### High Performance and Reduced Wattage T8 Fixtures and Lamps

**Description**

This measure applies to “High Performance T8” (HPT8) lamp/ballast systems that have higher lumens per watt than standard T8 systems. This measure applies to the installation of new equipment with efficiencies that exceed that of the equipment that would have been installed following standard market practices and is applicable to time of sale as well as retrofit measures. Retrofit measures may include new fixtures or relamp/reballast measures. In addition, options have been provided to allow for the “Reduced Wattage T8 lamps” or RWT8 lamps that result in re-lamping opportunities that produce equal or greater light levels than standard T8 lamps while using fewer watts.

If the implementation strategy does not allow for the installation location to be known, a deemed split of 99% Commercial and 1% Residential should be used[[1]](#footnote-1).

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

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

The measure applies to all commercial HPT8 installations excluding new construction and major renovation or change of use measures (see lighting power density measure). Lookup tables have been provided to account for the different types of installations. Whenever possible, actual costs and hours of use should be utilized for savings calculations. Default new and baseline assumptions have been provided in the reference tables. Default component costs and lifetimes have been provided for Operating and Maintenance Calculations. Please see the Definition Table to determine applicability for each program. HPT8 configurations not included in the TRM may be included in custom program design using the provided algorithms as long as energy savings is achieved. The following table defines the applicability for different programs

| **Time of Sale (TOS)** | **Retrofit (RF) and Direct Install (DI)** |
| --- | --- |
| This measure relates to the installation of new equipment with efficiency that exceeds that of equipment that would have been installed following standard market practices. In general, the measure will include qualifying high efficiency low ballast factor ballasts paired with high efficiency long life lamps as detailed in the attached tables. High-bay applications use this system paired with qualifying high ballast factor ballasts and high performance 32 w lamps. Custom lighting designs can use qualifying low, normal or high ballast factor ballasts and qualifying lamps in lumen equivalent applications where total system wattage is reduced when calculated using the Calculation of Savings Algorithms. | This measure relates to the replacement of existing equipment with new equipment with efficiency that exceeds that of the existing equipment. In general, the retrofit will include qualifying high efficiency low ballast factor ballasts paired with high efficiency long life lamps as detailed in the attached tables. Custom lighting designs can use qualifying low, normal or high ballast factor ballasts and qualifying lamps in lumen equivalent applications where total system wattage is reduced when calculated using the Calculation of Savings Algorithms.  High efficiency troffers (new/or retrofit) utilizing HPT8 technology can provide even greater savings. When used in a high-bay application, high-performance T8 fixtures can provide equal light to HID high-bay fixtures, while using fewer watts; these systems typically utilize high ballast factor ballasts, but qualifying low and normal ballast factor ballasts may be used when appropriate light levels are provided and overall wattage is reduced. |

**Definition of Efficient Equipment**

The definition of efficient equipment varies based on the program and is defined below:

|  |  |
| --- | --- |
| **Time of Sale (TOS)** | **Retrofit (RF) and Direct Install (DI)** |
| In order for this characterization to apply, new lamps and ballasts must be listed on the CEE website on the qualifying High Performance T8 lamps and ballasts list (<http://www.cee1.org/com/com-lt/com-lt-main.php3>).  High efficiency troffers combined with high efficiency lamps and ballasts allow for fewer lamps to be used to provide a given lumen output. High efficiency troffers must have a fixture efficiency of 80% or greater to qualify. Default values are given for a 2 lamp HPT8 fixture replacing a 3 lamp standard efficiency T8 fixture, but other configurations may qualify and the Calculation of savings algorithm used to account for base watts being replaced with EE watts.  High bay fixtures must have fixture efficiencies of 85% or greater.  RWT8 lamps: In order for this characterization to apply, new 4' and U-tube lamps must be listed on the CEE website on the qualifying Reduced Wattage High Performance T8 lamps list. (http://library.cee1.org/content/commercial-lighting-qualifying-products-lists). 2', 3' and 8' lamps must meet the wattage requirements specified in the RWT8 new and baseline assumptions table. This measure assumes a lamp only purchase. | In order for this characterization to apply, new lamps and ballasts must be listed on the CEE website on the qualifying High Performance T8 lamps and ballasts list ([http://www.cee1.org/com/com-lt/com-lt-main.php3](http://www.ilsag.org/questions)).  High efficiency troffers (new or retrofit kits) combined with high efficiency lamps and ballasts allow for fewer lamps to be used to provide a given lumen output. High efficiency troffers must have a fixture efficiency of 80% or greater to qualify. Default values are given for a 2 lamp HPT8 fixture replacing a 3 lamp standard efficiency T8 fixture, but other configurations may qualify and the Calculation of savings algorithm used to account for base watts being replaced with EE watts.  High bay fixtures will have fixture efficiencies of 85% or greater.  RWT8: in order for this characterization to apply, new 4' and U-tube lamps must be listed on the CEE website on the qualifying Reduced Wattage High Performance T8 lamps list.  (http://library.cee1.org/content/commercial-lighting-qualifying-products-lists). 2', 3' and 8' lamps must meet the wattage requirements specified in the RWT8 new and baseline assumptions table. |

**Definition of Baseline Equipment**

The definition of baseline equipment varies based on the program and is defined below:

|  |  |
| --- | --- |
| **Time of Sale (TOS)** | **Retrofit (RF) and Direct Install (DI)** |
| The baseline is standard efficiency T8 systems that would have been installed. The baseline for high-bay fixtures is pulse start metal halide fixtures, the baseline for a 2 lamp high efficiency troffer is a 3 lamp standard efficency troffer. | The baseline is the existing system.  In July 14, 2012, Federal Standards were enacted that were expected to eliminate T-12s as an option for linear fluorescent fixtures. Through v3.0 of the TRM, it was assumed that the T-12 would no longer be baseline for retrofits from 1/1/2016. However, due to significant loopholes in the legislation, T-12 compliant product is still freely available and in Illinois T-12s continue to hold a significant share of the existing and replacement lamp market. Therefore the timing of the sunsetting of T-12s as a viable baseline has been pushed back in v5.0 until 6/1/2018 and will be revisited in future update sessions.  There will be a baseline shift applied to all measures installed before 2018. See table C-1. |

**Deemed Lifetime of Efficient Equipment**

The deemed lifetime of efficient equipment varies based on the program and is defined below:

|  |  |
| --- | --- |
| **Time of Sale (TOS)** | **Retrofit (RF) and Direct Install (DI)** |
| Fixture lifetime is 15 years[[2]](#footnote-2).  Fixture retrofits which utilize RWT8 lamps have a lifetime equivalent to the life of the lamp, capped at 15 years. There is no guarantee that a reduced wattage lamp will be installed at time of burnout, but if one is, savings will be captured in the RWT8 measure below.  RWT8 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 "RWT8 Component Costs and Lifetime"), capped at 15 years.[[3]](#footnote-3) | Fixture lifetime is 15 years.  As per explanation above, for existing T12 fixtures, a mid life baseline shift should be applied in Jan 2018 as described in table C-1.  Note, since the fixture lifetime is deemed at 15 years, the replacement cost of both the lamp and ballast should be incorporated in to the O&M calculation. |

**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 |

**Algorithm**

**Calculation of Savings**

**Electric Energy Savings**

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

Where:

Wattsbase = Input wattage of the existing system which depends on the baseline fixture configuration (number and type of lamp) and number of fixtures. Value can be selected from the appropriate reference table as shown below, or a custom value can be entered if the configurations in the tables is not representative of the exisitng system.

| **Program** | **Reference Table** |
| --- | --- |
| Time of Sale | A-1: HPT8 New and Baseline Assumptions |
| Retrofit | A-2: HPT8 New and Baseline Assumptions |
| Reduced Wattage T8, time of sale or retrofit | A-3: RWT8 New and Baseline Assumptions |

WattsEE = New Input wattage of EE fixture which depends on new fixture configuration (number of lamps) and ballast factor and number of fixtures. Value can be selected from the appropriate reference table as shown below, of a custom value can be entered if the configurations in the tables is not representative of the exisitng system.

|  |  |
| --- | --- |
| **Program** | **Reference Table** |
| Time of Sale | A-1: HPT8 New and Baseline Assumptions |
| Retrofit | A-2: HPT8 New and Baseline Assumptions |
| Reduced Wattage T8, time of sale or retrofit | A-3: RWT8 New and Baseline Assumptions |

Hours = Average hours of use per year as provided by the customer or selected from the Reference Table in Section 4.5,Fixture annual operating hours. If hours or building type are unknown, use the Miscellaneous value.

WHFe = Waste heat factor for energy to account for cooling energy savings from efficient lighting is selected from the Reference Table in Section 4.5 for each building type. If building is un-cooled, the value is 1.0.

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

=100%[[4]](#footnote-4) 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** |
| --- | --- | --- | --- |
| 98%[[5]](#footnote-5) | 0% | 0% | 98.0%[[6]](#footnote-6) |

**Heating Penalty**

If electrically heated building:

ΔkWhheatpenalty[[7]](#footnote-7) = (((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.

**Summer Coincident Demand Savings**

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

Where:

WHFd = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is selected from the Reference Table in Section 4.5 for each building type. If the building is not cooled WHFd is 1.

CF = Summer Peak Coincidence Factor for measure is selected from the Reference Table in Section 4.5 for each building type. If the building type is unknown, use the Miscellaneous value of 0.66.

Other factors as defined above

**Natural Gas Savings**

ΔTherms[[8]](#footnote-8) = (((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. Please select from the Reference Table in Section 4.5 for each building type.

**Water Impact Descriptions and Calculation**

N/A

**Deemed O&M Cost Adjustment Calculation**

See Reference tables for Operating and Maintenance Values

| **Program** | **Reference Table** |
| --- | --- |
| Time of Sale | B-1: HPT8 Component Costs and Lifetime |
| Retrofit | B-2: HPT8 Component Costs and Lifetime |
| Reduced Wattage T8, time of sale or retrofit | B-3: HPT8 Component Costs and Lifetime |

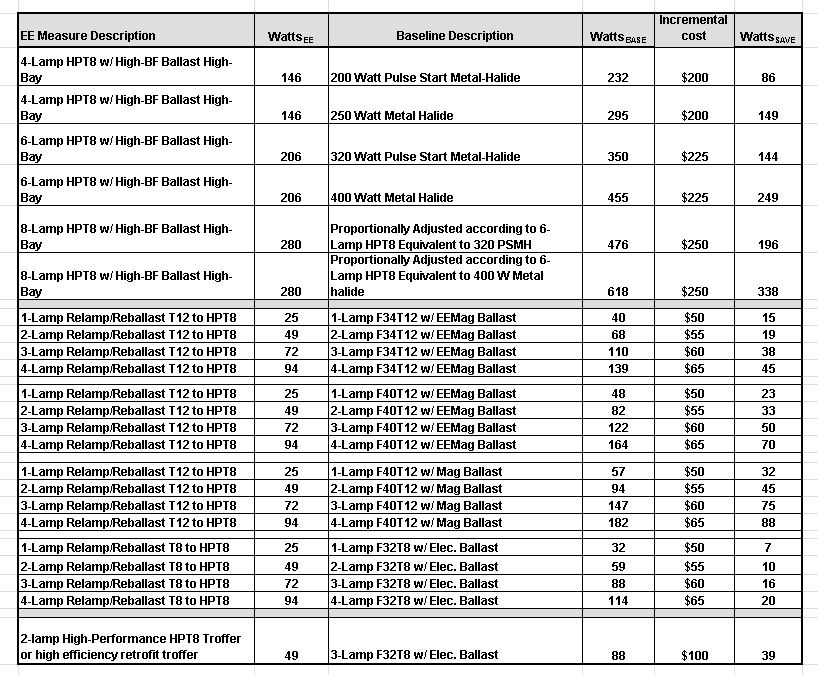
**Reference Tables**

See following page

A-1: Time of Sale: HPT8 New and Baseline Assumptions[[9]](#footnote-9)

| **EE Measure Description** | **WattsEE** | **Baseline Description** | **WattsBASE** | **Measure Cost** | **WattsSAVE** |
| --- | --- | --- | --- | --- | --- |
| 4-Lamp HPT8 w/ High-BF Ballast High-Bay | 146 | 200 Watt Pulse Start Metal-Halide | 232 | $75 | 86 |
| 6-Lamp HPT8 w/ High-BF Ballast High-Bay | 221 | 320 Watt Pulse Start Metal-Halide | 350 | $75 | 129 |
| 8-Lamp HPT8 w/ High-BF Ballast High-Bay | 280 | Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 320 PSMH | 455 | $75 | 175 |
|  |  |  |  |  |  |
| 1-Lamp HPT8-high performance 32 w lamp | 25 | 1-Lamp Standard F32T8 w/ Elec. Ballast | 32 | $15 | 7 |
| 1-Lamp HPT8-high performance 28 w lamp | 22 | 1-Lamp Standard F32T8 w/ Elec. Ballast | 32 | $15 | 10 |
| 1-Lamp HPT8-high performance 25 w lamp | 19 | 1-Lamp Standard F32T8 w/ Elec. Ballast | 32 | $15 | 13 |
| 2-Lamp HPT8 -high performance 32 w lamp | 49 | 2-Lamp Standard F32T8 w/ Elec. Ballast | 59 | $18 | 10 |
| 2-Lamp HPT8-high performance 28 w lamp | 43 | 2-Lamp Standard F32T8 w/ Elec. Ballast | 59 | $18 | 16 |
| 2-Lamp HPT8-high performance 25 w lamp | 35 | 2-Lamp Standard F32T8 w/ Elec. Ballast | 59 | $18 | 24 |
| 3-Lamp HPT8-high performance 32 w lamp | 72 | 3-Lamp Standard F32T8 w/ Elec. Ballast | 88 | $20 | 16 |
| 3-Lamp HPT8-high performance 28 w lamp | 65 | 3-Lamp Standard F32T8 w/ Elec. Ballast | 88 | $20 | 23 |
| 3-Lamp HPT8-high performance 25 w lamp | 58 | 3-Lamp Standard F32T8 w/ Elec. Ballast | 88 | $20 | 30 |
| 4-Lamp HPT8 -high performance 32 w lamp | 94 | 4-Lamp Standard F32T8 w/ Elec. Ballast | 114 | $23 | 20 |
| 4-Lamp HPT8-high performance 28 w lamp | 86 | 4-Lamp Standard F32T8 w/ Elec. Ballast | 114 | $23 | 28 |
| 4-Lamp HPT8-high performance 25 w lamp | 77 | 4-Lamp Standard F32T8 w/ Elec. Ballast | 114 | $23 | 37 |
|  |  |  |  |  |  |
| 2-lamp High-Performance HPT8 Troffer | 49 | 3-Lamp F32T8 w/ Elec. Ballast | 88 | $100 | 39 |
|  |  |  |  |  |  |
| Table developed using a constant ballast factor of .77. Input wattages are an average of manufacturer inputs that account for ballast efficacy | | | | | |

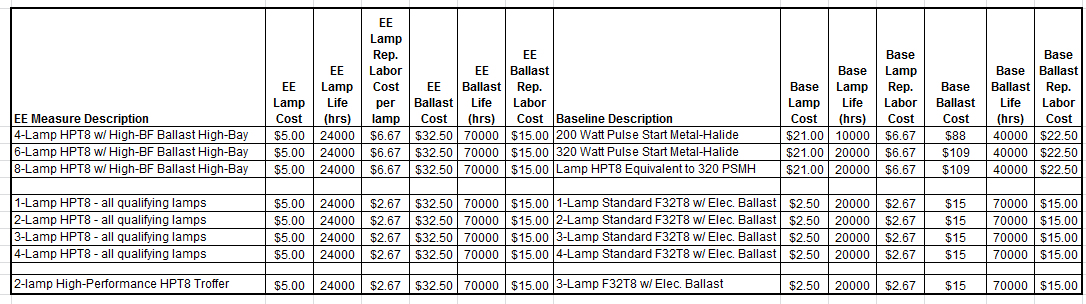
A-2: Retrofit HPT8 New and Baseline Assumptions[[10]](#footnote-10) (Note see definiton for validity after 2016)



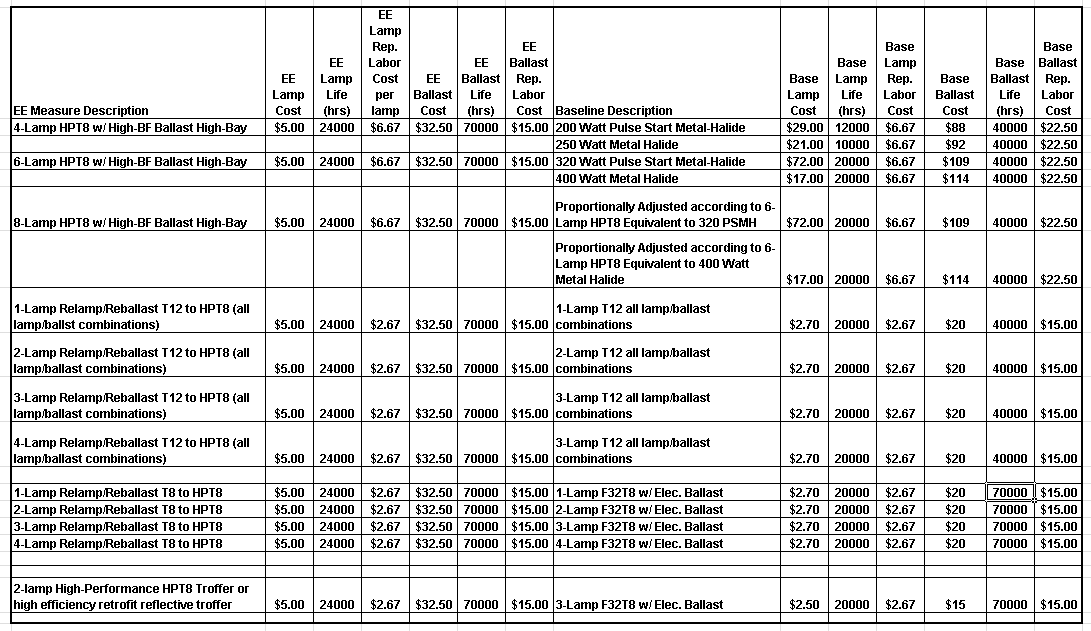
A– 3: RWT8 New and Baseline Assumptions



B-1: Time of Sale T8 Component Costs and Lifetime[[11]](#footnote-11)



B-2: T8 Retrofit Component Costs and Lifetime[[12]](#footnote-12)



B-3: Reduced Wattage T8 Component Costs and Lifetime[[13]](#footnote-13)



C-1: T12 Baseline Adjustment:

For measures installed up to 6/1/2018, the full savings (as calculated above in the Algorithm section) will be claimed up to 6/1/2018.  A savings adjustment will be applied to the annual savings for the remainder of the measure life.  The adjustment to be applied for each measure is listed in the reference table below.

|  |  |  |  |
| --- | --- | --- | --- |
| Savings Adjustment Factors |  |  |  |
| **EE Measure Description** | **Savings Adjustment T12 EEmag ballast and 34 w lamps to HPT8** | **Savings Adjustment T12 EEmag ballast and 40 w lamps to HPT8** | **Savings Adjustment T12 mag ballast and 40 w lamps to HPT8** |
| 1-Lamp Relamp/Reballast T12 to HPT8 | 47% | 30% | 20% |
| 2-Lamp Relamp/Reballast T12 to HPT8 | 53% | 30% | 22% |
| 3-Lamp Relamp/Reballast T12 to HPT8 | 42% | 38% | 21% |
| 4-Lamp Relamp/Reballast T12 to HPT8 | 44% | 29% | 23% |

Measures installed in 2016 will claim full savings for two years and 2017 for one year,.  Savings adjustment factors will be applied to the full savings for savings starting in 6/1/2018 and for the remainder of the measure life.  The savings adjustment is equal to the ratio between wattage reduction from T8 baseline to HPT8 and wattage reduction from T12 EE ballast with 40 w lamp baseline from the table ‘T8 New and Baseline Assumptions’.[[14]](#footnote-14)

Example: 2 lamp T8 to 2 lamp HPT8 retrofit saves 10 watts, while the T12 EE with 40 w lamp to HPT8 saves 33 watts. Thus the ratio of wattage reduced is 30%. Thus the ratio of wattage reduced is 30%.

**Measure Code: CI-LTG-T8FX-V05-160601**

1. Based on weighted average of Final ComEd’s BILD program data from PY5 and PY6. For Residential installations, hours of use assumptions from ‘5.5 Interior Hardwired Compact Fluorescent Lamp (CFL) Fixture’ measure should be used. [↑](#footnote-ref-1)
2. 15 years from GDS Measure Life Report, June 2007 [↑](#footnote-ref-2)
3. ibid [↑](#footnote-ref-3)
4. 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-4)
5. 1st year in service rate is based upon review of PY5-6 evaluations from ComEd’s commercial lighting program (BILD) (see ‘IL Commercial Lighting ISR\_2014.xls’ for more information [↑](#footnote-ref-5)
6. The 98% Lifetime ISR 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-6)
7. Negative value because this is an increase in heating consumption due to the efficient lighting. [↑](#footnote-ref-7)
8. Negative value because this is an increase in heating consumption due to the efficient lighting. [↑](#footnote-ref-8)
9. Adapted from Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, October 26, 2011. [↑](#footnote-ref-9)
10. Adapted from Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, October 26, 2011. [↑](#footnote-ref-10)
11. Ibid. [↑](#footnote-ref-11)
12. Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, January 2012. [↑](#footnote-ref-12)
13. Adapted from EVT Technical Resource Manual, 2012-75, page 85. [↑](#footnote-ref-13)
14. Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, October 26, 2011

    EPE Program Downloads. Web accessed [http://www.epelectricefficiency.com/downloads.asp?section=ci](http://www.eia.gov/consumption/residential/data/2009/xls/HC7.9%20Air%20Conditioning%20in%20Midwest%20Region.xls?section=ci) download Copy of LSF\_2012\_v4.04\_250rows.xls.

    Kuiken et al, Focus on Energy Evaluation. Business Programs: Deemed Savings Manual v1.0, Kema, march 22, 2010 available at [http://www.focusonenergy.com/files/Document\_Management\_System/Evaluation/bpdeemedsavingsmanuav10\_evaluationreport.pdf](http://www.deeresources.com) Based on ComEd’s BILD program data from PY4 and PY5. 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-14)