### LED Bulbs and Fixtures

###### Description

This characterization provides savings assumptions for a variety of LED lamps including Omnidirectional (e.g. A-Type lamps), Decorative (e.g. Globes and Torpedoes) and Directional (PAR Lamps, Reflectors, MR16), and fixtures including refrigerated case, recessed and outdoor/garage fixtures.

If the implementation strategy does not allow for the installation location to be known, a deemed split of 96% Commercial and 4% Residential should be used[[1]](#footnote-1).

This measure was developed to be applicable to the following program types:  TOS, NC, RF.

If applied to other program types, the measure savings should be verified.

###### Definition of Efficient Equipment

In order for this characterization to apply, new lamps must be Energy Star labeled. Lamps and fixtures should be found in the reference tables below. Fixtures must be Energy Star labeled or on the Design Lights Consortium qualifying fixture list.

###### Definition of Baseline Equipment

Refer to the baseline tables. In 2012, Federal legislation stemming from the Energy Independence and Security Act of 2007 (EIAS) required all general-purpose light bulbs between 40 watts and 100 watts to have ~30% increased efficiency, essentially phasing out standard incandescent technology. In 2012, the 100 w lamp standards apply; in 2013 the 75 w lamp standards will apply, followed by restrictions on the 60 w and 40 w lamps in 2014.

###### Deemed Lifetime of Efficient Equipment

Lifetime is the life of the product, at the reported operating hours (lamp life in hours divided by operating hours per year – see reference table "LED component Costs and Lifetime." The analysis period is the same as the lifetime, capped at 15 years. (15 years from GDS Measure Life Report, June 2007).

###### Deemed Measure Cost

Wherever possible, actual incremental costs should be used. Refer to reference table “LED component Cost & Lifetime” for defaults.

###### Loadshape

|  |
| --- |
| Loadshape C06 - Commercial Indoor Lighting |
| Loadshape C07 - Grocery/Conv. Store Indoor Lighting |
| Loadshape C08 - Hospital Indoor Lighting |
| Loadshape C09 - Office Indoor Lighting |
| Loadshape C10 - Restaurant Indoor Lighting |
| Loadshape C11 - Retail Indoor Lighting |
| Loadshape C12 - Warehouse Indoor Lighting |
| Loadshape C13 - K-12 School Indoor Lighting |
| Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights) |
| Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights) |
| Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights) |
| Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights) |
| Loadshape C18 - Industrial Indoor Lighting |
| Loadshape C19 - Industrial Outdoor Lighting |
| Loadshape C20 - Commercial Outdoor Lighting |

###### Coincidence Factor

The summer peak coincidence factor for this measure is dependent on the location type. Values are provided for each building type in the reference section below.

**Algorithm**

###### Calculation of Savings

###### Electric Energy Savings

ΔkWh = ((Wattsbase-WattsEE)/1000) \* Hours \*WHFe\*ISR

Where:

Wattsbase = Input wattage of the existing or baseline system. Reference the “LED New and Baseline Assumptions” table for default values.

WattsEE = Actual wattage of LED purchased / installed. If unknown, use default provided below:

For ENERGY STAR rated lamps the following lumen equivalence tables should be used:

**Omnidirectional Lamps - ENERGY STAR Minimum Luminous Efficacy = 50Lm/W for <10W lamps and 55Lm/W for >=10W lamps.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Minimum Lumens** | **Maximum Lumens** | **Lumens used to calculate LED Wattage (midpoint)** | **LED Wattage[[2]](#footnote-2) (WattsEE)** | **Baseline 2014-2019 (WattsBase)** | **Delta Watts 2014-2019 (WattsEE)** | **Baseline Post EISA 2020 requirement[[3]](#footnote-3)  (WattsBase)** | **Delta Watts Post 2020 (WattsEE)** |
|
|
| 5280 | 6209 | 5745 | 104.4 | 300.0 | 195.6 | 300.0 | 195.6 |
| 3000 | 5279 | 4140 | 75.3 | 200.0 | 124.7 | 200.0 | 124.7 |
| 2601 | 2999 | 2800 | 50.9 | 150.0 | 99.1 | 150.0 | 99.1 |
| 1490 | 2600 | 2045 | 37.2 | 72.0 | 34.8 | 45.4 | 8.3 |
| 1050 | 1489 | 1270 | 23.1 | 53.0 | 29.9 | 28.2 | 5.1 |
| 750 | 1049 | 900 | 16.4 | 43.0 | 26.6 | 20.0 | 3.6 |
| 310 | 749 | 530 | 9.6 | 29.0 | 19.4 | 11.8 | 2.1 |
| 250 | 309 | 280 | 5.6 | 25.0 | 19.4 | 25.0 | 19.4 |

**Decorative Lamps - ENERGY STAR Minimum Luminous Efficacy = 40Lm/W for all lamps**

|  |  |  |  |
| --- | --- | --- | --- |
| Nominal wattage of lamp to be replaced  (Wattsbase) | Minimum initial light output of LED lamp (lumens) | LED Wattage  (WattsEE) | Delta Watts |
| 10 | 70 | 1.75 | 8.25 |
| 15 | 90 | 2.25 | 12.75 |
| 25 | 150 | 3.75 | 21.25 |
| 40 | 300 | 7.5 | 32.5 |
| 60 | 500 | 12.5 | 47.5 |

Decorative lamps are exempt from EISA regulations.

**Directional Lamps -** ENERGY STAR Minimum Luminous Efficacy = 40Lm/W for lamps with rated wattages less than 20Wand 50 Lm/W for lamps with rated wattages >= 20 watts[[4]](#footnote-4).

For Directional R, BR, and ER lamp types[[5]](#footnote-5):

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Bulb Type** | **Lower Lumen Range** | **Upper Lumen Range** | **WattsBase** | **Lumens used to calculate LED Wattage (midpoint)** | **LED Wattage (WattsEE)** | **Delta Watts** |
| **R, ER, BR with medium screw bases w/ diameter >2.25" (\*see exceptions below)** | 420 | 472 | 40 | 446 | 11 | 29 |
| 473 | 524 | 45 | 499 | 12 | 33 |
| 525 | 714 | 50 | 620 | 15 | 35 |
| 715 | 937 | 65 | 826 | 21 | 44 |
| 938 | 1259 | 75 | 1099 | 22 | 53 |
| 1260 | 1399 | 90 | 1330 | 27 | 63 |
| 1400 | 1739 | 100 | 1570 | 31 | 69 |
| 1740 | 2174 | 120 | 1957 | 39 | 81 |
| 2175 | 2624 | 150 | 2400 | 48 | 102 |
| 2625 | 2999 | 175 | 2812 | 56 | 119 |
| 3000 | 4500 | 200 | 3750 | 75 | 125 |
| **\*R, BR, and ER with medium screw bases w/ diameter <=2.25"** | 400 | 449 | 40 | 425 | 11 | 29 |
| 450 | 499 | 45 | 475 | 12 | 33 |
| 500 | 649 | 50 | 575 | 14 | 36 |
| 650 | 1199 | 65 | 925 | 23 | 42 |
| **\*ER30, BR30, BR40, or ER40** | 400 | 449 | 40 | 425 | 11 | 29 |
| 450 | 499 | 45 | 475 | 12 | 33 |
| 500 | 649 | 50 | 575 | 14 | 36 |
| **\*BR30, BR40, or ER40** | 650 | 1419 | 65 | 1035 | 21 | 44 |
| **\*R20** | 400 | 449 | 40 | 425 | 11 | 29 |
| 450 | 719 | 45 | 585 | 15 | 30 |
| **\*All reflector lamps below lumen ranges specified above** | 200 | 299 | 20 | 250 | 6 | 14 |
| 300 | [[6]](#footnote-6)399 | 30 | 350 | 9 | 21 |

Directional lamps are exempt from EISA regulations.

For PAR, MR, and MRX Lamps Types:

For these highly focused directional lamp types, it is necessary to have Center Beam Candle Power (CBCP) and beam angle measurements to accurately estimate the equivalent baseline wattage. The formula below is based on the Energy Star Center Beam Candle Power tool.[[7]](#footnote-7) If CBCP and beam angle information are not available or if the equation below returns a negative value (or undefined), use the manufacturer’s recommended baseline wattage equivalent.[[8]](#footnote-8)

Where:

D = Bulb diameter (e.g. for PAR20 D = 20)

BA = Beam angle

CBCP = Center beam candle power

The result of the equation above should be rounded DOWN to the nearest wattage established by Energy Star:

|  |  |
| --- | --- |
| **Diameter** | **Permitted Wattages** |
| 16 | 20, 35, 40, 45, 50, 60, 75 |
| 20 | 50 |
| 30S | 40, 45, 50, 60, 75 |
| 30L | 50, 75 |
| 38 | 40, 45, 50, 55, 60, 65, 75, 85, 90, 100, 120, 150, 250 |

Hours = Average hours of use per year are provided in the Reference Table in Section 4.5,Screw based bulb annual operating hours, for each building type. If unknown, use the Miscellaneous value.

WHFe = Waste heat factor for energy to account for cooling energy savings from efficient lighting are provided below for each building type in the Referecne Table in Section 4.5. If unknown, use the Miscellaneous value.

ISR = In Service Rate -the percentage of units rebated that actually get installed.

=100%[[9]](#footnote-9) if application form completed with sign off that equipment is not placed into storage. If sign off form not completed assume the following 3 year ISR assumptions:

| **Weighted Average 1st year In Service Rate (ISR)** | **2nd year Installations** | **3rd year Installations** | **Final Lifetime In Service Rate** |
| --- | --- | --- | --- |
| 95.7%[[10]](#footnote-10) | 1.2% | 1.1% | 98.0%[[11]](#footnote-11) |

###### Heating Penalty

If electrically heated building:

ΔkWhheatpenalty[[12]](#footnote-12) = (((WattsBase-WattsEE)/1000) \* ISR \* Hours \* -IFkWh

Where:

IFkWh = Lighting-HVAC Interation Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, For example, a 9W LED lamp, 450 lumens, is installed in a heat pump heated office in 2014 and sign off form provided:

ΔkWhheatpenalty = ((29-9/1000)\*1.0\*3088\* -0.151

= - 9.3 kWh

###### Deferred Installs

As presented above, if a sign off form is not completed the characterization assumes that a percentage of bulbs purchased are not installed until Year 2 and Year 3 (see ISR assumption above). The Illinois Technical Advisory Committee has determined the following methodology for calculating the savings of these future installs.

Year 1 (Purchase Year) installs: Characterized using assumptions provided above or evaluated assumptions if available.

Year 2 and 3 installs: Characterized using delta watts assumption and hours of use from the Install Year i.e. the actual deemed (or evaluated if available) assumptions active in Year 2 and 3 should be applied.

The NTG factor for the Purchase Year should be applied.

###### Summer Coincident Peak Demand Savings

ΔkW =( (Wattsbase-WattsEE)/1000) \* ISR \* WHFd \* CF

Where:

WHFd = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is provided in Referecne Table in Section 4.5. If unknown, use the Miscellaneous value.

CF = Summer Peak Coincidence Factor for measure is provided in the Referecne Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, For example, a 9W LED lamp, 450 lumens, is installed in an office in 2014 and sign off form provided:

ΔkW = ((29-9/1000)\* 1.0\*1.3\*0.66

= 0.002 kW

###### Natural Gas Energy Savings

Heating Penalty if fossil fuel heated building (or if heating fuel is unknown):

ΔTherms = (((WattsBase-WattsEE)/1000) \* ISR \* Hours \* - IFTherms

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Referecne Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, For example, a 9W LED lamp, 450 lumens, is installed in an office in 2014 and sign off form provided:

ΔTherms = ((29-9/1000)\*1.0\*3088\* -0.016

= - 0.99 therms

###### Water Impact Descriptions and Calculation

N/A

###### Deemed O&M Cost Adjustment Calculation

For all measures except Standard Omnidirectional lamps (which have an EISA baseline shift) the individual component lifetimes and costs are provided in the reference table section below[[13]](#footnote-13).

In order to account for the falling EISA Qualified bulb replacement cost provided above, an equivalent annual levelized baseline replacement cost over the lifetime of the LED bulb (assumed to be 25,000/4683 =5.3 years) is calculated[[14]](#footnote-14). The key assumptions used in this calculation are documented below[[15]](#footnote-15):

|  | **Std Inc.** | **EISA Compliant Halogen** | **CFL** |
| --- | --- | --- | --- |
| 2015 | $0.34 | $0.90 | N/A |
| 2016 | $0.34 | $0.80 | N/A |
| 2017 | $0.34 | $0.70 | N/A |
| 2018 | $0.34 | $0.60 | N/A |
| 2019 | $0.34 | $0.60 | N/A |
| 2020 & after | $0.34 | N/A | $2.50 |

The NPV for replacement lamps and annual levelized replacement costs using the statewide real discount rate of 5.23% are presented below:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Location** | **Lumen Level** | **NPV of replacement costs for period** | | | **Levelized annual replacement cost savings** | | |
| **June 2016 - May 2017** | **June 2017 - May 2018** | **June 2018 - May 2019** | **June 2016 - May 2017** | **June 2017 - May 2018** | **June 2018 - May 2019** |
| Commercial | Lumens <310 or >2600 (EISA exempt) | $6.88 | $6.88 | $6.88 | $1.51 | $1.51 | $1.51 |
| Lumens ≥ 310 and ≤ 2600 (EISA compliant) | $11.63 | $9.52 | $7.76 | $2.55 | $2.09 | $1.70 |
| Multi Family Common Areas | Lumens <310 or >2600 (non-EISA compliant) | $7.03 | $7.03 | $7.03 | $1.72 | $1.72 | $1.72 |
| Lumens ≥ 310 and ≤ 2600 (EISA compliant) | $12.69 | $10.28 | $8.28 | $3.11 | $2.52 | $2.03 |

For halogen bulbs, we assume the same replacement cycle as incandescent bulbs.[[16]](#footnote-16) The replacement cycle is based on the miscellaneous hours of use. Both incandescent and halogen lamps are assumed to last for 1,000 hours before needing replacement and CFLs after 10,000 hours.

###### Reference Tables

**LED Bulb Assumptions**

Wherever possible, actual incremental costs should be used. If unavailable assume the following incremental costs[[17]](#footnote-19):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bulb Type** | **LED Wattage** | **LED** | **Incandescent** | **Incremental Cost** |
| **Directional** | < 20W | $22.42 | $6.31 | $16.11 |
| ≥20W | $70.78 | $64.47 |
| **Decorative and Globe** | <15W | $12.76 | $3.92 | $8.84 |
| 15 to <25W | $25.00 | $21.08 |
| ≥25W | $25.00 | $21.08 |

Directional and Decorative O&M; apply incandescent cost assumption provided above with a frequency calculated by dividing the assumed rated life of the baseline bulb (1000 hours) by the building specific hours of use assumption.

**LED Fixture Wattage and Incremental Cost Assumptions**[[18]](#footnote-20)



| **LED Category** | **EE Measure Description** | **WattsEE** | **Baseline Description** | **WattsBASE** | **Incremental Cost** | **Mid Life Savings Adjustment (2018)** |
| --- | --- | --- | --- | --- | --- | --- |
| LED Downlight Fixtures | LED Recessed, Surface, Pendant Downlights | 17.6 | Baseline LED Recessed, Surface, Pendant Downlights | 54.3 | $27 | N/A |
| LED Interior Directional | LED Track Lighting | 12.2 | Baseline LED Track Lighting | 60.4 | $59 | N/A |
| LED Wall-Wash Fixtures | 8.3 | Baseline LED Wall-Wash Fixtures | 17.7 | $59 | N/A |
| LED Display Case | LED Display Case Light Fixture | 7.1 per ft | Baseline LED Display Case Light Fixture | 36.2 per ft | $11/ft | N/A |
| LED Undercabinet Shelf-Mounted Task Light Fixtures | 7.1 per ft | Baseline LED Undercabinet Shelf-Mounted Task Light Fixtures | 36.2 per ft | $11/ft | N/A |
| LED Refrigerated Case Light, Horizontal or Vertical | 7.6 per ft | Baseline LED Refrigerated Case Light, Horizontal or Vertical (per foot) | 15.2 per ft | $11/ft | N/A |
| LED Freezer Case Light, Horizontal or Vertical | 7.7 per ft | Baseline LED Freezer Case Light, Horizontal or Vertical (per foot) | 18.7 per ft | $11/ft | N/A |
| LED Linear Replacement Lamps | LED 4' Linear Replacement Lamp | 18.7 | 80:20 T12:T8; Lamp Only 32w T8:34w T12 | 33.6 | $24 | 89% |
| LED 2' Linear Replacement Lamp | 9.7 | 80:20 T12:T8; Lamp Only 17w T8:20w T12 | 19.4 | $13 | 75% |
| LED Troffers | LED 2x2 Recessed Light Fixture, 2000-3500 lumens | 34.1 | 80:20 T12:Standard T8 2-Lamp 32w T8, 2-Lamp 34w T12 | 61.0 | $48 | 85% |
| LED 2x2 Recessed Light Fixture, 3501-5000 lumens | 42.8 | 80:20 T12:Standard T8 3-Lamp 32w T8, 3-Lamp 34w T12 | 103.3 | $91 | 69% |
| LED 2x4 Recessed Light Fixture, 3000-4500 lumens | 37.9 | 80:20 T12:Standard T8 2-Lamp 32w T8, 2-Lamp 34w T12 | 61.0 | $62 | 83% |
| LED 2x4 Recessed Light Fixture, 4501-6000 lumens | 54.3 | 80:20 T12:Standard T8 3-Lamp 32w T8, 3-Lamp 34w T12 | 103.3 | $99 | 62% |
| LED 2x4 Recessed Light Fixture, 6001-7500 lumens | 72.7 | 80:20 T12:Standard T8 4-Lamp 32w T8, 4-Lamp 34w T12 | 137.7 | $150 | 61% |
| LED 1x4 Recessed Light Fixture, 1500-3000 lumens | 18.1 | 80:20 T12:Standard T8 1-Lamp 32w T8 , 1-Lamp 34w T12 | 30.6 | $36 | 88% |
| LED 1x4 Recessed Light Fixture, 3001-4500 lumens | 39.6 | 80:20 T12:Standard T8 2-Lamp 32w T8, 2-Lamp 34w T12 | 61.0 | $76 | 81% |
| LED 1x4 Recessed Light Fixture, 4501-6000 lumens | 53.1 | 80:20 T12:Standard T8 3-Lamp 32w T8, 3-Lamp 34w T12 | 103.3 | $130 | 62% |
| LED Linear Ambient Fixtures | LED Surface & Suspended Linear Fixture, <= 3000 lumens | 19.7 | 80:20 T12:Standard T8 1-Lamp 32w T8, 1-Lamp 34w T12 | 30.6 | $54 | 86% |
| LED Surface & Suspended Linear Fixture, 3001-4500 lumens | 37.8 | 80:20 T12:Standard T8 2-Lamp 32w T8, 2-Lamp 34w T12 | 61.0 | $104 | 83% |
| LED Surface & Suspended Linear Fixture, 4501-6000 lumens | 55.9 | 80:20 T12:Standard T8 3-Lamp 32w T8, 3-Lamp 34w T12 | 103.3 | $158 | 60% |
| LED Surface & Suspended Linear Fixture, 6001-7500 lumens | 62.6 | T5HO 2L-F54T5HO - 4' | 120.0 | $215 | N/A |
| LED Surface & Suspended Linear Fixture, > 7500 lumens | 95.4 | T5HO 3L-F54T5HO - 4' | 180.0 | $374 | N/A |
| LED High & Low Bay Fixtures | LED Low-Bay Fixtures, <= 10,000 lumens | 90.3 | 3-Lamp T8HO Low-Bay | 157.0 | $191 | N/A |
| LED High-Bay Fixtures, 10,001-15,000 lumens | 127.5 | 4-Lamp T8HO High-Bay | 196.0 | $331 | N/A |
| LED High-Bay Fixtures, 15,001-20,000 lumens | 191.0 | 6-Lamp T8HO High-Bay | 294.0 | $482 | N/A |
| LED High-Bay Fixtures, > 20,000 lumens | 249.7 | 8-Lamp T8HO High-Bay | 392.0 | $818 | N/A |
| LED Agricultural Interior Fixtures | LED Ag Interior Fixtures, <= 2,000 lumens | 17.0 | 25% 73 Watt EISA Inc, 75% 1L T8 | 42.0 | $33 | N/A |
| LED Ag Interior Fixtures, 2,001-4,000 lumens | 27.8 | 25% 146 Watt EISA Inc, 75% 2L T8 | 81.0 | $54 | N/A |
| LED Ag Interior Fixtures, 4,001-6,000 lumens | 51.2 | 25% 217 Watt EISA Inc, 75% 3L T8 | 121.0 | $125 | N/A |
| LED Ag Interior Fixtures, 6,001-8,000 lumens | 71.7 | 25% 292 Watt EISA Inc, 75% 4L T8 | 159.0 | $190 | N/A |
| LED Ag Interior Fixtures, 8,001-12,000 lumens | 103.5 | 200W Pulse Start Metal Halide | 227.3 | $298 | N/A |
| LED Ag Interior Fixtures, 12,001-16,000 lumens | 143.8 | 320W Pulse Start Metal Halide | 363.6 | $450 | N/A |
| LED Ag Interior Fixtures, 16,001-20,000 lumens | 183.3 | 350W Pulse Start Metal Halide | 397.7 | $595 | N/A |
| LED Ag Interior Fixtures, > 20,000 lumens | 305.0 | (2) 320W Pulse Start Metal Halide | 727.3 | $998 | N/A |
| LED Exterior Fixtures | LED Exterior Fixtures, <= 5,000 lumens | 42.6 | 100W Metal Halide | 113.6 | $190 | N/A |
| LED Exterior Fixtures, 5,001-10,000 lumens | 68.2 | 175W Pulse Start Metal Halide | 198.9 | $287 | N/A |
| LED Exterior Fixtures, 10,001-15,000 lumens | 122.5 | 250W Pulse Start Metal Halide | 284.1 | $391 | N/A |
| LED Exterior Fixtures, > 15,000 lumens | 215.0 | 400W Pulse Start Metal Halide | 454.5 | $793 | N/A |

**LED Fixture Component Costs & Lifetime[[19]](#footnote-22)**

|  |  | **EE Measure** | | | | **Baseline** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **LED Category** | **EE Measure Description** | **Lamp Life (hrs)** | **Total Lamp Replacement Cost** | **LED Driver Life (hrs)** | **Total LED Driver Replacement Cost** | **Lamp Life (hrs)** | **Total Lamp Replacement Cost** | **Ballast Life (hrs)** | **Total Ballast Replacement Cost** |
| LED Downlight Fixtures | LED Recessed, Surface, Pendant Downlights | 50,000 | $30.75 | 70,000 | $47.50 | 2,500 | $8.86 | 40,000 | $14.40 |
| LED Interior Directional | LED Track Lighting | 50,000 | $39.00 | 70,000 | $47.50 | 2,500 | $12.71 | 40,000 | $11.00 |
| LED Wall-Wash Fixtures | 50,000 | $39.00 | 70,000 | $47.50 | 2,500 | $9.17 | 40,000 | $27.00 |
| LED Display Case | LED Display Case Light Fixture | 50,000 | $9.75/ft | 70,000 | $11.88/ft | 2,500 | $6.70 | 40,000 | $5.63 |
| LED Undercabinet Shelf-Mounted Task Light Fixtures | 50,000 | $9.75/ft | 70,000 | $11.88/ft | 2,500 | $6.70 | 40,000 | $5.63 |
| LED Refrigerated Case Light, Horizontal or Vertical | 50,000 | $8.63/ft | 70,000 | $9.50/ft | 15,000 | $1.13 | 40,000 | $8.00 |
| LED Freezer Case Light, Horizontal or Vertical | 50,000 | $7.88/ft | 70,000 | $7.92/ft | 12,000 | $0.94 | 40,000 | $6.67 |
| LED Linear Replacement Lamps | LED 4' Linear Replacement Lamp | 50,000 | $8.57 | 70,000 | $13.67 | 24,000 | $6.17 | 40,000 | $11.96 |
| LED 2' Linear Replacement Lamp | 50,000 | $5.76 | 70,000 | $13.67 | 24,000 | $6.17 | 40,000 | $11.96 |
| LED Troffers | LED 2x2 Recessed Light Fixture, 2000-3500 lumens | 50,000 | $46.68 | 70,000 | $40.00 | 24,000 | $26.33 | 40,000 | $35.00 |
| LED 2x2 Recessed Light Fixture, 3501-5000 lumens | 50,000 | $56.31 | 70,000 | $40.00 | 24,000 | $39.50 | 40,000 | $35.00 |
| LED 2x4 Recessed Light Fixture, 3000-4500 lumens | 50,000 | $49.58 | 70,000 | $40.00 | 24,000 | $12.33 | 40,000 | $35.00 |
| LED 2x4 Recessed Light Fixture, 4501-6000 lumens | 50,000 | $57.76 | 70,000 | $40.00 | 24,000 | $18.50 | 40,000 | $35.00 |
| LED 2x4 Recessed Light Fixture, 6001-7500 lumens | 50,000 | $68.89 | 70,000 | $40.00 | 24,000 | $24.67 | 40,000 | $35.00 |
| LED 1x4 Recessed Light Fixture, 1500-3000 lumens | 50,000 | $43.43 | 70,000 | $40.00 | 24,000 | $6.17 | 40,000 | $35.00 |
| LED 1x4 Recessed Light Fixture, 3001-4500 lumens | 50,000 | $52.31 | 70,000 | $40.00 | 24,000 | $12.33 | 40,000 | $35.00 |
| LED 1x4 Recessed Light Fixture, 4501-6000 lumens | 50,000 | $63.86 | 70,000 | $40.00 | 24,000 | $18.50 | 40,000 | $35.00 |
| LED Linear Ambient Fixtures | LED Surface & Suspended Linear Fixture, <= 3000 lumens | 50,000 | $45.01 | 70,000 | $40.00 | 24,000 | $6.17 | 40,000 | $35.00 |
| LED Surface & Suspended Linear Fixture, 3001-4500 lumens | 50,000 | $58.73 | 70,000 | $40.00 | 24,000 | $12.33 | 40,000 | $35.00 |
| LED Surface & Suspended Linear Fixture, 4501-6000 lumens | 50,000 | $73.50 | 70,000 | $40.00 | 24,000 | $18.50 | 40,000 | $35.00 |
| LED Surface & Suspended Linear Fixture, 6001-7500 lumens | 50,000 | $88.69 | 70,000 | $40.00 | 30,000 | $26.33 | 40,000 | $60.00 |
| LED Surface & Suspended Linear Fixture, > 7500 lumens | 50,000 | $123.91 | 70,000 | $40.00 | 30,000 | $39.50 | 40,000 | $60.00 |
| LED High & Low Bay Fixtures | LED Low-Bay Fixtures, <= 10,000 lumens | 50,000 | $90.03 | 70,000 | $62.50 | 18,000 | $64.50 | 40,000 | $92.50 |
| LED High-Bay Fixtures, 10,001-15,000 lumens | 50,000 | $122.59 | 70,000 | $62.50 | 18,000 | $86.00 | 40,000 | $92.50 |
| LED High-Bay Fixtures, 15,001-20,000 lumens | 50,000 | $157.22 | 70,000 | $62.50 | 18,000 | $129.00 | 40,000 | $117.50 |
| LED High-Bay Fixtures, > 20,000 lumens | 50,000 | $228.52 | 70,000 | $62.50 | 18,000 | $172.00 | 40,000 | $142.50 |
| LED Agricultural Interior Fixtures | LED Ag Interior Fixtures, <= 2,000 lumens | 50,000 | $37.00 | 70,000 | $40.00 | 1,000 | $1.23 | 40,000 | $26.25 |
| LED Ag Interior Fixtures, 2,001-4,000 lumens | 50,000 | $44.96 | 70,000 | $40.00 | 1,000 | $1.43 | 40,000 | $26.25 |
| LED Ag Interior Fixtures, 4,001-6,000 lumens | 50,000 | $63.02 | 70,000 | $40.00 | 1,000 | $1.62 | 40,000 | $26.25 |
| LED Ag Interior Fixtures, 6,001-8,000 lumens | 50,000 | $79.78 | 70,000 | $40.00 | 1,000 | $1.81 | 40,000 | $26.25 |
| LED Ag Interior Fixtures, 8,001-12,000 lumens | 50,000 | $119.91 | 70,000 | $62.50 | 15,000 | $63.00 | 40,000 | $112.50 |
| LED Ag Interior Fixtures, 12,001-16,000 lumens | 50,000 | $151.89 | 70,000 | $62.50 | 15,000 | $68.00 | 40,000 | $122.50 |
| LED Ag Interior Fixtures, 16,001-20,000 lumens | 50,000 | $184.62 | 70,000 | $62.50 | 15,000 | $73.00 | 40,000 | $132.50 |
| LED Ag Interior Fixtures, > 20,000 lumens | 50,000 | $285.75 | 70,000 | $62.50 | 15,000 | $136.00 | 40,000 | $202.50 |
| LED Exterior Fixtures | LED Exterior Fixtures, <= 5,000 lumens | 50,000 | $86.92 | 70,000 | $62.50 | 15,000 | $58.00 | 40,000 | $102.50 |
| LED Exterior Fixtures, 5,001-10,000 lumens | 50,000 | $111.81 | 70,000 | $62.50 | 15,000 | $63.00 | 40,000 | $112.50 |
| LED Exterior Fixtures, 10,001-15,000 lumens | 50,000 | $138.32 | 70,000 | $62.50 | 15,000 | $68.00 | 40,000 | $122.50 |
| LED Exterior Fixtures, > 15,000 lumens | 50,000 | $223.67 | 70,000 | $62.50 | 15,000 | $73.00 | 40,000 | $132.50 |



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1. Based on final ComEd’s BILD program data from PY4,PY5 and PY6. For Residential installations, hours of use assumptions from ‘5.5.6 LED Downlights’ should be used for LED fixtures and ‘5.5.8 LED Screw Based Omnidirectional Bulbs’ should be used for LED bulbs. [↑](#footnote-ref-1)
2. Based on ENERGY STAR specs – minimum luminous efficacy for Omnidirectional Lamps. For LED lamp power <10W = 50lm/W and for LED lamp power >=10W = 55lm/W. [↑](#footnote-ref-2)
3. Calculated as 45lm/W for all EISA non-exempt bulbs. [↑](#footnote-ref-3)
4. From pg 10 of the Energy Star Specification for lamps v1.1 [↑](#footnote-ref-4)
5. From pg 11 of the Energy Star Specification for lamps v1.1 [↑](#footnote-ref-5)
6. [↑](#footnote-ref-6)
7. http://energystar.supportportal.com/link/portal/23002/23018/Article/32655/ [↑](#footnote-ref-7)
8. The Energy Star Center Beam Candle Power tool does not accurately model baseline wattages for lamps with certain bulb characteristic combinations – specifically for lamps with very high CBCP. [↑](#footnote-ref-8)
9. Illinois evaluation of PY1 through PY3 has not found that fixtures or lamps placed into storage to be a significant enough issue to warrant including an “In-Service Rate” when commercial customers complete an application form. [↑](#footnote-ref-9)
10. Based on ComEd’s BILD program data from PY5 and PY6, see “IL Commercial Lighting ISR\_2014.xls”. [↑](#footnote-ref-10)
11. In the absence of any data for LEDs specifically it is assumed that the same proportion of bulbs eventually get installed as for CFLS. The 98% CFL assumption is based upon review of two evaluations:

    ‘Nexus Market Research, RLW Analytics and GDS Associates study; “New England Residential Lighting Markdown Impact Evaluation, January 20, 2009’ and ‘KEMA Inc, Feb 2010, Final Evaluation Report:, Upstream Lighting Program, Volume 1.’ This implies that only 2% of bulbs purchased are never installed. The second and third year installations are based upon Ameren analysis of the Californian KEMA study showing that 54% of future installs occur in year 2 and 46% in year 3. The 2nd and 3rd year installations should be counted as part of those future program year savings. Note that this Final Install Rate does NOT account for leakage of purchased bulbs being installed outside of the utility territory. EM&V should assess how and if data from evaluation should adjust this final installation rate to account for this impact [↑](#footnote-ref-11)
12. Negative value because this is an increase in heating consumption due to the efficient lighting. [↑](#footnote-ref-12)
13. See “LED Lighting Systems TRM Reference Tables” for breakdown of component cost assumptions. [↑](#footnote-ref-13)
14. See C&I OmniDirectional LED O&M Calc.xls” for more information. The values assume the non-residential average hours assumption of 4683. [↑](#footnote-ref-14)
15. Based upon pricing forecast developed by Applied Proactive Technologies Inc (APT) based on industry input and provided to Ameren. [↑](#footnote-ref-15)
16. The manufacturers of the new minimally compliant EISA Halogens are using regular incandescent lamps with halogen fill gas rather than halogen infrared to meet the standard and so the component rated life is equal to the standard incandescent. [↑](#footnote-ref-16)
17. LED lamp costs are based on VEIC review of a year’s worth of LED sales data through VEIC implemented programs and the retail cost averaged (see 2015 LED Sales Review.xls). Baseline cost based on “2010-2012 WA017 Ex Ante Measure Cost Study Draft Report”, Itron, February 28, 2014. Given LED prices are expected to continue declining assumed costs should be reassessed on an annual basis and replaced with IL specific LED program information when available. [↑](#footnote-ref-19)
18. Watt, lumen, lamp life, and ballast factor assumptions for efficient measures are based upon Consortium for Energy Efficiency (CEE) Commercial Lighting Qualifying Product Lists alongside past Efficiency Vermont projects and PGE refrigerated case study. Watt, lumen, lamp life, and ballast factor assumptions for baseline fixtures are based upon manufacturer specification sheets. Baseline cost data comes from lighting suppliers, past Efficiency Vermont projects, and professional judgment. Efficient cost data comes from 2012 DOE “Energy Savings Potential of Solid-State Lighting in General Illumination Applications”, Table A.1. See "LED Lighting Systems TRM Reference Tables.xlsx" for more information and specific product links. [↑](#footnote-ref-20)
19. Note some measures have blended baselines (T12:T8 80:20). All values are provided to enable calculation of appropriate O&M impacts. Total costs include lamp, labor and disposal cost assumptions where applicable, see “IL LED Lighting Systems TRM Tables” for more information. [↑](#footnote-ref-22)