiness	SOLAR HOT WATER COLLECTOR FOR DAIRY FARMS	Solar hot water collector to be used with electric hot water heater	$9,880.00
Building Plug Load	BEVERAGE VENDING MACHINE CONTROLS	Power Sensor and/or Occupancy Control for Refrigerated Vending Machine	$290.00
Commercial Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	<100 W (<0.134HP)	$1,225.00
Commercial Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=100<500 W (>=0.134<0.67HP)	$1,536.00
Commercial Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=1490<2237 W (>=2<3HP)	$1,896.00
Commercial Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=500<750 W (>=0.67<1HP)	$1,599.00
Commercial Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=750<1490 W (>=1<2HP)	$1,800.00
Commercial Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	2237 W (3HP)	$2,592.00
Compressed Air	COMPRESSED AIR LOW PRESSURE DROP FILTER	>=30 to <50 HP	$515.00
Compressed Air	COMPRESSED AIR LOW PRESSURE DROP FILTER	>=50 to <70 HP	$626.00
Compressed Air	COMPRESSED AIR LOW PRESSURE DROP FILTER	>=70 to <90 HP	$709.00
Compressed Air	COMPRESSED AIR LOW PRESSURE DROP FILTER	>=90 to <110 HP	$1,069.00
Compressed Air	COMPRESSED AIR LOW PRESSURE DROP FILTER	0 to <30 HP	$270.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 10 HP	$2,095.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 100 HP	$13,888.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 125 HP	$18,628.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 15 HP	$2,470.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 150 HP	$23,167.00

Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 20 HP	$2,980.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 200 HP	$24,092.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 25 HP	$3,289.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 30 HP	$3,514.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 40 HP	$4,929.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 50 HP	$5,430.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 60 HP	$9,323.00
Compressed Air	COMPRESSED AIR VD	Variable Displacement Compressor >= 75 HP	$13,118.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 10 HP	$2,893.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 100 HP	$22,128.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 125 HP	$28,888.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 15 HP	$3,441.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 150 HP	$32,717.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 20 HP	$5,336.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 200 HP	$54,642.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 25 HP	$5,580.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 30 HP	$6,113.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 40 HP	$6,643.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 50 HP	$8,993.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 60 HP	$15,578.00
Compressed Air	COMPRESSED AIR VSD	Variable Speed Drive Compressor >= 75 HP	$15,868.00
Compressed Air	CYCLING OR THERMAL MASS REFRIGERATED DRYER	>=200 to <400 CFM	$1,839.00
Compressed Air	CYCLING OR THERMAL MASS REFRIGERATED DRYER	>=400 to <750 CFM	$2,709.00
Compressed Air	CYCLING OR THERMAL MASS REFRIGERATED DRYER	0 to <200 CFM	$703.00
Compressed Air	ENGINEERED NOZZLE	1/16" Engineered Nozzle	$112.00
Compressed Air	ENGINEERED NOZZLE	1/4" Engineered Nozzle	$142.00
Compressed Air	ENGINEERED NOZZLE	1/8" Engineered Nozzle	$98.00

Compressed Air	ENGINEERED NOZZLE	3/8" Engineered Nozzle	$121.00
Compressed Air	PRIMARY AIR RECEIVER TANK	>=125 to <175 HP (>=2200 to <3150 USG)	$29,673.00
Compressed Air	PRIMARY AIR RECEIVER TANK	>=15 to <25 HP (>=240 to <400 USG)	$4,147.00
Compressed Air	PRIMARY AIR RECEIVER TANK	>=175 to <225 HP (>=3150 to <4050 USG)	$40,007.00
Compressed Air	PRIMARY AIR RECEIVER TANK	>=25 to <35 HP (>=400 to <660 USG)	$5,846.00
Compressed Air	PRIMARY AIR RECEIVER TANK	>=35 to <45 HP (>=660 to <1060 USG)	$11,363.00
Compressed Air	PRIMARY AIR RECEIVER TANK	>=45 to <55 HP (>=800 to <1060 USG)	$13,707.00
Compressed Air	PRIMARY AIR RECEIVER TANK	>=55 to <125 HP (>=1060 to <2220 USG)	$16,050.00
Compressed Air	PRIMARY AIR RECEIVER TANK	0 to <15 HP (0 to <240 USG)	$2,908.00
Compressed Air	REGENERATIVE DRYER WITH DEWPOINT CONTROL	>=200 to <400 CFM	$4,538.00
Compressed Air	REGENERATIVE DRYER WITH DEWPOINT CONTROL	>=400 to <750 CFM	$4,538.00
Compressed Air	REGENERATIVE DRYER WITH DEWPOINT CONTROL	0 to <200 CFM	$4,538.00
Compressed Air	ZERO LOSS DRAIN	Zero Loss Drain	$380.00
Demand Control Ventilation	DEMAND CONTROL KITCHEN VENTILATION	10001 - 15000 CFM exhaust fan capacity	$42,101.00
Demand Control Ventilation	DEMAND CONTROL KITCHEN VENTILATION	5001 - 10000 CFM exhaust fan capacity	$25,261.00
Demand Control Ventilation	DEMAND CONTROL KITCHEN VENTILATION	Up to 5000 CFM exhaust fan capacity	$8,420.00
Demand Control Ventilation	DEMAND CONTROL VENTILATION - ENCLOSED PARKING GARAGES	>=2 to <= 5 HP	$2,100.00
Demand Control Ventilation	DEMAND CONTROL VENTILATION - ENCLOSED PARKING GARAGES	>10 to <= 25 HP	$4,200.00
Demand Control Ventilation	DEMAND CONTROL VENTILATION - ENCLOSED PARKING GARAGES	>25 to <= 50 HP	$4,200.00
Demand Control Ventilation	DEMAND CONTROL VENTILATION - ENCLOSED PARKING GARAGES	>5 to <= 10 HP	$2,100.00
Demand Control Ventilation	DEMAND CONTROL VENTILATION - ENCLOSED PARKING GARAGES	>50 to <= 75 HP	$8,400.00
Demand Control Ventilation	DEMAND CONTROL VENTILATION - ENCLOSED PARKING GARAGES	>75 to <= 100 HP	$8,400.00

Demand Control Ventilation	DEMAND CONTROL VENTILATION - INTERIOR CONDITIONED SPACES	>100000 & <250000 SQ.FT.	$29,750.00
Demand Control Ventilation	DEMAND CONTROL VENTILATION - INTERIOR CONDITIONED SPACES	>250000 & <500000 SQ.FT.	$63,750.00
Demand Control Ventilation	DEMAND CONTROL VENTILATION - INTERIOR CONDITIONED SPACES	>500000 & <750000 SQ.FT.	$106,250.00
Demand Control Ventilation	DEMAND CONTROL VENTILATION - INTERIOR CONDITIONED SPACES	>750000 to <1000000 SQ.FT.	$148,750.00
Demand Control Ventilation	DEMAND CONTROL VENTILATION - INTERIOR CONDITIONED SPACES	50000 to <= 100000 SQ.FT.	$12,750.00
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 1 HP, 1200 RPM, 83.5%	$66.79
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 1 HP, 1800 RPM, 86.5%	$66.79
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 1 HP, 3600 RPM, 78%	$66.79
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 1.5 HP, 1200 RPM, 87.5%	$97.73
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 1.5 HP, 1800 RPM, 87.5%	$97.73
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 1.5 HP, 3600 RPM, 85%	$97.73
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 10 HP, 1200 RPM, 92.7%	$269.08
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 10 HP, 1800 RPM, 92.7%	$269.08
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 10 HP, 3600 RPM, 90.5%	$269.08
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 100 HP, 1200 RPM, 96%	$1,132.70
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 100 HP, 1800 RPM, 96.4%	$1,132.70
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 100 HP, 3600 RPM, 94.6%	$1,132.70
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 125 HP, 1200 RPM, 96%	$4,360.91
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 125 HP, 1800 RPM, 96.4%	$4,360.91
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 125 HP, 3600 RPM, 95.1%	$4,360.91
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 15 HP, 1200 RPM, 92.7%	$234.99
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 15 HP, 1800 RPM, 94%	$234.99
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 15 HP, 3600 RPM, 91.2%	$234.99
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 150 HP, 1200 RPM, 96.4%	$5,318.51

Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 150 HP, 1800 RPM, 96.8%	$5,318.51
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 150 HP, 3600 RPM, 95.1%	$5,318.51
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 2 HP, 1200 RPM, 88.5%	$105.01
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 2 HP, 1800 RPM, 87.5%	$105.01
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 2 HP, 3600 RPM, 86.5%	$105.01
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 20 HP, 1200 RPM, 93.4%	$263.31
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 20 HP, 1800 RPM, 94%	$263.31
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 20 HP, 3600 RPM, 92%	$263.31
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 200 HP, 1200 RPM, 96.4%	$6,123.77
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 200 HP, 1800 RPM, 96.8%	$6,123.77
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 200 HP, 3600 RPM, 96%	$6,123.77
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 25 HP, 1200 RPM, 94%	$322.80
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 25 HP, 1800 RPM, 94.6%	$322.80
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 25 HP, 3600 RPM, 92.7%	$322.80
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 250 HP, 1200 RPM, 96.4%	$7,258.34
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 250 HP, 1800 RPM, 96.8%	$7,258.34
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 250 HP, 3600 RPM, 96%	$7,258.34
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 3 HP, 1200 RPM, 89.5%	$120.89
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 3 HP, 1800 RPM, 90.5%	$120.89
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 3 HP, 3600 RPM, 86.5%	$120.89
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 30 HP, 1200 RPM, 94.6%	$385.46
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 30 HP, 1800 RPM, 95.1%	$385.46
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 30 HP, 3600 RPM, 92.7%	$385.46
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 300 HP, 1200 RPM, 96.4%	$8,739.56
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 300 HP, 1800 RPM, 96.8%	$8,739.56
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 300 HP, 3600 RPM, 96.4%	$8,739.56
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 40 HP, 1200 RPM, 95.1%	$459.00

Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 40 HP, 1800 RPM, 95.1%	$459.00
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 40 HP, 3600 RPM, 93.4%	$459.00
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 5 HP, 1200 RPM, 90.5%	$166.98
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 5 HP, 1800 RPM, 90.5%	$166.98
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 5 HP, 3600 RPM, 87.5%	$166.98
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 50 HP, 1200 RPM, 95.1%	$553.23
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 50 HP, 1800 RPM, 95.5%	$553.23
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 50 HP, 3600 RPM, 94%	$553.23
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 60 HP, 1200 RPM, 95.5%	$690.70
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 60 HP, 1800 RPM, 96%	$690.70
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 60 HP, 3600 RPM, 94.6%	$690.70
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 7.5 HP, 1200 RPM, 91.2%	$210.95
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 7.5 HP, 1800 RPM, 92%	$210.95
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 7.5 HP, 3600 RPM, 89.5%	$210.95
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 75 HP, 1200 RPM, 95.5%	$867.08
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 75 HP, 1800 RPM, 96%	$867.08
Electric Auxiliary	OPEN DRIP-PROOF (ODP) MOTORS	ODP Motor, 75 HP, 3600 RPM, 94.6%	$867.08
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 1 HP, 1200 RPM, 83.5%	$66.79
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 1 HP, 1800 RPM, 86.5%	$66.79
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 1 HP, 3600 RPM, 78%	$66.79
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 1.5 HP, 1200 RPM, 88.5%	$97.73
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 1.5 HP, 1800 RPM, 87.5%	$97.73
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 1.5 HP, 3600 RPM, 85%	$97.73
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 10 HP, 1200 RPM, 92.0%	$269.08
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 10 HP, 1800 RPM, 92.7%	$269.08
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 10 HP, 3600 RPM, 91.2%	$269.08
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 100 HP, 1200 RPM, 96%	$1,132.70

Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 100 HP, 1800 RPM, 96.4%	$1,132.70
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 100 HP, 3600 RPM, 95.1%	$1,132.70
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 125 HP, 1200 RPM, 96%	$4,360.91
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 125 HP, 1800 RPM, 96.4%	$4,360.91
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 125 HP, 3600 RPM, 96%	$4,360.91
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 15 HP, 1200 RPM, 92.7%	$234.99
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 15 HP, 1800 RPM, 93.4%	$234.99
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 15 HP, 3600 RPM, 92.0%	$234.99
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 150 HP, 1200 RPM, 96.8%	$5,318.51
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 150 HP, 1800 RPM, 96.8%	$5,318.51
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 150 HP, 3600 RPM, 96%	$5,318.51
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 2 HP, 1200 RPM, 89.5%	$105.01
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 2 HP, 1800 RPM, 87.5%	$105.01
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 2 HP, 3600 RPM, 86.5%	$105.01
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 20 HP, 1200 RPM, 92.7%	$263.31
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 20 HP, 1800 RPM, 94%	$263.31
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 20 HP, 3600 RPM, 92%	$263.31
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 200 HP, 1200 RPM, 96.8%	$6,123.77
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 200 HP, 1800 RPM, 97.2%	$6,123.77
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 200 HP, 3600 RPM, 96.4%	$6,123.77
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 25 HP, 1200 RPM, 94%	$322.80
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 25 HP, 1800 RPM, 94.6%	$322.80
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 25 HP, 3600 RPM, 92.7%	$322.80
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 250 HP, 1200 RPM, 96.8%	$7,258.34
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 250 HP, 1800 RPM, 97.2%	$7,258.34
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 250 HP, 3600 RPM, 96.8%	$7,258.34
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 3 HP, 1200 RPM, 90.5%	$120.89

Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 3 HP, 1800 RPM, 90.5%	$120.89
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 3 HP, 3600 RPM, 87.5%	$120.89
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 30 HP, 1200 RPM, 94%	$385.46
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 30 HP, 1800 RPM, 94.6%	$385.46
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 30 HP, 3600 RPM, 92.7%	$385.46
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 300 HP, 1200 RPM, 96.8%	$8,739.56
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 300 HP, 1800 RPM, 97.2%	$8,739.56
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 300 HP, 3600 RPM, 96.8%	$8,739.56
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 40 HP, 1200 RPM, 95.1%	$459.00
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 40 HP, 1800 RPM, 95.1%	$459.00
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 40 HP, 3600 RPM, 93.4%	$459.00
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 5 HP, 1200 RPM, 90.5%	$166.98
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 5 HP, 1800 RPM, 90.5%	$166.98
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 5 HP, 3600 RPM, 89.5%	$166.98
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 50 HP, 1200 RPM, 95.1%	$553.23
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 50 HP, 1800 RPM, 95.5%	$553.23
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 50 HP, 3600 RPM, 94%	$553.23
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 60 HP, 1200 RPM, 95.5%	$690.70
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 60 HP, 1800 RPM, 96%	$690.70
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 60 HP, 3600 RPM, 94.6%	$690.70
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 7.5 HP, 1200 RPM, 92.0%	$210.95
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 7.5 HP, 1800 RPM, 92.7%	$210.95
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 7.5 HP, 3600 RPM, 90.5%	$210.95
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 75 HP, 1200 RPM, 95.5%	$867.08
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 75 HP, 1800 RPM, 96.4%	$867.08
Electric Auxiliary	TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS	TEFC Motor, 75 HP, 3600 RPM, 94.6%	$867.08
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 1 HP, 66% Load Factor	$1,818.17

Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 1.5 HP, 66% Load Factor	$1,870.71
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 10 HP, 66% Load Factor	$3,673.04
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 100 HP, 66% Load Factor	$23,935.39
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 125 HP, 66% Load Factor	$27,073.45
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 15 HP, 66% Load Factor	$4,199.66
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 150 HP, 66% Load Factor	$30,024.42
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 2 HP, 66% Load Factor	$2,650.17
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 20 HP, 66% Load Factor	$4,527.30
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 200 HP, 66% Load Factor	$38,276.96
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 25 HP, 66% Load Factor	$5,762.33
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 250 HP, 66% Load Factor	$39,124.45
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 3 HP, 66% Load Factor	$2,779.80
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 30 HP, 66% Load Factor	$7,612.12
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 300 HP, 66% Load Factor	$42,837.87
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 40 HP, 66% Load Factor	$8,178.70
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 5 HP, 66% Load Factor	$2,969.31
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 50 HP, 66% Load Factor	$12,510.36
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 60 HP, 66% Load Factor	$13,294.42
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 7.5 HP, 66% Load Factor	$3,333.91
Electric Auxiliary	VARIABLE FREQUENCY DRIVE (VFD)	Motor Size: 75 HP, 66% Load Factor	$21,024.32
Multi-Residential In Suite Appliance	ENERGY STAR® REFRIGERATOR	Energy Star® Refrigerator	$35.00
Multi-Residential In Suite Appliance	IN-SUITE TEMPERATURE CONTROLS FOR ELECTRIC SPACE HEATING & COOLING	In-suite temperature controls for electric space heating & cooling	$370.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (FREEZER WALK-IN)	Motor Size >= 1/20 hp to < 1/10 hp	$300.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (REFRIGERATOR WALK-IN)	Motor Size >= 1/20 hp to < 1/10 hp	$300.00

Residential Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	<100 W (<0.134HP)	$1,225.00
Residential Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=100<500 W (>=0.134<0.67HP)	$1,536.00
Residential Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=1490<2237 W (>=2<3HP)	$1,896.00
Residential Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=500<750 W (>=0.67<1HP)	$1,599.00
Residential Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=750<1490 W (>=1<2HP)	$1,800.00
Residential Domestic Hot Water	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	2237 W (3HP)	$2,592.00
Space Cooling	ADVANCED ROOFTOP UNIT CONTROLS	Single-zone packaged RTU with single-speed supply fan retrofitted with advanced controls (>=11.4 ton to <19.9 tons)	$9,390.00
Space Cooling	ADVANCED ROOFTOP UNIT CONTROLS	Single-zone packaged RTU with single-speed supply fan retrofitted with advanced controls (>=19.9 ton to <63.4 tons)	$24,990.00
Space Cooling	ADVANCED ROOFTOP UNIT CONTROLS	Single-zone packaged RTU with single-speed supply fan retrofitted with advanced controls (>=3.0 ton to <5.4 tons)	$2,520.00
Space Cooling	ADVANCED ROOFTOP UNIT CONTROLS	Single-zone packaged RTU with single-speed supply fan retrofitted with advanced controls (>=5.4 ton to <11.4 tons)	$5,040.00
Space Cooling	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	<100 W (<0.134HP)	$1,225.00
Space Cooling	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=100<500 W (>=0.134<0.67HP)	$1,536.00
Space Cooling	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=1490<2237 W (>=2<3HP)	$1,896.00
Space Cooling	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=500<750 W (>=0.67<1HP)	$1,599.00
Space Cooling	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=750<1490 W (>=1<2HP)	$1,800.00

Space Cooling	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	2237 W (3HP)	$2,592.00
Space Cooling	ECM MOTORS FOR HVAC APPLICATION (FAN MOTOR REPLACEMENT)	Motor < 1 hp	$524.00
Space Cooling	ECM MOTORS FOR HVAC APPLICATION (FAN-POWERED VAV BOX)	VAV Units < 1000 CFM	$380.00
Space Cooling	ECM MOTORS FOR HVAC APPLICATION (FAN-POWERED VAV BOX)	VAV Units > 1000 CFM	$640.00
Space Cooling	HOTEL OCCUPANCY CONTROLS (HVAC + LIGHTING)	Electrically heated facility	$670.00
Space Cooling	HOTEL OCCUPANCY CONTROLS (HVAC + LIGHTING)	Gas heated facility	$670.00
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Single Package with Economizer >= 3.0 to < 5.4 tons, All Heating Type, 12.5 EER	$1,428.00
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Single Package with Economizer >= 5.4 to <= 7.5 tons, All Other Heating, 12.0 EER / 13.8 IEER	$2,193.00
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Single Package with Economizer >= 5.4 to <= 7.5 tons, Electric Resistance, 12.2 EER / 14.0 IEER	$2,193.00
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System >= 3.0 to < 5.4 tons, All Heating Type, 12.5 EER	$1,428.00
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System >= 5.4 to <= 7.5 tons, All Other Heating, 12.0 EER / 13.8 IEER	$2,193.00
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System >= 5.4 to <= 7.5 tons, Electric Resistance, 12.2 EER / 14.0 IEER	$2,193.00
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System/Single Package >= 11.25 to < 20 tons, All Other, 12.0 EER / 14.0 IEER	$3,906.25
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System/Single Package >= 11.25 to < 20 tons, Electric Resistance, 12.2 EER / 14.2 IEER	$3,906.25
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System/Single Package >= 20 to < 63 tons, All Other, 10.6 EER / 13.0 IEER	$7,470.00
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System/Single Package >= 20 to < 63 tons, Electric Resistance, 10.8 EER / 13.2 IEER	$7,470.00

Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System/Single Package >= 63 tons, All Other, 10.2 EER / 12.1 IEER	$11,340.00
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System/Single Package >= 63 tons, Electric Resistance, 10.4 EER / 12.3 IEER	$11,340.00
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System/Single Package >= 7.5 to < 11.25 tons, All Other, 12.0 EER /13.8 IEER	$2,343.75
Space Cooling	UNITARY AIR-CONDITIONING UNIT	Split System/Single Package >= 7.5 to < 11.25 tons, Electric Resistance, 12.2 EER / 14.0 IEER	$2,343.75
Space Cooling and Heating	PACKAGED TERMINAL AIR CONDITIONERS (PTAC)	Cooling Capacity <7000 Btu/h and EER >= 12.9	$135.30
Space Cooling and Heating	PACKAGED TERMINAL AIR CONDITIONERS (PTAC)	Cooling Capacity >=7000 Btu/h & <=15000 Btu/h and EER >= [14.0-(0.3 × Cap)] x 1.06	$216.30
Space Cooling and Heating	PACKAGED TERMINAL AIR CONDITIONERS (PTAC)	Cooling Capacity >15000 Btu/h and EER >= 10.5	$307.50
Space Cooling and Heating	PACKAGED TERMINAL HEAT PUMPS (PTHP)	Cooling Capacity <7000 Btu/h and EER >= 12.9 and COP >= 3.5	$68.80
Space Cooling and Heating	PACKAGED TERMINAL HEAT PUMPS (PTHP)	Cooling Capacity >=7000 Btu/h & <=15000 Btu/h and EER >= [14.0 - (0.3 × Cap)] x 1.06 and COP >= [3.7 - (0.052 x Cap)] x 1.06	$108.20
Space Cooling and Heating	PACKAGED TERMINAL HEAT PUMPS (PTHP)	Cooling Capacity >15000 Btu/h and EER >= 10.5 and COP >= 3.2	$147.50
Space Cooling and Heating	ROOM AIR CONDITIONERS	<8,000 Btu/h and CEER >= 12.1	$76.00
Space Cooling and Heating	ROOM AIR CONDITIONERS	>=28000 Btu/h and CEER >= 9.9	$76.00
Space Cooling and Heating	ROOM AIR CONDITIONERS	14000 to 19999 Btu/h and CEER >= 11.8	$76.00
Space Cooling and Heating	ROOM AIR CONDITIONERS	20000 to 27999 Btu/h and CEER >= 10.3	$76.00
Space Cooling and Heating	ROOM AIR CONDITIONERS	8000 to 13999 Btu/h and CEER >= 12.0	$76.00
Space Cooling and Heating	UNITARY AIR SOURCE HEAT PUMP (ASHP) - SINGLE PACKAGE AND SPLIT SYSTEM	Single Package >=3.0 to <5.4 Tons, All Heating Type, 12 EER, 15 SEER, 8.2 HSPF	$3,024.00
Space Cooling and Heating	UNITARY AIR SOURCE HEAT PUMP (ASHP) - SINGLE PACKAGE AND SPLIT SYSTEM	Split System >=3.0 to <5.4 Tons, All Heating Type, 12.5 EER, 15 SEER, 8.5 HSPF	$3,024.00

Space Cooling and Heating	UNITARY AIR SOURCE HEAT PUMP (ASHP) - SINGLE PACKAGE AND SPLIT SYSTEM	Split System/Single Package >=11.25 to <20.0 Tons, All Other, 10.7 EER, 12.6 IEER, 3.3 COP, 2.1 COP	$9,844.00
Space Cooling and Heating	UNITARY AIR SOURCE HEAT PUMP (ASHP) - SINGLE PACKAGE AND SPLIT SYSTEM	Split System/Single Package >=11.25 to <20.0 Tons, Electric Resistance, 10.9 EER, 12.8 IEER, 3.3 COP, 2.1 COP	$9,844.00
Space Cooling and Heating	UNITARY AIR SOURCE HEAT PUMP (ASHP) - SINGLE PACKAGE AND SPLIT SYSTEM	Split System/Single Package >=20.0 to <63.3 Tons, All Other 10.1 EER, 11.6 IEER, 3.3 COP, 2.1 COP	$13,280.00
Space Cooling and Heating	UNITARY AIR SOURCE HEAT PUMP (ASHP) - SINGLE PACKAGE AND SPLIT SYSTEM	Split System/Single Package >=20.0 to <63.3 Tons, Electric Resistance, 10.3 EER, 11.8 IEER, 3.3 COP, 2.1 COP	$13,280.00
Space Cooling and Heating	UNITARY AIR SOURCE HEAT PUMP (ASHP) - SINGLE PACKAGE AND SPLIT SYSTEM	Split System/Single Package >=5.4 to <11.25 Tons, All Other, 11.6 EER, 13.4 IEER, 3.4 COP, 2.4 COP	$5,744.00
Space Cooling and Heating	UNITARY AIR SOURCE HEAT PUMP (ASHP) - SINGLE PACKAGE AND SPLIT SYSTEM	Split System/Single Package >=5.4 to <11.25 Tons, Electric Resistance (or None), 11.8 EER, 13.6 IEER, 3.4 COP, 2.4 COP	$5,744.00
Space Heating	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	<100 W (<0.134HP)	$1,225.00
Space Heating	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=100<500 W (>=0.134<0.67HP)	$1,536.00
Space Heating	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=1490<2237 W (>=2<3HP)	$1,896.00
Space Heating	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=500<750 W (>=0.67<1HP)	$1,599.00
Space Heating	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	>=750<1490 W (>=1<2HP)	$1,800.00
Space Heating	CIRCULATOR PUMPS WITH ELECTRONICALLY COMMUTATED MOTORS (ECMs)	2237 W (3HP)	$2,592.00
Lighting - Greenhouses	HORTICULTURAL INTER-LIGHTING LED GROW LIGHT FIXTURE OTHERS	LED grow lights installed within the canopy illuminating a vertical growing surface.	-$360.93
Lighting - Greenhouses	HORTICULTURAL INTER-LIGHTING LED GROW LIGHT FIXTURE - CUCUMBERS	LED grow lights installed within the canopy illuminating a vertical growing surface.	-$360.93
Lighting - Greenhouses	HORTICULTURAL INTER-LIGHTING LED GROW LIGHT FIXTURE - TOMATOES	LED grow lights installed within the canopy illuminating a vertical growing surface.	-$360.93

Lighting - Greenhouses	HORTICULTURAL INTER-LIGHTING LED GROW LIGHT FIXTURE - PEPPERS	LED grow lights installed within the canopy illuminating a vertical growing surface.	-$360.93
Lighting - Greenhouses	LED GROW LIGHTS - VEGETABLE GREENHOUSES	LED top lighting fixture installed in a vegetables/fruits/flowers greenhouse	$580.00
Lighting - Greenhouses	LED GROW LIGHTS - CANNABIS GREENHOUSES	LED top lighting fixture installed in a cannabis greenhouse	$104.00
Lighting - Greenhouses	LED GROW LIGHTS - CANNABIS WAREHOUSES	LED top lighting fixture installed in a cannabis warehouse	$307.00
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) AIR-COOLED	Cooling Capacity <65,000 Btu/h, and SCOP >= 2.47	$3,178.30
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) AIR-COOLED	Cooling Capacity >=65,000 Btu/h and <240,000 Btu/h, and SCOP >= 2.35	$11,704.97
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) AIR-COOLED	Cooling Capacity >=240,000 Btu/h and <760,000 Btu/h and SCOP >= 2.12	$26,316.00
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) WATER-COOLED	Cooling Capacity <65,000 Btu/h, and SCOP >= 2.93	$3,178.30
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) WATER-COOLED	Cooling Capacity >=65,000 Btu/h and <240,000 Btu/h, and SCOP >= 2.81	$11,704.97
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) WATER-COOLED	Cooling Capacity >=240,000 Btu/h and <760,000 Btu/h and SCOP >= 2.70	$26,316.00
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) WATER-COOLED W/ FLUID ECONOMIZER	Cooling Capacity <65,000 Btu/h, and SCOP >= 2.87	$3,178.30
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) WATER-COOLED W/ FLUID ECONOMIZER	Cooling Capacity >=65,000 Btu/h and <240,000 Btu/h, and SCOP >= 2.75	$11,704.97
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) WATER-COOLED W/ FLUID ECONOMIZER	Cooling Capacity >=240,000 Btu/h and <760,000 Btu/h and SCOP >= 2.64	$26,316.00
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) GLYCOL-COOLED	Cooling Capacity <65,000 Btu/h, and SCOP >= 2.81	$3,178.30
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) GLYCOL-COOLED	Cooling Capacity >=65,000 Btu/h and <240,000 Btu/h, and SCOP >= 2.41	$11,704.97
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) GLYCOL-COOLED	Cooling Capacity >=240,000 Btu/h and <760,000 Btu/h and SCOP >= 2.35	$26,316.00
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC)	Cooling Capacity <65,000 Btu/h, and SCOP >= 2.75	$3,178.30

	GLYCOL-COOLED W/ ECONOMIZER		
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) GLYCOL-COOLED W/ ECONOMIZER	Cooling Capacity >=65,000 Btu/h and <240,000 Btu/h, and SCOP >= 2.35	$11,704.97
Space Cooling and Heating	COMPUTER ROOM AIR CONDITIONERS (CRAC) GLYCOL-COOLED W/ ECONOMIZER	Cooling Capacity >=240,000 Btu/h and <760,000 Btu/h and SCOP >= 2.29	$26,316.00

Appendix A - Incremental Costs

Commercial & Industrial Measures (Quasi-Prescriptive)

END_USE	CONSERVATION_MEASURE_NAME	DESCRIPTION	INCREMENTAL_LIFE_CYCLE_COST
Chillers	HVAC CHILLER-AIR-COOLED CHILLERS	<150 Tons, <=0.876 kW/Ton IPLV.IP	$268/Ton
Chillers	HVAC CHILLER-AIR-COOLED CHILLERS	>=150 Tons, <=0.857 kW/Ton IPLV.IP	$268/Ton
Chillers	HVAC CHILLER-WATER COOLED CENTRIFUGAL	<75 Tons, <=0.550 kW/Ton IPLV.IP	$210/Ton
Chillers	HVAC CHILLER-WATER COOLED CENTRIFUGAL	>=150 Tons and <300 Tons, <=0.520 kW/Ton IPLV.IP	$210/Ton
Chillers	HVAC CHILLER-WATER COOLED CENTRIFUGAL	>=300 Tons and <600 Tons, <=0.500 kW/Ton IPLV.IP	$210/Ton
Chillers	HVAC CHILLER-WATER COOLED CENTRIFUGAL	>=600 Tons, <=0.500 kW/Ton IPLV.IP	$210/Ton
Chillers	HVAC CHILLER-WATER COOLED CENTRIFUGAL	>=75 Tons and <150 Tons, <=0.550 kW/Ton IPLV.IP	$210/Ton
Chillers	HVAC CHILLER-WATER COOLED POSITIVE DISPLACEMENT	<75 Tons, <=0.600 kW/Ton IPLV.IP	$270/Ton
Chillers	HVAC CHILLER-WATER COOLED POSITIVE DISPLACEMENT	>=150 Tons and <300 Tons, <=0.540 kW/Ton IPLV.IP	$270/Ton
Chillers	HVAC CHILLER-WATER COOLED POSITIVE DISPLACEMENT	>=300 Tons and <600 Tons, <=0.520 kW/Ton IPLV.IP	$270/Ton
Chillers	HVAC CHILLER-WATER COOLED POSITIVE DISPLACEMENT	>=600 Tons, <=0.500 kW/Ton IPLV.IP	$270/Ton
Chillers	HVAC CHILLER-WATER COOLED POSITIVE DISPLACEMENT	>=75 Tons and <150 Tons, <=0.560 kW/Ton IPLV.IP	$270/Ton
Chillers	PROCESS CHILLER-WATER COOLED CENTRIFUGAL	<75 Tons, <=0.610 kW/Ton FL	$210/Ton
Chillers	PROCESS CHILLER-WATER COOLED CENTRIFUGAL	>=150 Tons and <300 Tons, <=0.560 kW/Ton FL	$210/Ton
Chillers	PROCESS CHILLER-WATER COOLED CENTRIFUGAL	>=300 Tons and <600 Tons, <=0.560 kW/Ton FL	$210/Ton

Chillers	PROCESS CHILLER-WATER COOLED CENTRIFUGAL	>=600 Tons, <=0.560 kW/Ton FL	$210/Ton
Chillers	PROCESS CHILLER-WATER COOLED CENTRIFUGAL	>=75 Tons and <150 Tons, <=0.610 kW/Ton FL	$210/Ton
Chillers	PROCESS CHILLER-WATER COOLED POSITIVE DISPLACEMENT	<75 Tons, <=0.750 kW/Ton FL	$270/Ton
Chillers	PROCESS CHILLER-WATER COOLED POSITIVE DISPLACEMENT	>=150 Tons and <300 Tons, <=0.660 kW/Ton FL	$270/Ton
Chillers	PROCESS CHILLER-WATER COOLED POSITIVE DISPLACEMENT	>=300 Tons and <600 Tons, <=0.610 kW/Ton FL	$270/Ton
Chillers	PROCESS CHILLER-WATER COOLED POSITIVE DISPLACEMENT	>=600 Tons, <=0.560 kW/Ton FL	$270/Ton
Chillers	PROCESS CHILLER-WATER COOLED POSITIVE DISPLACEMENT	>=75 Tons and <150 Tons, <=0.720 kW/Ton FL	$270/Ton
Electric Auxiliary	VARIABLE SPEED DOMESTIC COLD WATER BOOSTER PUMP SYSTEM	Replacement of a Constant Speed Domestic Cold Water Booster Pump System with a Variable Speed Domestic Cold Water Booster Pump System	$2,960/HP
Industrial Machine	ALL ELECTRIC INJECTION MOULDING MACHINE	Replacement of an existing hydraulic injection moulding machine with all electric injection moulding machine	$297.7/Clamping Ton
Industrial Machine	HYBRID INJECTION MOULDING MACHINE	Replacement of an existing hydraulic injection moulding machine with a hybrid injection moulding machine	$127.60/Clamping Ton
Lighting - Food Retail	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - Greenhouses	GREENHOUSE ADVANCED LIGHTING CONTROL	Enter the total wattage (kW) of the lighting fixtures which are being controlled by the Greenhouse Advanced Lighting Control System.	$2,780/kW

Lighting - Hospital	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - Large Hotel (Corridor/Lobby)	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - Large Non-Food Retail	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - Large Office	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - Nursing Home	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - Other Commercial Buildings	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - Other Non-Food Retail	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - Restaurant	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - Schools	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - University Colleges	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW
Lighting - Warehouse Wholesale	NETWORKED LIGHTING CONTROLS	Enter the total wattage (kW) of the luminaires being controlled by the Networked Lighting Control system	$2,780/kW

Refrigeration	ADD DOOR TO OPEN REFRIGERATED DISPLAY CASE	Coolers	$ = FT * $510 per linear foot
Refrigeration	ADD DOOR TO OPEN REFRIGERATED DISPLAY CASE	Freezers	$ = FT * $510 per linear foot
Refrigeration	REFRIGERATION COMPRESSORS	High-Efficiency Discus Compressors	$226 per HP
Refrigeration	REFRIGERATION COMPRESSORS	High-Efficiency Scroll Compressors	$235 per HP
Industrial Machine	ENERGY MANAGEMENT INFORMATION SYSTEM	Implementation or Augmentation of an Energy Management Information System	-
Distributed Energy Resources	Province Wide Solar Photovoltaic System Small to Medium Generation >10 kW and <=1 MW	Enter the total maximum power in kW-AC capacity of the Solar Photovoltaic System being installed.	-
Distributed Energy Resources	Province Wide Solar Photovoltaic System Micro Generation up to 10 kW-DC	Enter the total maximum power in kW-DC capacity of the Solar Photovoltaic System being installed.	-

Appendix A - Incremental Costs

Instant Discount Program

END_USE	CONSERVATION_MEASURE_NAME	DESCRIPTION	INCREMENTAL_LIFE_CYCLE_COST
Lighting - Food Retail	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Hospital	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Large Hotel (Corridor/Lobby)	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Large Non-Food Retail	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Large Office	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Nursing Home	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Other Commercial Buildings	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Other Non-Food Retail	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Restaurant	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Schools	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - University Colleges	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Warehouse Wholesale	4' T5 LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<=28W >= 1600 Lumens	$5.16
Lighting - Food Retail	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - Hospital	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - Large Hotel (Corridor/Lobby)	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - Large Non-Food Retail	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - Large Office	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - Nursing Home	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71

Lighting - Other Commercial Buildings	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - Other Non-Food Retail	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - Restaurant	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - Schools	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - University Colleges	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - Warehouse Wholesale	4' T5HO LED TUBE REPLACEMENT (UL TYPE A, B, & C)	<= 32W >= 3200 Lumens	$0.71
Lighting - Food Retail	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Food Retail	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - Hospital	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Hospital	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - Large Hotel (Corridor/Lobby)	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Large Hotel (Corridor/Lobby)	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - Large Non-Food Retail	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Large Non-Food Retail	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - Large Office	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Large Office	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - Nursing Home	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Nursing Home	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - Other Commercial Buildings	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Other Commercial Buildings	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - Other Non-Food Retail	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Other Non-Food Retail	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - Restaurant	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Restaurant	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06

Lighting - Schools	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Schools	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - University Colleges	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - University Colleges	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - Warehouse Wholesale	4' T8 LED / LED U-BEND LAMP	<= 22W >= 2100 Lumens	$3.08
Lighting - Warehouse Wholesale	4' T8 LED / LED U-BEND LAMP	<=15W >= 1500 Lumens	-$2.06
Lighting - Food Retail	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Food Retail	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - Hospital	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Hospital	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - Large Hotel (Corridor/Lobby)	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Large Hotel (Corridor/Lobby)	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - Large Non-Food Retail	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Large Non-Food Retail	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - Large Office	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Large Office	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - Nursing Home	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Nursing Home	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - Other Commercial Buildings	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Other Commercial Buildings	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00

Lighting - Other Non-Food Retail	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Other Non-Food Retail	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - Restaurant	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Restaurant	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - Schools	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Schools	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - University Colleges	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - University Colleges	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - Warehouse Wholesale	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 4500 <9000 Lumens)	$145.00
Lighting - Warehouse Wholesale	8' LED LINEAR AMBIENT FIXTURES	8' LED linear ambient fixture (>= 9000 Lumens)	$167.00
Lighting - Food Retail	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Food Retail	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - Hospital	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Hospital	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - Large Hotel (Corridor/Lobby)	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Large Hotel (Corridor/Lobby)	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - Large Non-Food Retail	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Large Non-Food Retail	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - Large Office	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Large Office	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - Nursing Home	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Nursing Home	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04

Lighting - Other Commercial Buildings	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Other Commercial Buildings	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - Other Non-Food Retail	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Other Non-Food Retail	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - Restaurant	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Restaurant	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - Schools	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Schools	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - University Colleges	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - University Colleges	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - Warehouse Wholesale	8' LED LINEAR AMBIENT RETROFIT KIT	>= 4500 < 9000 Lumens	$56.48
Lighting - Warehouse Wholesale	8' LED LINEAR AMBIENT RETROFIT KIT	>= 9000 Lumens	$20.04
Lighting - Food Retail	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Hospital	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Large Hotel (Corridor/Lobby)	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Large Non-Food Retail	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Large Office	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Nursing Home	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Other Commercial Buildings	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Other Non-Food Retail	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Restaurant	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Schools	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - University Colleges	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Warehouse Wholesale	8' T8 LED LAMP	<= 43W >= 3200 Lumens	-$4.18
Lighting - Food Retail	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Food Retail	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99

Lighting - Food Retail	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Hospital	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Hospital	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99
Lighting - Hospital	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Large Hotel (Corridor/Lobby)	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Large Hotel (Corridor/Lobby)	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99
Lighting - Large Hotel (Corridor/Lobby)	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Large Non-Food Retail	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Large Non-Food Retail	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99
Lighting - Large Non-Food Retail	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Large Office	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Large Office	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99
Lighting - Large Office	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Nursing Home	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Nursing Home	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99
Lighting - Nursing Home	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Other Commercial Buildings	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Other Commercial Buildings	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99

Lighting - Other Commercial Buildings	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Other Non-Food Retail	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Other Non-Food Retail	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99
Lighting - Other Non-Food Retail	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Restaurant	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Restaurant	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99
Lighting - Restaurant	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Schools	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Schools	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99
Lighting - Schools	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - University Colleges	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - University Colleges	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99
Lighting - University Colleges	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Warehouse Wholesale	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	1' x 4' LED troffer / 4' LED linear ambient fixture (>= 1500 Lumens)	$114.37
Lighting - Warehouse Wholesale	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 2' LED troffer / 2' LED linear ambient fixture (>= 2000 Lumens)	$61.99
Lighting - Warehouse Wholesale	INTEGRAL LED TROFFER & LED LINEAR AMBIENT FIXTURE	2' x 4' LED troffer / 4' LED linear ambient fixture (>= 3000 Lumens)	$116.78
Lighting - Food Retail	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - Food Retail	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87

Lighting - Food Retail	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - Hospital	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - Hospital	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - Hospital	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - Large Hotel (Corridor/Lobby)	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - Large Hotel (Corridor/Lobby)	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - Large Hotel (Corridor/Lobby)	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - Large Non-Food Retail	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - Large Non-Food Retail	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - Large Non-Food Retail	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - Large Office	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - Large Office	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - Large Office	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - Nursing Home	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - Nursing Home	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - Nursing Home	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06

Lighting - Other Commercial Buildings	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - Other Commercial Buildings	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - Other Commercial Buildings	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - Other Non-Food Retail	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - Other Non-Food Retail	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - Other Non-Food Retail	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - Restaurant	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - Restaurant	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - Restaurant	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - Schools	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - Schools	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - Schools	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - University Colleges	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95
Lighting - University Colleges	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - University Colleges	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - Warehouse Wholesale	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	1' x 4' LED troffer / 4' LED linear ambient retrofit kit (>= 1500 Lumens)	$83.95

Lighting - Warehouse Wholesale	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 2' LED troffer / 2' linear ambient retrofit kit (>= 2000 Lumens)	$38.87
Lighting - Warehouse Wholesale	INTEGRAL LED TROFFER & LINEAR AMBIENT RETROFIT KITS	2' x 4' LED troffer / 4' linear ambient retrofit kit (>= 3000 Lumens)	$104.06
Lighting - Food Retail	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Food Retail	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Food Retail	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - Food Retail	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - Food Retail	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Hospital	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Hospital	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Hospital	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - Hospital	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - Hospital	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Large Hotel (Corridor/Lobby)	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Large Hotel (Corridor/Lobby)	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Large Hotel (Corridor/Lobby)	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - Large Hotel (Corridor/Lobby)	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - Large Hotel (Corridor/Lobby)	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Large Non-Food Retail	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Large Non-Food Retail	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Large Non-Food Retail	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - Large Non-Food Retail	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - Large Non-Food Retail	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Large Office	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Large Office	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Large Office	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - Large Office	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51

Lighting - Large Office	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Nursing Home	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Nursing Home	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Nursing Home	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - Nursing Home	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - Nursing Home	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Other Commercial Buildings	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Other Commercial Buildings	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Other Commercial Buildings	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - Other Commercial Buildings	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - Other Commercial Buildings	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Other Non-Food Retail	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Other Non-Food Retail	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Other Non-Food Retail	LED HIGH BAY FIXTURE	>= 15,500 Lumens & < 178W	-$135.51
Lighting - Other Non-Food Retail	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - Other Non-Food Retail	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Restaurant	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Restaurant	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Restaurant	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - Restaurant	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - Restaurant	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Schools	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Schools	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Schools	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - Schools	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - Schools	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - University Colleges	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44

Lighting - University Colleges	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - University Colleges	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - University Colleges	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - University Colleges	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Warehouse Wholesale	LED HIGH BAY FIXTURE	>= 10000 Lumens & < 105W	-$449.44
Lighting - Warehouse Wholesale	LED HIGH BAY FIXTURE	>= 12200 Lumens & < 132W	-$449.44
Lighting - Warehouse Wholesale	LED HIGH BAY FIXTURE	>= 15500 Lumens & < 178W	-$135.51
Lighting - Warehouse Wholesale	LED HIGH BAY FIXTURE	>= 20100 Lumens & < 305W	-$135.51
Lighting - Warehouse Wholesale	LED HIGH BAY FIXTURE	>= 34700 Lumens & >= 305W	-$135.51
Lighting - Food Retail	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Hospital	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Large Hotel (Corridor/Lobby)	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Large Non-Food Retail	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Large Office	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Nursing Home	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Other Commercial Buildings	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Other Non-Food Retail	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Restaurant	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Schools	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - University Colleges	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Warehouse Wholesale	LED LOW-BAY FIXTURES	<=100W <=10000 Lumens	$184.00
Lighting - Food Retail	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71
Lighting - Food Retail	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Food Retail	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Hospital	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71

Lighting - Hospital	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Hospital	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Large Hotel (Corridor/Lobby)	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71
Lighting - Large Hotel (Corridor/Lobby)	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Large Hotel (Corridor/Lobby)	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Large Non-Food Retail	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71
Lighting - Large Non-Food Retail	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Large Non-Food Retail	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Large Office	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71
Lighting - Large Office	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Large Office	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Nursing Home	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71
Lighting - Nursing Home	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Nursing Home	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Other Commercial Buildings	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71
Lighting - Other Commercial Buildings	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Other Commercial Buildings	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Other Non-Food Retail	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71

Lighting - Other Non-Food Retail	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Other Non-Food Retail	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Restaurant	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71
Lighting - Restaurant	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Restaurant	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Schools	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71
Lighting - Schools	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Schools	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - University Colleges	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71
Lighting - University Colleges	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - University Colleges	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Warehouse Wholesale	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 400 and < 600 Lumens	$15.71
Lighting - Warehouse Wholesale	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 600 and < 800 Lumens	$55.36
Lighting - Warehouse Wholesale	LED RECESSED DOWNLIGHTS	LED Downlight with Light Output >= 800 Lumens	$55.82
Lighting - Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - Hospital	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06

Lighting - Hospital	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - Hospital	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Hospital	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - Hospital	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - Large Hotel (Corridor/Lobby)	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - Large Hotel (Corridor/Lobby)	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - Large Hotel (Corridor/Lobby)	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Large Hotel (Corridor/Lobby)	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - Large Hotel (Corridor/Lobby)	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - Large Non-Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - Large Non-Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - Large Non-Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Large Non-Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - Large Non-Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - Large Office	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - Large Office	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - Large Office	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Large Office	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68

Lighting - Large Office	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - Nursing Home	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - Nursing Home	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - Nursing Home	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Nursing Home	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - Nursing Home	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - Other Commercial Buildings	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - Other Commercial Buildings	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - Other Commercial Buildings	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Other Commercial Buildings	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - Other Commercial Buildings	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - Other Non-Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - Other Non-Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - Other Non-Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Other Non-Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - Other Non-Food Retail	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - Restaurant	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - Restaurant	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42

Lighting - Restaurant	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Restaurant	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - Restaurant	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - Schools	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - Schools	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - Schools	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Schools	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - Schools	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - University Colleges	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - University Colleges	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - University Colleges	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - University Colleges	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - University Colleges	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29
Lighting - Warehouse Wholesale	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 14W >= 400 Lumens	-$55.06
Lighting - Warehouse Wholesale	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 16W >= 600 Lumens	-$27.42
Lighting - Warehouse Wholesale	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 20W >= 800 Lumens	-$37.86
Lighting - Warehouse Wholesale	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 30W >= 1100 Lumens	-$138.68
Lighting - Warehouse Wholesale	LED REFLECTOR (FLOOD/SPOT) LAMP PIN & SCREW BASE	<= 7W >= 250 Lumens	-$94.29

Lighting - Refrigeration	REFRIGERATED DISPLAY CASE LED FIXTURE - HORIZONTAL (UNDERSHELF) INSTALLATION	< 13W Nominal 24"-48"	$236.42
Lighting - Refrigeration	REFRIGERATED DISPLAY CASE LED FIXTURE - VERTICAL INSTALLATION	< 30W Nominal 48"-72"	$230.48

Appendix A - Incremental Costs

Small Business Program - Non-Lighting

END_USE	CONSERVATION_MEASURE_NAME	DESCRIPTION	INCREMENTAL_LIFE_CYCLE_COST
Refrigeration	AUTOMATIC DOOR CLOSER (for Walk-in Coolers)	AUTOMATIC DOOR CLOSER (for Walk-in Coolers)	$50.00
Refrigeration	AUTOMATIC DOOR CLOSER (for Walk-in Freezers)	AUTOMATIC DOOR CLOSER (for Walk-in Freezers)	$50.00
Refrigeration	CONDENSER COIL CLEANING (for Coolers)	CONDENSER COIL CLEANING (for Coolers)	$20.00
Refrigeration	CONDENSER COIL CLEANING (for Freezers)	CONDENSER COIL CLEANING (for Freezers)	$20.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Coolers)	1/15 HP (50W) ECM Condenser Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Coolers)	1/20 HP (37W) ECM Condenser Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Coolers)	1/25 HP (30W) ECM Condenser Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Coolers)	1/5 HP (150W) ECM Condenser Fan Motor Replacement	$345.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Coolers)	12 Watt ECM Condenser Fan Motor Replacement	$135.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Coolers)	16 Watt ECM Condenser Fan Motor Replacement	$135.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Coolers)	9 Watt ECM Condenser Fan Motor Replacement	$135.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Freezers)	1/15 HP (50W) ECM Condenser Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Freezers)	1/20 HP (37W) ECM Condenser Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Freezers)	1/25 HP (30W) ECM Condenser Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Freezers)	1/5 HP (150W) ECM Condenser Fan Motor Replacement	$345.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Freezers)	12 Watt ECM Condenser Fan Motor Replacement	$135.00

Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Freezers)	16 Watt ECM Condenser Fan Motor Replacement	$135.00
Refrigeration	ECM MOTORS FOR CONDENSER FANS (for Freezers)	9 Watt ECM Condenser Fan Motor Replacement	$135.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Coolers)	1/15 HP (50W) ECM Evaporator Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Coolers)	1/20 HP (37W) ECM Evaporator Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Coolers)	1/25 HP (30W) ECM Evaporator Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Coolers)	1/5 HP (150W) ECM Evaporator Fan Motor Replacement	$345.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Coolers)	12 Watt ECM Evaporator Fan Motor Replacement	$135.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Coolers)	16 Watt ECM Evaporator Fan Motor Replacement	$135.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Coolers)	9 Watt ECM Evaporator Fan Motor Replacement	$135.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Freezers)	1/15 HP (50W) ECM Evaporator Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Freezers)	1/20 HP (37W) ECM Evaporator Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Freezers)	1/25 HP (30W) ECM Evaporator Fan Motor Replacement	$185.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Freezers)	1/5 HP (150W) ECM Evaporator Fan Motor Replacement	$345.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Freezers)	12 Watt ECM Evaporator Fan Motor Replacement	$135.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Freezers)	16 Watt ECM Evaporator Fan Motor Replacement	$135.00
Refrigeration	ECM MOTORS FOR EVAPORATOR FANS (for Freezers)	9 Watt ECM Evaporator Fan Motor Replacement	$135.00
Refrigeration	NIGHT COVER (for reach-in Coolers)	NIGHT COVER (for reach-in Coolers)	$170.00
Refrigeration	STRIP CURTAINS (for Walk-in Coolers)	STRIP CURTAINS (for Walk-in Coolers)	$195.00
Refrigeration	STRIP CURTAINS (for Walk-in Freezers)	STRIP CURTAINS (for Walk-in Freezers)	$195.00

Space Cooling	Smart Thermostat	Web Enabled Smart Thermostat	$350.00

Appendix A - Incremental Costs

Residential

END_USE	CONSERVATION_MEASURE_NAME	DESCRIPTION	INCREMENTAL_LIFE_CYCLE_COST
Appliances	COMPACT CHEST FREEZER	Compact Chest Freezer Replacement (ENERGY STAR Qualified< 7.75 cu ft)	$628.00
Appliances	ENERGY STAR® FREEZER	Chest Freezer Replacement (ENERGY STAR Qualified 12 ≤ and < 14.5 cu ft)	$1,047.00
Appliances	ENERGY STAR® FREEZER	Chest Freezer Replacement (ENERGY STAR Qualified 14.5 ≤ and < 16.0 cu ft)	$1,349.00
Appliances	ENERGY STAR® FREEZER	Chest Freezer Replacement (ENERGY STAR Qualified 7.75 ≤ and < 12.0 cu ft)	$734.00
Appliances	ENERGY STAR® REFRIGERATOR	Refrigerator Replacement (ENERGY STAR Qualified 10.0 ≤ and < 12.5 cu ft)	$1,010.00
Appliances	ENERGY STAR® REFRIGERATOR	Refrigerator Replacement (ENERGY STAR Qualified 12.5 ≤ and < 15.5 cu ft)	$1,183.00
Appliances	ENERGY STAR® REFRIGERATOR	Refrigerator Replacement (ENERGY STAR Qualified 15.5 ≤ and < 17.0 cu ft)	$1,578.00
Appliances	ENERGY STAR® REFRIGERATOR	Refrigerator Replacement (ENERGY STAR Qualified 17.0 ≤ and < 18.4 cu ft)	$1,451.00
Hot Water	EFFICIENT BATHROOM AERATORS-MULTI-FAMILY	Bathroom - Flow Rate ≤ 3.8 L/min	$6.00
Hot Water	EFFICIENT BATHROOM AERATORS-SINGLE FAMILY	Bathroom - Flow Rate ≤ 3.8 L/min	$6.00
Hot Water	EFFICIENT KITCHEN AERATORS-MULTI-FAMILY	Kitchen - Flow Rate ≤ 5.7 L/min	$6.00
Hot Water	EFFICIENT KITCHEN AERATORS-SINGLE FAMILY	Kitchen - Flow Rate ≤ 5.7 L/min	$6.00
Hot Water	EFFICIENT SHOWERHEAD (HANDHELD)-MULTI-FAMILY	Flow Rate < 4.8 L/min	$12.00
Hot Water	EFFICIENT SHOWERHEAD (HANDHELD)-SINGLE FAMILY	Flow Rate < 4.8 L/min	$12.00
Hot Water	EFFICIENT SHOWERHEAD (STANDARD)-MULTI-FAMILY	Flow Rate < 4.8 L/min	$10.00
Hot Water	EFFICIENT SHOWERHEAD (STANDARD)-SINGLE FAMILY	Flow Rate < 4.8 L/min	$10.00
Hot Water	HOT WATER PIPE WRAP	Per 1' Pipe Wrap (1/2" Pipe)	$4.00
Hot Water	HOT WATER PIPE WRAP	Per 1' Pipe Wrap (3/4" Pipe)	$4.00
Hot Water	WATER HEATER BLANKET	Hot water tank wrap	$138.00

HVAC	ENERGY STAR® DEHUMIDIFIER	Dehumidifier Replacement (ENERGY STAR Qualified 14.2 - 21.2 l/day)	$354.00
HVAC	ENERGY STAR® DEHUMIDIFIER	Dehumidifier Replacement (ENERGY STAR Qualified 21.3 - 25.4 l/day)	$380.00
HVAC	ENERGY STAR® DEHUMIDIFIER	Dehumidifier Replacement (ENERGY STAR Qualified 25.5 - 35.5 l/day)	$449.00
HVAC	ENERGY STAR® ROOM AIR CONDITIONER	Room Air Conditioner Replacement (ENERGY STAR Qualified 10,000 - 12,000 BTU/hr)	$787.00
HVAC	ENERGY STAR® ROOM AIR CONDITIONER	Room Air Conditioner Replacement (ENERGY STAR Qualified 6,000 - 7,999 BTU/hr)	$338.00
HVAC	ENERGY STAR® ROOM AIR CONDITIONER	Room Air Conditioner Replacement (ENERGY STAR Qualified 8,000 - 9,999 BTU/hr)	$569.00
HVAC Control	LINE VOLTAGE SMART THERMOSTATS	Line Voltage Smart Thermostat – Baseboard Heater	$208.00
HVAC Control	LOW VOLTAGE SMART THERMOSTATS	Low-voltage Smart Thermostat – Electric Furnace	$373.00
HVAC Control	LOW VOLTAGE SMART THERMOSTATS	Low-voltage Smart Thermostat requiring C wire connection – Electric Furnace	$390.00
HVAC Control	PROGRAMMABLE THERMOSTAT	Line-voltage Programmable Thermostat - Baseboard Heater	$272.00
Lighting	≤11W ENERGY STAR® QUALIFIED LED A SHAPE (60W) (MINIMUM 600 LUMEN OUTPUT)	≤11W ENERGY STAR® Qualified LED A Shape (60W) (minimum 600 Lumen output)	$7.00
Lighting	≤14W ENERGY STAR® QUALIFIED LED A SHAPE (75W) (MINIMUM 800 LUMEN OUTPUT)	≤14W ENERGY STAR® Qualified LED A Shape (75W) (minimum 800 Lumen output)	$10.00
Lighting	≤16W ENERGY STAR® QUALIFIED LED PAR30 & PAR38 (MINIMUM 600 LUMEN OUTPUT)	≤16W ENERGY STAR® Qualified LED PAR30 & PAR38 (minimum 600 Lumen output)	$16.00
Lighting	≤23W ENERGY STAR® QUALIFIED LED A SHAPE (100W) (MINIMUM 1600 LUMEN OUTPUT)	≤23W ENERGY STAR® Qualified LED A Shape (100W) (minimum 1600 Lumen output)	$19.00
Lighting	≤6W ENERGY STAR® QUALIFIED LED MR 16 / PAR 16 (MINIMUM 250 LUMEN OUTPUT)	≤6W ENERGY STAR® Qualified LED MR 16 / PAR 16 (minimum 250 Lumen output)	$10.00
Lighting	ENERGY STAR® LED WET LOCATION RATED PAR LAMP ≤ 23 WATT (MINIMUM 1100 LUMEN OUTPUT)	ENERGY STAR® LED Wet Location Rated PAR lamp ≤ 23 Watt (minimum 1100 Lumen output)	$17.00
Lighting	LED NIGHTLIGHT	LED Nightlight	$2.50

Miscellaneous	HEAVY DUTY PLUG-IN TIMERS	Car Block Heater Timer	$50.00
Miscellaneous	INDOOR CLOTHES DRYING RACK/OUTDOOR RETRACTABLE CLOTHESLINE KIT	Indoor Clothes Drying Rack/Outdoor Retractable Clothesline Kit	$50.00
Miscellaneous	TIER 2 ADVANCED POWER STRIP	Home entertainment and office equipment controlled with Tier 2 Advance Power Strips (APS)	$85.00
Weatherization	ATTIC INSULATION	Minimum R50 from new attic insulation and incentive calculated based on area of insulation installed	$1.92/sqft
Weatherization	BASEMENT INSULATION	Minimum R20 from new basement insulation and incentive calculated based on are of insulation installed	$2.86/sqft

Appendix B - End Use Load Profiles

End Use Load Profile	Summer Peak Demand	Winter Peak Demand	Alternative Summer Peak Demand	Alternative Winter Peak Demand
PSP-Business-Commercial-Chiller	0.0314%	0.0020%	0.0562%	0.0040%
PSP-Business-Commercial-Clip_on_Timer	0.0076%	0.0114%	0.0228%	0.0228%
PSP-Business-Commercial-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Commercial-Cooking	0.0125%	0.0102%	0.0192%	0.0128%
PSP-Business-Commercial-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Commercial-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Commercial-Creep_Heat_Controller	0.0114%	0.0114%	0.0114%	0.0114%
PSP-Business-Commercial-D&N_Exhaust_Fans_(dairy)	0.0000%	0.0176%	0.0000%	0.0284%
PSP-Business-Commercial-D&N_Exhaust_Fans_(non-dairy)	0.0144%	0.0090%	0.0144%	0.0144%
PSP-Business-Commercial-Domestic_Hot_Water	0.0122%	0.0154%	0.0145%	0.0173%
PSP-Business-Commercial-Double_Creep_Pad	0.0092%	0.0125%	0.0092%	0.0125%
PSP-Business-Commercial-Electric_Auxiliary	0.0127%	0.0122%	0.0158%	0.0152%
PSP-Business-Commercial-Elevators	0.0118%	0.0112%	0.0148%	0.0127%
PSP-Business-Commercial-Exit_Signs	0.0114%	0.0114%	0.0114%	0.0114%
PSP-Business-Commercial-Forced_Air_Central_Heating	0.0055%	0.0204%	0.0123%	0.0349%
PSP-Business-Commercial-Ground Source Heat Pump	0.0053%	0.0116%	0.0106%	0.0191%
PSP-Business-Commercial-HE_Exhaust_Fans_>24"	0.0248%	0.0000%	0.0745%	0.0000%
PSP-Business-Commercial-HE_Exhaust_Fans_≤24"	0.0293%	0.0000%	0.0293%	0.0000%
PSP-Business-Commercial-HT_Cutout_Thermostat	0.0546%	0.0000%	0.0820%	0.0000%
PSP-Business-Commercial-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Commercial-HVLS	0.0342%	0.0000%	0.0342%	0.0000%
PSP-Business-Commercial-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Commercial-Lighting_Interior_Architectural	0.0122%	0.0112%	0.0159%	0.0130%
PSP-Business-Commercial-Lighting_Interior_General	0.0122%	0.0112%	0.0159%	0.0130%

PSP-Business-Commercial-Lighting_Interior_High_Bay	0.0122%	0.0112%	0.0159%	0.0130%
PSP-Business-Commercial-Lighting_Interior_Office	0.0122%	0.0112%	0.0159%	0.0130%
PSP-Business-Commercial-Lighting_Small Business	0.0132%	0.0111%	0.0189%	0.0140%
PSP-Business-Commercial-Livestock_Waterer	0.0000%	0.0000%	0.0000%	0.0000%
PSP-Business-Commercial-Miscellaneous_Equipment	0.0121%	0.0120%	0.0127%	0.0123%
PSP-Business-Commercial-Non_Ducted_Central_Heating	0.0000%	0.0268%	0.0004%	0.0419%
PSP-Business-Commercial-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Commercial-Refrigerated_Display_Case_Food Retail	0.0142%	0.0122%	0.0241%	0.0158%
PSP-Business-Commercial-Refrigeration	0.0117%	0.0113%	0.0126%	0.0117%
PSP-Business-Commercial-Single_Creep_Pad	0.0076%	0.0133%	0.0076%	0.0133%
PSP-Business-Commercial-Space_Cooling_&_Heating	0.0233%	0.0130%	0.0609%	0.0180%
PSP-Business-Commercial-Timer_Photocell	0.0089%	0.0000%	0.0295%	0.0000%
PSP-Business-Food_Retail-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Food_Retail-Cooking	0.0109%	0.0106%	0.0121%	0.0112%
PSP-Business-Food_Retail-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Food_Retail-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Food_Retail-Domestic_Hot_Water	0.0131%	0.0180%	0.0141%	0.0193%
PSP-Business-Food_Retail-Elevators	0.0120%	0.0119%	0.0130%	0.0126%
PSP-Business-Food_Retail-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Food_Retail-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Food_Retail-Lighting_Interior_Architectural	0.0138%	0.0139%	0.0145%	0.0145%
PSP-Business-Food_Retail-Lighting_Interior_General	0.0138%	0.0139%	0.0145%	0.0145%
PSP-Business-Food_Retail-Lighting_Interior_High_Bay	0.0138%	0.0139%	0.0145%	0.0145%
PSP-Business-Food_Retail-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Food_Retail-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Food_Retail-Refrigeration	0.0124%	0.0107%	0.0138%	0.0111%
PSP-Business-Hospital-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Hospital-Cooking	0.0100%	0.0066%	0.0167%	0.0081%
PSP-Business-Hospital-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Hospital-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Hospital-Domestic_Hot_Water	0.0097%	0.0118%	0.0128%	0.0133%

PSP-Business-Hospital-Elevators	0.0107%	0.0095%	0.0142%	0.0101%
PSP-Business-Hospital-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Hospital-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Hospital-Lighting_Interior_Architectural	0.0113%	0.0104%	0.0144%	0.0112%
PSP-Business-Hospital-Lighting_Interior_General	0.0113%	0.0104%	0.0144%	0.0112%
PSP-Business-Hospital-Lighting_Interior_High_Bay	0.0113%	0.0104%	0.0144%	0.0112%
PSP-Business-Hospital-Miscellaneous_Equipment	0.0107%	0.0095%	0.0142%	0.0101%
PSP-Business-Hospital-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Hospital-Refrigeration	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Large_Hotel-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Large_Hotel-Cooking	0.0156%	0.0161%	0.0175%	0.0169%
PSP-Business-Large_Hotel-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Large_Hotel-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Large_Hotel-Domestic_Hot_Water	0.0115%	0.0155%	0.0118%	0.0162%
PSP-Business-Large_Hotel-Elevators	0.0139%	0.0145%	0.0150%	0.0150%
PSP-Business-Large_Hotel-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Large_Hotel-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Large_Hotel-Lighting_Interior_Architectural	0.0131%	0.0141%	0.0156%	0.0151%
PSP-Business-Large_Hotel-Lighting_Interior_General	0.0131%	0.0141%	0.0156%	0.0151%
PSP-Business-Large_Hotel-Lighting_Interior_High_Bay	0.0131%	0.0141%	0.0156%	0.0151%
PSP-Business-Large_Hotel-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Large_Hotel-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Large_Hotel-Refrigeration	0.0117%	0.0116%	0.0123%	0.0121%
PSP-Business-Large_Non_Food_Retail-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Large_Non_Food_Retail-Cooking	0.0174%	0.0175%	0.0189%	0.0188%
PSP-Business-Large_Non_Food_Retail-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Large_Non_Food_Retail-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Large_Non_Food_Retail-Domestic_Hot_Water	0.0142%	0.0185%	0.0164%	0.0205%
PSP-Business-Large_Non_Food_Retail-Elevators	0.0144%	0.0144%	0.0149%	0.0149%

PSP-Business-Large_Non_Food_Retail-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Large_Non_Food_Retail-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Large_Non_Food_Retail-Lighting_Interior_Architectural	0.0148%	0.0146%	0.0148%	0.0148%
PSP-Business-Large_Non_Food_Retail-Lighting_Interior_General	0.0148%	0.0146%	0.0148%	0.0148%
PSP-Business-Large_Non_Food_Retail-Lighting_Interior_High_Bay	0.0148%	0.0146%	0.0148%	0.0148%
PSP-Business-Large_Non_Food_Retail-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Large_Non_Food_Retail-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Large_Non_Food_Retail-Refrigeration	0.0116%	0.0116%	0.0123%	0.0121%
PSP-Business-Large_Office-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Large_Office-Cooking	0.0104%	0.0061%	0.0234%	0.0109%
PSP-Business-Large_Office-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Large_Office-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Large_Office-Domestic_Hot_Water	0.0096%	0.0116%	0.0113%	0.0121%
PSP-Business-Large_Office-Elevators	0.0109%	0.0091%	0.0167%	0.0114%
PSP-Business-Large_Office-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Large_Office-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Large_Office-Lighting_Interior_Architectural	0.0127%	0.0113%	0.0180%	0.0148%
PSP-Business-Large_Office-Lighting_Interior_General	0.0127%	0.0113%	0.0180%	0.0148%
PSP-Business-Large_Office-Lighting_Interior_High_Bay	0.0127%	0.0113%	0.0180%	0.0148%
PSP-Business-Large_Office-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Large_Office-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Large_Office-Refrigeration	0.0110%	0.0106%	0.0124%	0.0109%
PSP-Business-Nursing_Home-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Nursing_Home-Cooking	0.0181%	0.0187%	0.0201%	0.0200%
PSP-Business-Nursing_Home-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Nursing_Home-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Nursing_Home-Domestic_Hot_Water	0.0123%	0.0168%	0.0129%	0.0176%
PSP-Business-Nursing_Home-Elevators	0.0131%	0.0128%	0.0149%	0.0137%

PSP-Business-Nursing_Home-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Nursing_Home-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Nursing_Home-Lighting_Interior_Architectural	0.0138%	0.0137%	0.0153%	0.0145%
PSP-Business-Nursing_Home-Lighting_Interior_General	0.0138%	0.0137%	0.0153%	0.0145%
PSP-Business-Nursing_Home-Lighting_Interior_High_Bay	0.0138%	0.0137%	0.0153%	0.0145%
PSP-Business-Nursing_Home-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Nursing_Home-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Nursing_Home-Refrigeration	0.0117%	0.0116%	0.0123%	0.0121%
PSP-Business-Other_Commercial_Buildings-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Commercial_Buildings-Cooking	0.0071%	0.0006%	0.0258%	0.0010%
PSP-Business-Other_Commercial_Buildings-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Other_Commercial_Buildings-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Other_Commercial_Buildings-Domestic_Hot_Water	0.0144%	0.0191%	0.0143%	0.0196%
PSP-Business-Other_Commercial_Buildings-Elevators	0.0100%	0.0064%	0.0194%	0.0067%
PSP-Business-Other_Commercial_Buildings-HVAC_Fans_Pumps	0.0114%	0.0114%	0.0114%	0.0114%
PSP-Business-Other_Commercial_Buildings-Lighting_Exterior	0.0032%	0.0213%	0.0117%	0.0218%
PSP-Business-Other_Commercial_Buildings-Lighting_Interior_Architectural	0.0092%	0.0040%	0.0236%	0.0041%
PSP-Business-Other_Commercial_Buildings-Lighting_Interior_General	0.0092%	0.0040%	0.0236%	0.0041%
PSP-Business-Other_Commercial_Buildings-Lighting_Interior_High_Bay	0.0092%	0.0040%	0.0236%	0.0041%
PSP-Business-Other_Commercial_Buildings-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Commercial_Buildings-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Commercial_Buildings-Refrigeration	0.0121%	0.0120%	0.0124%	0.0122%
PSP-Business-Other_Hotel_Motel-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%

PSP-Business-Other_Hotel_Motel-Cooking	0.0156%	0.0161%	0.0175%	0.0169%
PSP-Business-Other_Hotel_Motel-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Other_Hotel_Motel-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Other_Hotel_Motel-Domestic_Hot_Water	0.0115%	0.0155%	0.0118%	0.0162%
PSP-Business-Other_Hotel_Motel-Elevators	0.0139%	0.0145%	0.0150%	0.0150%
PSP-Business-Other_Hotel_Motel-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Other_Hotel_Motel-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Other_Hotel_Motel-Lighting_Interior_Architectural	0.0131%	0.0141%	0.0156%	0.0151%
PSP-Business-Other_Hotel_Motel-Lighting_Interior_General	0.0131%	0.0141%	0.0156%	0.0151%
PSP-Business-Other_Hotel_Motel-Lighting_Interior_High_Bay	0.0131%	0.0141%	0.0156%	0.0151%
PSP-Business-Other_Hotel_Motel-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Hotel_Motel-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Hotel_Motel-Refrigeration	0.0117%	0.0116%	0.0123%	0.0121%
PSP-Business-Other_Non_Food_Retail-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Non_Food_Retail-Cooking	0.0147%	0.0082%	0.0284%	0.0165%
PSP-Business-Other_Non_Food_Retail-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Other_Non_Food_Retail-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Other_Non_Food_Retail-Domestic_Hot_Water	0.0140%	0.0185%	0.0143%	0.0196%
PSP-Business-Other_Non_Food_Retail-Elevators	0.0136%	0.0108%	0.0194%	0.0152%
PSP-Business-Other_Non_Food_Retail-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Other_Non_Food_Retail-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Other_Non_Food_Retail-Lighting_Interior_Architectural	0.0144%	0.0103%	0.0223%	0.0200%
PSP-Business-Other_Non_Food_Retail-Lighting_Interior_General	0.0144%	0.0103%	0.0223%	0.0200%
PSP-Business-Other_Non_Food_Retail-Lighting_Interior_High_Bay	0.0144%	0.0103%	0.0223%	0.0200%

PSP-Business-Other_Non_Food_Retail-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Non_Food_Retail-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Non_Food_Retail-Refrigeration	0.0118%	0.0117%	0.0124%	0.0122%
PSP-Business-Other_Office-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Office-Cooking	0.0104%	0.0061%	0.0234%	0.0109%
PSP-Business-Other_Office-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Other_Office-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Other_Office-Domestic_Hot_Water	0.0096%	0.0116%	0.0113%	0.0121%
PSP-Business-Other_Office-Elevators	0.0109%	0.0091%	0.0167%	0.0114%
PSP-Business-Other_Office-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Other_Office-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Other_Office-Lighting_Interior_Architectural	0.0127%	0.0113%	0.0180%	0.0148%
PSP-Business-Other_Office-Lighting_Interior_General	0.0127%	0.0113%	0.0180%	0.0148%
PSP-Business-Other_Office-Lighting_Interior_High_Bay	0.0127%	0.0113%	0.0180%	0.0148%
PSP-Business-Other_Office-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Office-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Other_Office-Refrigeration	0.0110%	0.0106%	0.0124%	0.0109%
PSP-Business-Restaurant-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Restaurant-Cooking	0.0182%	0.0182%	0.0205%	0.0198%
PSP-Business-Restaurant-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Restaurant-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Restaurant-Domestic_Hot_Water	0.0167%	0.0229%	0.0180%	0.0243%
PSP-Business-Restaurant-Elevators	0.0147%	0.0146%	0.0157%	0.0155%
PSP-Business-Restaurant-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Restaurant-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Restaurant-Lighting_Interior_Architectural	0.0158%	0.0157%	0.0164%	0.0164%
PSP-Business-Restaurant-Lighting_Interior_General	0.0158%	0.0157%	0.0164%	0.0164%
PSP-Business-Restaurant-Lighting_Interior_High_Bay	0.0158%	0.0157%	0.0164%	0.0164%
PSP-Business-Restaurant-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Restaurant-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Restaurant-Refrigeration	0.0119%	0.0118%	0.0125%	0.0123%

PSP-Business-Schools-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Schools-Cooking	0.0027%	0.0016%	0.0042%	0.0021%
PSP-Business-Schools-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Schools-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Schools-Domestic_Hot_Water	0.0091%	0.0063%	0.0212%	0.0096%
PSP-Business-Schools-Elevators	0.0040%	0.0077%	0.0077%	0.0079%
PSP-Business-Schools-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Schools-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Schools-Lighting_Interior_Architectural	0.0039%	0.0045%	0.0055%	0.0049%
PSP-Business-Schools-Lighting_Interior_General	0.0039%	0.0045%	0.0055%	0.0049%
PSP-Business-Schools-Lighting_Interior_High_Bay	0.0039%	0.0045%	0.0055%	0.0049%
PSP-Business-Schools-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Schools-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Schools-Refrigeration	0.0110%	0.0106%	0.0124%	0.0109%
PSP-Business-University_Colleges-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-University_Colleges-Cooking	0.0126%	0.0119%	0.0228%	0.0198%
PSP-Business-University_Colleges-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-University_Colleges-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-University_Colleges-Domestic_Hot_Water	0.0141%	0.0167%	0.0178%	0.0236%
PSP-Business-University_Colleges-Elevators	0.0097%	0.0117%	0.0117%	0.0155%
PSP-Business-University_Colleges-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-University_Colleges-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-University_Colleges-Lighting_Interior_Architectural	0.0102%	0.0109%	0.0150%	0.0137%
PSP-Business-University_Colleges-Lighting_Interior_General	0.0102%	0.0109%	0.0150%	0.0137%
PSP-Business-University_Colleges-Lighting_Interior_High_Bay	0.0102%	0.0109%	0.0150%	0.0137%
PSP-Business-University_Colleges-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-University_Colleges-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-University_Colleges-Refrigeration	0.0110%	0.0106%	0.0124%	0.0109%
PSP-Business-Warehouse_Wholesale-Computer_Equipment	0.0122%	0.0122%	0.0126%	0.0124%

PSP-Business-Warehouse_Wholesale-Cooking	0.0108%	0.0044%	0.0258%	0.0068%
PSP-Business-Warehouse_Wholesale-Cooling_Chillers	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Warehouse_Wholesale-Cooling_DX	0.0511%	0.0000%	0.0933%	0.0000%
PSP-Business-Warehouse_Wholesale-Domestic_Hot_Water	0.0115%	0.0120%	0.0185%	0.0180%
PSP-Business-Warehouse_Wholesale-Elevators	0.0133%	0.0098%	0.0216%	0.0133%
PSP-Business-Warehouse_Wholesale-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
PSP-Business-Warehouse_Wholesale-Lighting_Exterior	0.0031%	0.0207%	0.0117%	0.0218%
PSP-Business-Warehouse_Wholesale-Lighting_Interior_Architectural	0.0119%	0.0074%	0.0231%	0.0100%
PSP-Business-Warehouse_Wholesale-Lighting_Interior_General	0.0119%	0.0074%	0.0231%	0.0100%
PSP-Business-Warehouse_Wholesale-Lighting_Interior_High_Bay	0.0119%	0.0074%	0.0231%	0.0100%
PSP-Business-Warehouse_Wholesale-Miscellaneous_Equipment	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Warehouse_Wholesale-Other_Plug_Loads	0.0122%	0.0122%	0.0126%	0.0124%
PSP-Business-Warehouse_Wholesale-Refrigeration	0.0125%	0.0107%	0.0139%	0.0110%
PSP-Consumer-Residential-AC_Central	0.0458%	0.0000%	0.1218%	0.0000%
PSP-Consumer-Residential-AC_Room	0.0458%	0.0000%	0.1218%	0.0000%
PSP-Consumer-Residential-Attic Insulation - Electric Fired	0.0020%	0.0252%	0.0031%	0.0348%
PSP-Consumer-Residential-Attic Insulation - Gas Fired	0.0277%	0.0060%	0.0638%	0.0060%
PSP-Consumer-Residential-Car_Block_Heater	0.0000%	0.0000%	0.0001%	0.0000%
PSP-Consumer-Residential-Clothes_Dryers	0.0137%	0.0163%	0.0197%	0.0180%
PSP-Consumer-Residential-Clothes_Washers	0.0111%	0.0137%	0.0152%	0.0158%
PSP-Consumer-Residential-Clothesline	0.0455%	0.0000%	0.0683%	0.0000%
PSP-Consumer-Residential-Computers	0.0171%	0.0185%	0.0185%	0.0185%
PSP-Consumer-Residential-Cooking	0.0198%	0.0241%	0.0311%	0.0339%
PSP-Consumer-Residential-Dehumidifiers	0.0262%	0.0103%	0.0607%	0.0108%
PSP-Consumer-Residential-Dishwashers	0.0156%	0.0257%	0.0228%	0.0275%
PSP-Consumer-Residential-Domestic_Hot_Water	0.0103%	0.0159%	0.0110%	0.0160%
PSP-Consumer-Residential-Duct Sealing - Electric Fired	0.0035%	0.0241%	0.0066%	0.0331%
PSP-Consumer-Residential-Duct Sealing - Gas Fired, ECM	0.0315%	0.0047%	0.0760%	0.0047%

PSP-Consumer-Residential-Duct Sealing - Gas Fired, PSC	0.0252%	0.0068%	0.0559%	0.0068%
PSP-Consumer-Residential-Elevators	0.0137%	0.0163%	0.0197%	0.0180%
PSP-Consumer-Residential-Energy Star Windows - Electric Fired	0.0028%	0.0245%	0.0050%	0.0338%
PSP-Consumer-Residential-Energy Star Windows - Gas Fired, ECM	0.0310%	0.0049%	0.0746%	0.0049%
PSP-Consumer-Residential-Energy Star Windows - Gas Fired, PSC	0.0238%	0.0073%	0.0514%	0.0073%
PSP-Consumer-Residential-Forced_Air_Central_Heating	0.0009%	0.0260%	0.0009%	0.0360%
PSP-Consumer-Residential-Freezers	0.0132%	0.0113%	0.0140%	0.0114%
PSP-Consumer-Residential-Furnace_ECM_1	0.0062%	0.0187%	0.0061%	0.0237%
PSP-Consumer-Residential-Furnace_ECM_2	0.0009%	0.0260%	0.0009%	0.0360%
PSP-Consumer-Residential-Furnace_ECM_3	0.0233%	0.0130%	0.0609%	0.0180%
PSP-Consumer-Residential-Holiday_Lighting_Timer	0.0000%	0.0831%	0.0000%	0.1395%
PSP-Consumer-Residential-Lighting	0.0146%	0.0290%	0.0261%	0.0303%
PSP-Consumer-Residential-Lighting_Common_Area	0.0103%	0.0289%	0.0238%	0.0303%
PSP-Consumer-Residential-Miscellaneous	0.0114%	0.0114%	0.0114%	0.0114%
PSP-Consumer-Residential-Non_Ducted_Central_Heating	0.0009%	0.0260%	0.0009%	0.0360%
PSP-Consumer-Residential-On_Site_Generation	0.0000%	0.0000%	0.0000%	0.0000%
PSP-Consumer-Residential-Other_Consumer_Electronics	0.0114%	0.0114%	0.0114%	0.0114%
PSP-Consumer-Residential-Outdoor Solar Lighting	0.0000%	0.0000%	0.0000%	0.0000%
PSP-Consumer-Residential-Power_Bar	0.0011%	0.0000%	0.0036%	0.0001%
PSP-Consumer-Residential-Refrigerators	0.0134%	0.0125%	0.0147%	0.0130%
PSP-Consumer-Residential-Set_Top_Boxes	0.0171%	0.0185%	0.0185%	0.0185%
PSP-Consumer-Residential-Space_Heating_Room	0.0009%	0.0260%	0.0009%	0.0360%
PSP-Consumer-Residential-Swimming_Pool_And_Spa_Heaters	0.0227%	0.0258%	0.0269%	0.0269%
PSP-Consumer-Residential-Swimming_Pool_Pumps	0.0227%	0.0258%	0.0269%	0.0269%
PSP-Consumer-Residential-Televisions	0.0171%	0.0185%	0.0185%	0.0185%
PSP-Consumer-Residential-Ventilation_And_Circulation	0.0114%	0.0114%	0.0114%	0.0114%
PSP-Consumer-Residential-Water_Heater_Blanket	0.0124%	0.0184%	0.0167%	0.0223%
PSP-Consumer-Residential-Weatherstripping	0.0018%	0.0255%	0.0031%	0.0353%

PSP-Consumer-Residential-Window Solar Film - Electric Fired	0.0028%	0.0246%	0.0049%	0.0338%
PSP-Consumer-Residential-Window Solar Film - Gas Fired	0.0271%	0.0062%	0.0617%	0.0062%
PSP-Consumer-Residential-Forced_Air_Central_Heating	0.0009%	0.0260%	0.0009%	0.0360%
PSP-Industrial-Miscellaneous_Industrial-Compressed_Air	0.0108%	0.0107%	0.0123%	0.0113%
PSP-Industrial-Miscellaneous_Industrial-Motors_Pumps	0.0108%	0.0107%	0.0123%	0.0113%
PSP-Industrial-Miscellaneous_Industrial-Other	0.0114%	0.0114%	0.0114%	0.0114%
PSP-Industrial-Miscellaneous_Industrial-Process_Specific	0.0108%	0.0107%	0.0123%	0.0113%
PSP-Industrial-Agriculture-Process_Specific	0.0000%	0.0000%	0.0000%	0.0000%
PSP-Industrial-Agriculture-Process_Heating	0.0000%	0.0000%	0.0000%	0.0000%
PSP-Industrial-Agriculture-Other	0.0114%	0.0114%	0.0114%	0.0114%
PSP-Industrial-Agriculture-Process_Cooling	0.0000%	0.0000%	0.0000%	0.0000%
PSP-Business-Food_Retail-CE_Space_Heating	0.0001%	0.0289%	0.0003%	0.0556%
PSP-Business-Hospital-CE_Space_Heating	0.0006%	0.0252%	0.0056%	0.0558%
PSP-Business-Large_Hotel-CE_Space_Heating	0.0000%	0.0220%	0.0001%	0.0625%
PSP-Business-Large_Non_Food_Retail-CE_Space_Heating	0.0001%	0.0289%	0.0003%	0.0556%
PSP-Business-Large_Office-CE_Space_Heating	0.0001%	0.0289%	0.0003%	0.0556%
PSP-Business-Nursing_Home-CE_Space_Heating	0.0003%	0.0251%	0.0006%	0.0486%
PSP-Business-Other_Commercial_Buildings-CE_Space_Heating	0.0000%	0.0136%	0.0002%	0.0259%
PSP-Business-Other_Hotel_Motel-CE_Space_Heating	0.0001%	0.0239%	0.0004%	0.0510%
PSP-Business-Other_Non_Food_Retail-CE_Space_Heating	0.0001%	0.0289%	0.0003%	0.0556%
PSP-Business-Other_Office-CE_Space_Heating	0.0001%	0.0289%	0.0003%	0.0556%
PSP-Business-Restaurant-CE_Space_Heating	0.0001%	0.0289%	0.0003%	0.0556%
PSP-Business-Schools-CE_Space_Heating	0.0001%	0.0289%	0.0003%	0.0556%
PSP-Business-University_Colleges-CE_Space_Heating	0.0001%	0.0289%	0.0003%	0.0556%
PSP-Business-Warehouse_Wholesale-CE_Space_Heating	0.0003%	0.0240%	0.0005%	0.0356%
EM&V-Residential-Car_Block_Heater_North_Ontario	0.0000%	0.0129%	0.0717%	0.0717%
EM&V-Residential-Car_Block_Heater_South_Ontario	0.0000%	0.0162%	0.3669%	0.3669%
EM&V-Residential-Clothesline_Outdoor	0.0424%	0.0000%	0.0000%	0.0000%
EM&V-Residential-AC_Cooling	0.0453%	0.0000%	0.0000%	0.0000%

EM&V-Residential-Cooling_and_Gas_Heating	0.0267%	0.0089%	0.0130%	0.0130%
EM&V-Residential-Electric_Heating_and_Cooling	0.0232%	0.0130%	0.0176%	0.0176%
EM&V-Residential-Electric_Heating_and_Ventilation	0.0063%	0.0187%	0.0233%	0.0233%
EM&V-Residential-Electric_Heating	0.0012%	0.0261%	0.0351%	0.0351%
EM&V-Residential-Lighting_Interior	0.0150%	0.0288%	0.0307%	0.0307%
EM&V-Residential-Consumer_Electronics	0.0171%	0.0185%	0.0185%	0.0185%
EM&V-Commercial-HE_Ventilation_Exhaust_Fans	0.0291%	0.0000%	0.0000%	0.0000%
EM&V-Commercial-Agricultural_Ground_Source_Heat_Pump	0.0077%	0.0155%	0.0221%	0.0221%
EM&V-Commercial-Cooling	0.0511%	0.0000%	0.0000%	0.0000%
EM&V-Commercial-Creep_Heat_Pad	0.0037%	0.0153%	0.0153%	0.0153%
EM&V-Commercial-Dual_&_Natural_Ventilation_Fans_All_Year	0.0144%	0.0088%	0.0144%	0.0144%
EM&V-Commercial-Dual_&_Natural_Ventilation_Fans_Winter_Only	0.0003%	0.0173%	0.0284%	0.0284%
EM&V-Commercial-Heating	0.0052%	0.0213%	0.0354%	0.0354%
EM&V-Commercial-HT_Cut-Off_Thermostat	0.0529%	0.0000%	0.0000%	0.0000%
EM&V-Commercial-HVAC_Fans_Pumps	0.0111%	0.0111%	0.0114%	0.0114%
EM&V-Commercial-HVLS_No_Summer_Operation	0.0338%	0.0000%	0.0000%	0.0000%
EM&V-Commercial-Low_Energy_Livestock_Waterers	0.0000%	0.0000%	0.0000%	0.0000%
EM&V-Commercial-Space_Cooling_&_Heating	0.0256%	0.0137%	0.0191%	0.0191%
CUSTOM-Residential-Residential-Nightlight	0.0000%	0.0000%	0.0000%	0.0000%
CUSTOM-Business-Other_Commercial_Buildings-CUSTOM-Industrial-Agriculture-Horticultural Lighting - Veg	0.0006%	0.0008%	0.0013%	0.0042%
CUSTOM-Business-Other_Commercial_Buildings-CUSTOM-Industrial-Agriculture-Horticultural Lighting - Cannabis	0.0013%	0.0152%	0.0017%	0.0241%
PSP-Business-Lighting_Industrial_General	0.0108%	0.0095%	0.0225%	0.0109%

Independent Electricity
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