Guidehouse

# ComEd Residential Lighting Discounts Program Impact Evaluation Report

## Energy Efficiency / Demand Response Plan: Program Year 2019 (CY2019) (1/1/2019-12/31/2019)

**Presented to**
**ComEd**

**FINAL**

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# ComEd Residential Lighting Discounts Impact Evaluation Report

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# 1. Introduction

This report presents the results of the impact evaluation of ComEd's CY2019 Residential Lighting Discounts Program. It includes a summary of the energy and demand impacts for the total program broken out by relevant measure and program structure details. The appendix provides the impact analysis methodology and details of the Total Resource Cost inputs. CY2019 covers January 1, 2019 through December 31, 2019.

# 2. Program Description

The primary goal of the Residential Lighting Discounts Program is to increase the market penetration of energy-efficient lighting within ComEd's service territory by providing incentives for bulbs purchased through various retail channels. The program also seeks to increase customer awareness and acceptance of energy-efficient lighting technologies through the distribution of educational materials. In CY2019, the Residential Lighting Discounts Program offered incentives for the purchase of reflector and specialty LED lamps, as well as LED fixtures and retrofit kits. Starting in CY2019, the program no longer incentivizes omni-directional LEDs, however, some CY2018 omni-directional LED sales were not invoiced until 2019. As a result, omni-directional LEDs are included as a distinct measure group in CY2019.

The CY2019 Residential Lighting Discounts Program incentivized over 4.65 million high efficiency LED lamps and fixtures. This included 570,619 omni-directional LEDs,[1] 1,781,459 directional LEDs, 1,296,725 specialty LEDs, and 1,004,484 LED fixtures and retrofit kits as shown in the following table and figure. While not all of these bulbs were installed in CY2019 (the TRM[2] deems installation rates for years one, two and three years after purchase), the overall quantity of bulbs estimated to be installed in ComEd Territory during CY2019 was 5,249,739. This quantity includes delayed installations of bulbs sold in PY9 and CY2018 (carryover). Table 2-1 provides the volume of carryover bulbs estimated to have been installed in CY2019 from program sales in PY9 and CY2018 and a preliminary estimate of carryover bulb savings that will be counted in CY2020 and CY2021 from CY2019 sales. The derivation of the CY2020 and CY2021 carryover savings estimates are provided in Section 7.3.

**Table 2-1. CY2019 Volumetric Findings Detail**

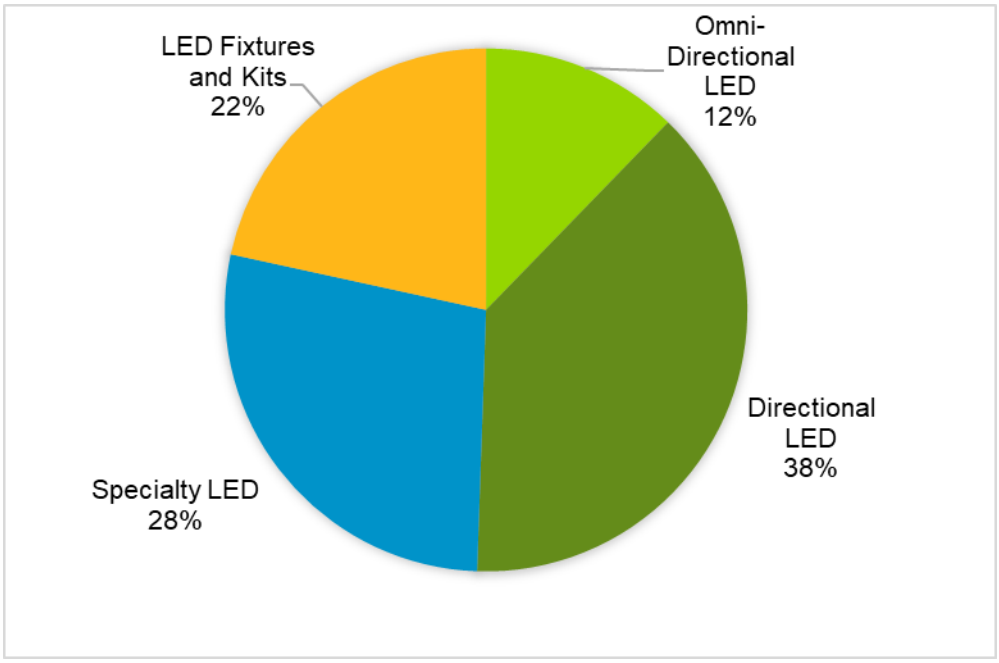
| Participation | Total | Standard CFLs | Omni-Directional LEDs | Directional LEDs | Specialty LEDs | LED Fixtures and Kits |
|---|---|---|---|---|---|---|
| CY2019 Incentivized Bulbs | 4,653,287 | 0 | 570,619 | 1,781,459 | 1,296,725 | 1,004,484 |
| CY2019 1st Year Installed Bulbs | 4,330,406 | 0 | 510,382 | 1,634,271 | 1,189,587 | 996,166 |
| PY9 Carryover – CY2019 Installs | 530,726 | 300,250 | 165,007 | 45,871 | 19,249 | 349 |
| CY2018 Carryover – CY2019 Installs | 388,607 | 0 | 323,336 | 44,587 | 20,278 | 407 |
| Total Installed Bulbs in CY2019 | 5,249,739 | 300,250 | 998,724 | 1,724,729 | 1,229,113 | 996,922 |
| CY2018 Carryover – CY2020 Installs | 336,768 | 0 | 278,872 | 39,680 | 17,808 | 407 |
| CY2019 Carryover – CY2020 Installs | 97,154 | 0 | 24,006 | 42,443 | 30,343 | 362 |
| CY2019 Carryover – CY2021 Installs | 84,793 | 0 | 20,685 | 37,099 | 26,648 | 362 |

*Source: ComEd tracking data and evaluation team analysis*

[1] CY2019 omni-directional LED lamps are residual sales from the CY2018 program that were invoiced in CY2019 and thus were excluded from the CY2018 impact reporting. As a result, these omni-directional LED lamps are counted towards CY2019 impacts.

[2] TRM is the State of Illinois Technical Reference Manual version 7.0 from http://www.ilsag.info/technical-reference-manual.html.

**Figure 2-1. Distribution of CY2019 Measures Incentivized by Type**




*Source: ComEd tracking data and evaluation team analysis*

## 3. Program Savings Detail

Table 3-1 summarizes the incremental energy and demand savings for the Residential Lighting Discounts Program achieved in CY2019 from CY2019 first year savings and carryover savings from PY9 and CY2018 purchases installed in CY 2019. There are no gas savings associated with this program.

**Table 3-1. CY2019 Total Annual Incremental Electric Savings**

| Savings Category | Energy Savings (kWh) | Non-Coincident Demand Savings (kW) | Summer Peak* Demand Savings (kW) |
|---|---|---|---|
| Electricity | | | |
| Ex Ante Gross Savings | 246,991,886 | NR | NR |
| Program Gross Realization Rate | 0.99 | NA | NA |
| Verified Gross Savings | 245,361,396 | 209,396 | 32,877 |
| Program Net-to-Gross Ratio (NTG) | Varies | Varies | Varies |
| PY9 and CY2018 Net Carryover Savings | 22,466,113 | 18,965 | 2,791 |
| Verified Net Savings | 173,374,006 | 148,097 | 23,041 |
| Converted from Gas | | | |
| Ex Ante Gross Savings | NA | NA | NA |
| Program Gross Realization Rate | NA | NA | NA |
| Verified Gross Savings | NA | NA | NA |
| Program Net-to-Gross Ratio (NTG) | NA | NA | NA |
| PY9 and CY2018 Net Carryover Savings | NA | NA | NA |
| Verified Net Savings | NA | NA | NA |
| Total Electric Plus Gas | | | |
| Ex Ante Gross Savings | 246,991,886 | NR | NR |
| Program Gross Realization Rate | 0.99 | NA | NA |
| Verified Gross Savings | 245,361,396 | 209,396 | 32,877 |
| Program Net-to-Gross Ratio (NTG) | Varies | Varies | Varies |
| PY9 and CY2018 Net Carryover Savings | 22,466,113 | 18,965 | 2,791 |
| Verified Net Savings | 173,374,006 | 148,097 | 23,041 |

NR = Not reported (refers to a piece of data that was not reported, i.e., non-coincident demand savings)
NA = Not applicable (refers to a piece of data that cannot be produced or does not apply)
* The coincident summer peak period is defined as 1:00-5:00 p.m. Central Prevailing Time on non-holiday weekdays, June through August.
† The Winter Peak Period is defined by PJM as the period from 6-8 a.m. and 5-7 p.m., Central Time Zone, between January 1 and February 28.
*Source: ComEd tracking data and evaluation team analysis*

## 4. Cumulative Persisting Annual Savings

Table 4-1 and Figure 4-1 show the measure-specific and total verified gross savings for the Residential Lighting Discount Program and the cumulative persisting annual savings (CPAS) for the measures installed in CY2019. The electric and total CPAS across all measures installed in 2019 is 173,374,006 kWh (Table 4-1). The “historic” rows in each table are the CPAS contribution back to CY2018.

## Table 4-1. Cumulative Persisting Annual Savings (CPAS) – Electric and Total

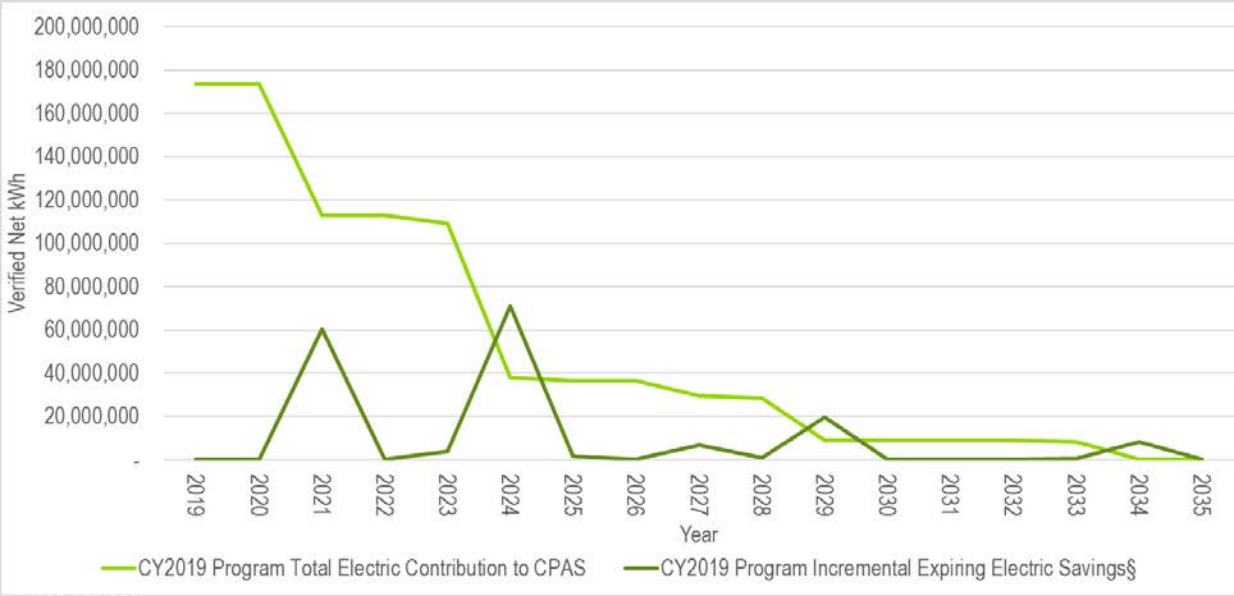
| End Use Type | Research Category | EUL | CY2019 Verified Gross Savings (kWh) | NTG* | Lifetime Net Savings (kWh)† | Verified Net kWh Savings 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lighting | Omni-Directional LED (Residential) | 10.0 | 18,708,972 | 0.67 | 60,666,762 | | 12,535,011 | 12,535,011 | 4,449,593 | 4,449,593 | 4,449,593 | 4,449,593 | 4,449,593 | 4,449,593 |
| Lighting | Omni-Directional LED (Non-Residential) | 4.7 | 1,968,001 | 0.67 | 3,799,414 | | 1,318,561 | 1,318,561 | 468,054 | 468,054 | 226,185 | | | |
| Lighting | Directional LED (Residential) | 10.0 | 87,172,268 | 0.61 | 320,558,454 | | 53,175,084 | 53,175,084 | 53,175,084 | 53,175,084 | 53,175,084 | 10,936,607 | 10,936,607 | 10,936,607 |
| Lighting | Directional LED (Non-Residential) | 5.8 | 16,628,068 | 0.61 | 52,319,014 | | 10,143,121 | 10,143,121 | 10,143,121 | 10,143,121 | 10,143,121 | 1,603,407 | | |
| Lighting | Specialty LED (Residential) | 10.0 | 43,527,346 | 0.53 | 137,414,169 | | 23,069,493 | 23,069,493 | 23,069,493 | 23,069,493 | 23,069,493 | 4,413,341 | 4,413,341 | 4,413,341 |
| Lighting | Specialty LED (Non-Residential) | 4.3 | 8,302,820 | 0.53 | 19,100,031 | | 4,400,495 | 4,400,495 | 4,400,495 | 4,400,495 | 1,498,052 | | | |
| Lighting | LED Fixtures and Kits (Residential) | 15.0 | 63,112,141 | 0.67 | 189,429,522 | | 42,285,134 | 42,285,134 | 8,066,096 | 8,066,096 | 8,066,096 | 8,066,096 | 8,066,096 | 8,066,096 |
| Lighting | LED Fixtures and Kits (Non-Residential) | 14.2 | 5,941,781 | 0.67 | 17,260,108 | | 3,980,993 | 3,980,993 | 760,989 | 760,989 | 760,989 | 760,989 | 760,989 | 760,989 |
| Lighting | Carryover (Residential) | 8.2 | 34,876,629 | 0.58 | 88,450,228 | | 20,280,714 | 20,280,714 | 7,772,801 | 7,772,801 | 7,772,801 | 7,871,516 | 7,871,516 | 7,871,516 |
| Lighting | Carryover (Non-Residential) | 3.8 | 3,729,264 | 0.59 | 5,622,459 | | 2,185,400 | 2,185,400 | 702,272 | 549,387 | | | | |
| CY2019 Program Total Electric Contribution to CPAS | | | 283,967,289 | | 894,620,160 | | 173,374,006 | 173,374,006 | 113,007,998 | 112,855,112 | 109,161,414 | 38,101,548 | 36,498,142 | 36,498,142 |
| Historic Program Total Electric Contribution to CPAS‡ | | | | | | 301,534,004 | 301,534,004 | 301,534,004 | 176,209,185 | 168,972,262 | 157,383,937 | 147,675,707 | 146,460,578 | 146,460,578 |
| Program Total Electric CPAS | | | | | | 301,534,004 | 474,908,010 | 474,908,010 | 289,217,183 | 281,827,374 | 266,545,351 | 185,777,255 | 182,958,720 | 182,958,720 |
| CY2019 Program Incremental Expiring Electric Savings§ | | | | | | | | - | 60,366,008 | 152,886 | 3,693,698 | 71,059,866 | 1,603,407 | - |
| Historic Program Incremental Expiring Electric Savings‡§ | | | | | | | - | - | 125,324,819 | 7,236,923 | 11,588,325 | 9,708,230 | 1,215,129 | - |
| Program Total Incremental Expiring Electric Savings§ | | | | | | | - | - | 185,690,827 | 7,389,809 | 15,282,023 | 80,768,096 | 2,818,536 | - |

| End Use Type | Research Category | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lighting | Omni-Directional LED (Residential) | 4,449,593 | 4,449,593 | | | | | | | | | | |
| Lighting | Omni-Directional LED (Non-Residential) | | | | | | | | | | | | |
| Lighting | Directional LED (Residential) | 10,936,607 | 10,936,607 | | | | | | | | | | |
| Lighting | Directional LED (Non-Residential) | | | | | | | | | | | | |
| Lighting | Specialty LED (Residential) | 4,413,341 | 4,413,341 | | | | | | | | | | |
| Lighting | Specialty LED (Non-Residential) | | | | | | | | | | | | |
| Lighting | LED Fixtures and Kits (Residential) | 8,066,096 | 8,066,096 | 8,066,096 | 8,066,096 | 8,066,096 | 8,066,096 | 8,066,096 | | | | | |
| Lighting | LED Fixtures and Kits (Non-Residential) | 760,989 | 760,989 | 760,989 | 760,989 | 760,989 | 760,989 | 166,255 | | | | | |
| Lighting | Carryover (Residential) | 955,850 | | | | | | | | | | | |
| Lighting | Carryover (Non-Residential) | | | | | | | | | | | | |
| CY2019 Program Total Electric Contribution to CPAS | | 29,582,476 | 28,626,625 | 8,827,085 | 8,827,085 | 8,827,085 | 8,827,085 | 8,232,351 | - | - | - | - | - |
| Historic Program Total Electric Contribution to CPAS‡ | | 146,460,578 | 34,061,690 | 34,061,690 | 34,061,690 | 32,925,721 | 28,749,940 | - | - | - | - | - | - |
| Program Total Electric CPAS | | 176,043,054 | 62,688,315 | 42,888,775 | 42,888,775 | 41,752,806 | 37,577,025 | 8,232,351 | - | - | - | - | - |
| CY2019 Program Incremental Expiring Electric Savings§ | | 6,915,666 | 955,850 | 19,799,540 | - | - | - | 594,734 | 8,232,351 | - | - | - | - |
| Historic Program Incremental Expiring Electric Savings‡§ | | - | 112,398,888 | - | - | 1,135,969 | 4,175,781 | 28,749,940 | - | - | - | - | - |
| Program Total Incremental Expiring Electric Savings§ | | 6,915,666 | 113,354,738 | 19,799,540 | - | 1,135,969 | 4,175,781 | 29,344,674 | 8,232,351 | - | - | - | - |

Note: The green highlighted cell shows program total first year electric savings (including direct electric savings and those converted from gas). The gray cells are blank, indicating no values or do not contribute to calculating CPAS in CY2019.

* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
† Lifetime savings are the sum of CPAS savings through the EUL.
‡ Historic savings go back to CY2018.
§ Incremental expiring savings are equal to CPAS $Y_{n-1}$ - CPAS $Y_n$
*Source: Evaluation team analysis*

**Figure 4-1. Cumulative Persisting Annual Savings – Electric and Total**



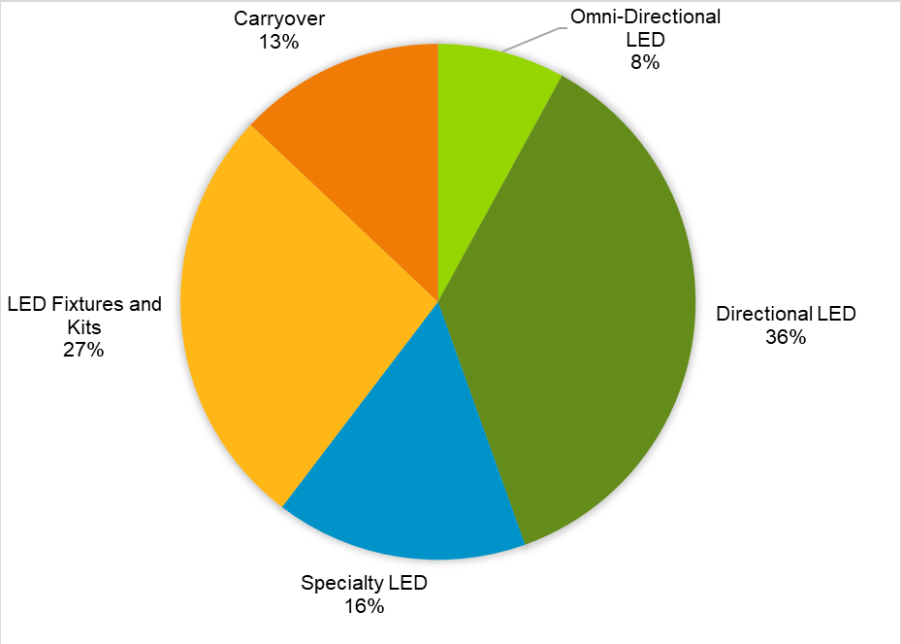

* Expiring savings are equal to CPAS $Y_{n-1}$ - CPAS $Y_n$.
*Source: Evaluation team analysis*

## 5. Program Savings by Measure

The Residential Lighting Discounts Program includes five distinct lighting measure groups as shown in the following tables. These groups include omni-directional LEDs, directional LEDs (BR, R, MR, and PAR reflector lamps), specialty LEDs (globe, candelabra, and 3-way lamps), LED fixtures and retrofit kits, and carryover lamps (CFL and LED lamps and fixtures purchased in PY9 and CY2018 but not installed until CY2019). In CY2019, directional LEDs made up the largest share of program net electric energy savings as seen in Figure 5-1 below.

Table 5-1 to Table 5-4 below provide the CY2019 energy savings estimates (electric only, non-coincident demand, summer peak, winter peak, and overall) by measure group. All five of the measure groups are broken out by residential and non-residential sector to show where the savings are expected to be realized.

**Figure 5-1. Verified Net Savings by Measure – Electric**




*Source: ComEd tracking data and evaluation team analysis*

As seen in Figure 5-1 below, the verified gross realization rate for energy savings was 1.15 for the overall program, however, this includes verified gross carryover savings and does not include gross ex ante carryover savings in program savings totals. The gross realization rate, excluding gross verified carryover savings is 0.99, as shown in Table 3-1 above. Realization rates for measures at the sector level and lamp category level were not equal to 1.00 in all cases. In general, there were two main contributors as to why ex ante savings did not align with verified savings at this level. These included inconsistent lumen mappings of baseline wattages with the TRM v7 and the application of incorrect residential and non-residential splits for omni-directional LED lamps and LED Fixtures and retrofit kits. Further details on these discrepancies can be found in Section 6.2.

### Table 5-1. CY2019 Energy Savings by Measure – Electric

| End Use Type | Research Category | Ex Ante Gross Savings (kWh) | Verified Gross Realization Rate | Verified Gross Savings (kWh) | NTG* | Verified Net Savings (kWh) | EUL (years) |
|---|---|---|---|---|---|---|---|
| Lighting | Omni-Directional LED (Residential) | 20,210,470 | 0.93 | 18,708,972 | 0.67 | 12,535,011 | 10.0 |
| Lighting | Omni-Directional LED (Non-Residential) | 3,617,835 | 0.54 | 1,968,001 | 0.67 | 1,318,561 | 4.7 |
| Lighting | Directional LED (Residential) | 82,862,442 | 1.05 | 87,172,268 | 0.61 | 53,175,084 | 10.0 |
| Lighting | Directional LED (Non-Residential) | 15,805,971 | 1.05 | 16,628,068 | 0.61 | 10,143,121 | 5.8 |
| Lighting | Specialty LED (Residential) | 45,050,637 | 0.97 | 43,527,346 | 0.53 | 23,069,493 | 10.0 |
| Lighting | Specialty LED (Non-Residential) | 8,593,387 | 0.97 | 8,302,820 | 0.53 | 4,400,495 | 4.3 |
| Lighting | LED Fixtures and Kits (Residential) | 61,028,906 | 1.03 | 63,112,141 | 0.67 | 42,285,134 | 15.0 |
| Lighting | LED Fixtures and Kits (Non-Residential) | 9,822,238 | 0.60 | 5,941,781 | 0.67 | 3,980,993 | 14.2 |
| Lighting | Carryover (Residential) | NA | NA | 34,876,629 | 0.58 | 20,280,714 | 8.2 |
| Lighting | Carryover (Non-Residential) | NA | NA | 3,729,264 | 0.59 | 2,185,400 | 3.8 |
| Lighting | Total | 246,991,886 | 1.15** | 283,967,289 | NA | 173,374,006 | NA |

NA = Not applicable
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
** The overall program realization rate does not include ex ante carryover savings and includes verified gross carryover savings in program savings totals. The overall program realization rate excluding verified carryover savings is 0.99.
Note: The savings in this table includes secondary electric energy (kWh) savings from water supply and wastewater treatment plants for measures claimed by ComEd.
*Source: ComEd tracking data and evaluation team analysis*

### Table 5-2. CY2019 Non-Coincident Demand Savings by Measure

| End Use Type | Research Category | Ex Ante Gross Non-Coincident Demand Reduction (kW) | Verified Gross Realization Rate | Verified Gross Non-Coincident Demand Reduction (kW) | NTG* | Verified Net Non-Coincident Demand Reduction (kW) |
|---|---|---|---|---|---|---|
| Lighting | Omni-Directional LED (Residential) | NR | NA | 15,359 | 0.67 | 10,291 |
| Lighting | Omni-Directional LED (Non-Residential) | NR | NA | 500 | 0.67 | 335 |
| Lighting | Directional LED (Residential) | NR | NA | 81,705 | 0.61 | 49,840 |
| Lighting | Directional LED (Non-Residential) | NR | NA | 4,223 | 0.61 | 2,576 |
| Lighting | Specialty LED (Residential) | NR | NA | 40,797 | 0.53 | 21,623 |
| Lighting | Specialty LED (Non-Residential) | NR | NA | 2,109 | 0.53 | 1,118 |
| Lighting | LED Fixtures and Kits (Residential) | NR | NA | 63,093 | 0.67 | 42,272 |
| Lighting | LED Fixtures and Kits (Non-Residential) | NR | NA | 1,610 | 0.67 | 1,079 |
| Lighting | Carryover (Residential) | NR | NA | 31,677 | 0.58 | 18,408 |
| Lighting | Carryover (Non-Residential) | NR | NA | 950 | 0.59 | 557 |
| Lighting | Total | NR | NA | 242,022 | NA | 148,097 |

NA = Not applicable
NR = Not reported
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
*Source: ComEd tracking data and evaluation team analysis*

**Table 5-3. CY2019 Summer Peak Demand Savings by Measure**

| End Use Type | Research Category | Ex Ante Gross Peak Demand Reduction (kW) | Verified Gross Realization Rate | Verified Gross Peak Demand Reduction (kW) | NTG* | Verified Net Peak Demand Reduction (kW) |
|---|---|---|---|---|---|---|
| Lighting | Omni-Directional LED (Residential) | NR | NA | 2,266 | 0.67 | 1,518 |
| Lighting | Omni-Directional LED (Non-Residential) | NR | NA | 394 | 0.67 | 264 |
| Lighting | Directional LED (Residential) | NR | NA | 10,353 | 0.61 | 6,315 |
| Lighting | Directional LED (Non-Residential) | NR | NA | 3,331 | 0.61 | 2,032 |
| Lighting | Specialty LED (Residential) | NR | NA | 5,169 | 0.53 | 2,740 |
| Lighting | Specialty LED (Non-Residential) | NR | NA | 1,663 | 0.53 | 882 |
| Lighting | LED Fixtures and Kits(Residential) | NR | NA | 8,446 | 0.67 | 5,659 |
| Lighting | LED Fixtures and Kits (Non-Residential) | NR | NA | 1,254 | 0.67 | 840 |
| Lighting | Carryover (Residential) | NR | NA | 4,045 | 0.58 | 2,354 |
| Lighting | Carryover (Non-Residential) | NR | NA | 746 | 0.59 | 437 |
| Lighting | Total | NR | NA | 37,668 | NA | 23,041 |

NA = Not applicable
NR = Not reported
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
*Source: ComEd tracking data and evaluation team analysis*

**Table 5-4. CY2019 Winter Peak Demand Savings by Measure**

| End Use Type | Research Category | Ex Ante Gross Winter Peak Demand Reduction (kW) | Verified Gross Realization Rate | Verified Gross Winter Peak Demand Reduction (kW) | NTG* | Verified Net Winter Peak Demand Reduction (kW) |
|---|---|---|---|---|---|---|
| Lighting | Omni-Directional LED (Residential) | NR | NA | 1,782 | 0.67 | 1,194 |
| Lighting | Omni-Directional LED (Non-Residential) | NR | NA | 275 | 0.67 | 184 |
| Lighting | Directional LED (Residential) | NR | NA | 14,135 | 0.61 | 8,622 |
| Lighting | Directional LED (Non-Residential) | NR | NA | 2,323 | 0.61 | 1,417 |
| Lighting | Specialty LED (Residential) | NR | NA | 6,838 | 0.53 | 3,624 |
| Lighting | Specialty LED (Non-Residential) | NR | NA | 1,160 | 0.53 | 615 |
| Lighting | LED Fixtures and Kits(Residential) | NR | NA | 8,454 | 0.67 | 5,665 |
| Lighting | LED Fixtures and Kits (Non-Residential) | NR | NA | 874 | 0.67 | 586 |
| Lighting | Carryover (Residential) | NR | NA | 3,784 | 0.58 | 2,201 |
| Lighting | Carryover (Non-Residential) | NR | NA | 459 | 0.59 | 269 |
| Lighting | Total | NR | NA | 40,084 | NA | 24,377 |

NA = Not applicable
NR = Not reported
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
*Source: ComEd tracking data and evaluation team analysis*

# 6. Impact Analysis Findings and Recommendations

## 6.1 Impact Parameter Estimates

Energy and demand savings for LED lamps and fixtures sold through the program are estimated using the following formula as specified in the TRM:

**Verified Gross Annual ΔkWh** = ResSplit * Res ΔkWh + NonResSplit * NonRes ΔkWh
**Where:**

- **Res ΔkWh =** Bulbs * DeltaWatts/1000 * $ISR_r$ * (1-Leakage) * $HOU_r$ * $WHFe_r$
- **NonRes ΔkWh =** Bulbs * DeltaWatts/1000 * $ISR_{nr}$ * (1-Leakage) * $HOU_{nr}$* $WHFe_{nr}$
- **Verified Gross Annual ΔkW** = Delta Watts/1000 * ISR * (1-Leakage)
- **Verified Gross Annual Summer Peak ΔkW** = Gross Annual ΔkW * Summer Peak CF * WHFd
- **Verified Gross Annual Winter Peak ΔkW** = Gross Annual ΔkW * Winter Peak CF

**Where:**

- **Res/NonRes Split** = Percentage of program bulbs installed in residential and non-residential locations. Deemed within TRM v7.
- **Bulbs** = Quantity of bulbs sold through the CY2019 program, based on program tracking data.
- **Delta Watts** = Difference in wattage between the baseline bulb (WattsBase) and the efficient program bulb (WattsEE):
  - WattsBase = Baseline bulb wattage, mapping deemed in TRM v7.
  - WattsEE = Wattage of efficient program bulb, based on program tracking data.
- **$ISR_{r(nr)}$ =** First-year installation rate (residential or non-residential), deemed in TRM v7.
- **Leakage** = Percentage of program bulbs installed outside of ComEd service territory, deemed in Illinois TRM v7.
- **$HOU_{r(nr)}$** = Annual hours-of-use (residential/non-residential), deemed in TRM v7.
- **$WHFe_{r(nr)}$** = Waste heat factor – Energy (residential/non-residential), deemed in TRM v7.
- **$WHFd_{r(nr)}$** = Waste heat factor – Demand (residential/non-residential), deemed in TRM v7.
- **Summer Peak CF** = Peak load coincidence factor, the percentage of program bulbs turned on during summer peak hours (weekdays from 1 to 5 p.m.).
- **Winter Peak CF** = Peak load coincidence factor, the percentage of program bulbs turned on during the PJM Winter Peak hours.[3]

The source of the verified first-year gross and net savings parameters are shown in the table below. The sources of the parameters used to calculate the second- and third-year carryover are presented in the carryover section (Section 7.3). The lifetime energy and demand savings are estimated by multiplying the verified savings by the effective useful life for each measure.[4]

[3] The Winter Peak Period is defined by PJM as the period from 6-8 a.m. and 5-7 p.m., Central Time Zone, between January 1 and February 28.

[4] Standard LED Lamps receive baseline adjustments in lifetime savings starting 2021 to account for the implementation of the EISA efficiency standards for these measures. Specialty and Reflector Lamps also receive an EISA baseline adjustment in 2024

**Table 6-1. CY2019 Savings Parameters**

| Gross Savings Input Parameters | Deemed * or Evaluated? | Source |
|---|---|---|
| Program Bulbs | Evaluated | CY2019 Program Tracking Data |
| Delta Watts | Deemed | TRM v7 |
| Installation Rate | Deemed | TRM v7 |
| Leakage | Evaluated | TRM v7 |
| Res / Non-Res Split | Deemed | TRM v7 |
| Hours of Use (HOU) | Deemed | TRM v7 |
| Summer Peak Coincidence Factor (CF) | Deemed | TRM v7 |
| Winter Peak Coincidence Factor (CF) | Evaluated | Memo to ComEd |
| Waste Heat Factor (Energy) | Deemed | TRM v7 |
| Waste Heat Factor (Demand) | Deemed | TRM v7 |
| NTG | Deemed | SAG Consensus |

* TRM is the State of Illinois Technical Reference Manual version 7.0 from http://www.ilsag.info/technical-reference-manual.html. The NTG values can be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.

## 6.2 Other Impact Findings and Recommendations

The evaluation team developed several recommendations based on findings from the CY2019 evaluation.

**Finding 1.** The ex ante tracking data currently does not provide an estimate for peak demand savings for lighting measures.

**Recommendation 1.** Peak demand savings should be calculated per the current version of the TRM and included in the program tracking data.

**Finding 2.** An incorrect residential and non-residential split (Res/NonRes split) was applied for a subset of measure groups. The ex ante gross savings estimates utilized a Res/NonRes split of 95%/5% for all measures. However, a Res/NonRes split of 97%3% was applied by the evaluation team for omni-directional LED lamps, retrofit kits, and LED fixtures in accordance with the TRM v7.

**Recommendation 2.** The current version of the TRM (v7) should be used to apply the residential and non-residential splits to program sales.

**Finding 3.** The evaluation team found delta wattage discrepancies for 5,547 omni-directional, 42,617 directional, 17,831 specialty LEDs, and 7,239 LED fixture and retrofit kits.

**Recommendation 3.** The current version of the TRM (v7) should be used to apply the lumen mapping and generate the baseline wattages used to calculate the measure level delta wattage values used to estimate program savings.

# 7. Appendix 1. Impact Analysis Methodology

## 7.1 Verified Gross Program Savings Analysis Approach Estimates

For CY2019, the evaluation team calculated verified savings for omni-directional LEDs, directional LEDs, specialty LEDs, LED fixtures. The data used to estimate the verified gross program savings came from the CY2019 program tracking data,[5] and the ITRM v7.

## 7.2 Verified Net Program Savings Analysis Approach

Verified net energy and demand (coincident peak and overall) savings are calculated by multiplying the verified gross savings estimates by a net-to-gross (NTG) ratio. For the CY2019 Residential Lighting Discounts Program, the NTG ratio estimates are 0.67 for omni-directional LEDs and LED fixtures and kits, 0.61 for directional LEDs and 0.53 specialty LEDs. These NTG ratio estimates are based on past evaluation research and approved through the Illinois Stakeholder Advisory Group (SAG) consensus process.

## 7.3 Carryover Savings Estimation

### *7.3.1 CY2019 Carryover Savings*

The evaluation team calculated the CY2019 carryover savings estimates using the TRM (v5, v6, and v7) and the PY9 and CY2018 Impact Evaluation Reports. The energy and demand savings from third year (PY9) and second year (CY2018) installations are calculated based on the following parameters:

- Delta Watts – Verified savings estimate from the year of installation (source: TRM v7)
- Residential/Non-Residential Split – Evaluation research from the year of purchase (PY9 and CY2018 Reports)
- HOU and Peak CF – Verified savings estimate from the year of installation (source: TRM v7)
- Energy and Demand IE – Verified savings estimate from the year of installation (source TRM v7)
- Installation Rate – Verified savings estimate from the year of purchase (source: TRM v5 and Illinois TRM v6)
- NTG – Evaluation research from the year of purchase (source: PY9 and CY2018 Reports)
- EUL – The deemed measure life from the year of installation (source: TRM v7)

Table 7-1 shows that in CY2019 a total of 919,333 bulbs, purchased during PY9 and CY2018 are expected to be installed within ComEd's service territory. The table below provides both the gross and net energy and demand savings from these carryover bulbs attributable to the CY2019 program. Total CY2019 net carryover savings are estimated to be 22,466,133 kWh, 18,965 kW, 2,791 Summer Peak kW, and 2,471 Winter Peak kW.

[5] The Evaluation Team received the final CY2019 tracking data on January 22, 2020: RLD_CY2019_EOY_Data_Rev1_01222020.xlsx.

**Table 7-1. CY2019 Carryover Savings**

| CY2019 Carryover Savings | PY9 Bulbs | CY2018 Bulbs | Total CY2019 Carryover |
|---|---|---|---|
| Carryover Bulbs Installed During CY2019 | 530,726 | 388,607 | 919,333 |
| Average Delta Watts | 34.6 | 38.4 | NA |
| Average Daily Hours of Use | 2.92 | 2.78 | NA |
| Summer Peak Load Coincidence Factor | 0.120 | 0.419 | NA |
| Winter Peak Load Coincidence Factor | 0.132 | 0.133 | NA |
| Energy Interactive Effects | 1.06 | 1.06 | NA |
| Demand Interactive Effects | 1.11 | 1.12 | NA |
| Gross kWh Impact Per Unit | 38.6 | 46.4 | NA |
| Gross kW Impact Per Unit | 0.034 | 0.038 | NA |
| Carryover Gross Energy Savings (kWh) | 20,516,659 | 18,089,233 | 38,605,892 |
| Carryover Gross Demand Savings (kW) | 18,001 | 14,626 | 32,626 |
| Carryover Gross Summer Peak Demand Savings (kW) | 2,523 | 2,268 | 4,791 |
| Carryover Gross Winter Peak Demand Savings (kW) | 2,392 | 1,852 | 4,243 |
| Net-to-Gross Ratio | 0.58 | 0.58 | NA |
| Carryover Net Energy Savings (kWh) | 11,889,370 | 10,576,743 | 22,466,113 |
| Carryover Net Demand Savings (kW) | 10,416 | 8,549 | 18,965 |
| Carryover Net Summer Peak Demand Savings (kW) | 1,463 | 1,327 | 2,791 |
| Carryover Net Winter Peak Demand Savings (kW) | 1,386 | 1,085 | 2,471 |
| EUL Res | 6.5 | 10.0 | 8.2 |
| EUL NonRes | 3.5 | 4.5 | 3.8 |

NA = Not applicable
NR = Not reported
*Source: ComEd tracking data and evaluation team analysis.*

### *7.3.2 CY2020 Preliminary Carryover Savings*

The evaluation team calculated a preliminary CY2020 carryover estimate using the TRM (v6, v7, and v8) and the CY2018 and CY2019 Impact Evaluation Reports. The energy and demand savings from these CY2018 third year and CY2019 second year installations are calculated based on the following parameters:

- Delta Watts – Verified savings estimate from the year of installation (source: TRM v8)
- Residential/Non-Residential Split – Verified savings from the year of purchase (source: TRM v6 and v7)
- HOU and Peak CF – Verified savings estimate from the year of installation (source: TRM v8)
- Energy and Demand IE – Verified savings estimate from the year of installation (source: TRM v8)
- Installation Rate – Verified savings estimate from the year of purchase (source: TRM v6 and v7)
- NTG – The deemed net-to-gross values from the year of purchase.
- EUL – The deemed measure life from the year of installation (source: TRM v8)

Table 7-2 shows that in CY2020 a total of 433,922 bulbs that were purchased in CY2018 or CY2019 are expected to be installed within ComEd's service territory. The table below provides both the gross and net energy and demand savings from these bulbs. Total **preliminary** net energy savings estimate is expected to be 12,195,201 kWh, 9,848 kW, 1,573 Summer Peak kW, and 1,346 Winter Peak kW.

**Table 7-2. CY2020 Preliminary Carryover Savings Estimates from CY2018 and CY2019 Bulb Sales**

| Preliminary CY2020 Carryover Savings | CY2018 Bulbs | CY2019 Bulbs | Total CY2020 Carryover |
|---|---|---|---|
| Carryover Bulbs Installed During CY2020 | 336,768 | 97,154 | 433,922 |
| Average Delta Watts | 38.5 | 44.8 | NA |
| Average Daily Hours of Use | 3.26 | 3.12 | NA |
| Summer Peak Load Coincidence Factor | 0.143 | 0.139 | NA |
| Winter Peak Load Coincidence Factor | 0.130 | 0.150 | NA |
| Energy Interactive Effects | 1.05 | 1.05 | NA |
| Demand Interactive Effects | 1.10 | 1.09 | NA |
| Gross kWh Impact Per Unit | 46.7 | 52.7 | NA |
| Gross kW Impact Per Unit | 0.038 | 0.044 | NA |
| Carryover Gross Energy Savings (kWh) | 15,856,774 | 5,124,830 | 20,981,604 |
| Carryover Gross Demand Savings (kW) | 12,694 | 4,274 | 16,968 |
| Carryover Gross Summer Peak Demand Savings (kW) | 2,031 | 673 | 2,704 |
| Carryover Gross Winter Peak Demand Savings (kW) | 1,665 | 648 | 2,314 |
| Net-to-Gross Ratio | 0.58 | 0.60 | NA |
| Carryover Net Energy Savings (kWh) | 9,210,629 | 2,984,572 | 12,195,201 |
| Carryover Net Demand Savings (kW) | 7,366 | 2,482 | 9,848 |
| Carryover Net Summer Peak Demand Savings (kW) | 1,181 | 393 | 1,573 |
| Carryover Net Winter Peak Demand Savings (kW) | 968 | 378 | 1,346 |
| EUL Res | 2.6 | 3.3 | 2.8 |
| EUL NonRes | 3.3 | 4.9 | 3.8 |

NA = Not applicable
*Source: ComEd tracking data and evaluation team analysis.*

### *7.3.3 CY2021 Preliminary Partial Carryover Savings from CY2019*

The evaluation team calculated a preliminary partial CY2021 carryover savings estimate based on the bulbs sold during CY2019 that are estimated to be installed in CY2021. We are calling these preliminary as several of the parameters used to estimate CY2021 carryover savings are based on deemed parameters from the year of install (Delta Watts, HOU and Peak CF, and Waste Heat Factors of Energy and Demand) which for CY2021 would be TRM v9. Since TRM v9 is not yet finalized, the evaluation team used v8 of the TRM to estimate these parameters. Hence the **preliminary** parameters for the partial CY2020 carryover savings are taken from:

- Delta Watts – Verified savings estimate from the year of installation (source: TRM v8[6]) – this value is subject to change and will ultimately use the values from TRM v9.
- Residential/Non-Residential Split – Verified savings from the year of purchase (source: TRM v7) – this value is not subject to change.
- HOU and Peak CF – Verified savings estimate from the year of installation (source: TRM v8) – this value is subject to change and will ultimately use the values from TRM v9.
- Energy and Demand IE – Verified savings estimate from the year of installation (source: TRM v8) – this value is subject to change and will ultimately use the values from TRM v9.
- Installation Rate – Verified savings estimate from the year of purchase (source: TRM v7) – this value is not subject to change.
- NTG – The deemed net-to-gross values from the year of purchase – this value is not subject to change.
- EUL – The deemed measure life from the year of install (source: TRM v8) – this value is subject to change and will ultimately use the values from Illinois TRM v9.

Table 7-3 shows that in CY2021 a total of 84,793 bulbs that were purchased in CY2019 are expected to be installed within ComEd's service territory. The table below provides both the gross and net energy and demand savings from these bulbs. The total preliminary net energy savings is estimated to be 2,264,405 kWh, 1,912 kW, 298 Summer Peak kW, and 328 Winter Peak kW which will be counted in CY2021.

[6] Since the Illinois TRM v9 is not yet finalized v8 was used as a proxy. It is for this reason these CY2021 savings are label as "preliminary".

**Table 7-3. CY2021 Preliminary Carryover Savings Estimates from CY2019 Bulb Sales**

| Preliminary Partial CY2021 Carryover Savings | CY2019 Bulbs |
|---|---|
| Carryover Bulbs Installed During CY2021 | 84,793 |
| Average Delta Watts | 44.7 |
| Average Daily Hours of Use | 3.12 |
| Summer Peak Load Coincidence Factor | 0.139 |
| Winter Peak Load Coincidence Factor | 0.150 |
| Energy Interactive Effects | 1.05 |
| Demand Interactive Effects | 1.09 |
| Gross kWh Impact Per Unit | 45.2 |
| Gross kW Impact Per Unit | 0.038 |
| Carryover Gross Energy Savings (kWh) | 3,831,055 |
| Carryover Gross Demand Savings (kW) | 3,240 |
| Carryover Gross Summer Peak Demand Savings (kW) | 504 |
| Carryover Gross Winter Peak Demand Savings (kW) | 558 |
| Net-to-Gross Ratio | 0.60 |
| Carryover Net Energy Savings (kWh) | 2,264,405 |
| Carryover Net Demand Savings (kW) | 1,912 |
| Carryover Net Summer Peak Demand Savings (kW) | 298 |
| Carryover Net Winter Peak Demand Savings (kW) | 328 |
| EUL Res | 3.7 |
| EUL NonRes | 3.9 |

*Source: ComEd tracking data and evaluation team analysis.*

# 8. Appendix 2. Impact Analysis Detail

## 8.1 Program Volumetric Detail

During the CY2019 Residential Lighting Discounts Program a total of 4,653,287 lamps and fixtures were sold through the program, which is a 62% decrease from the bulbs and fixtures sold during the tenth program year (CY2018). Starting in CY2019 LED omni-directional lamps were phased out program, however, there were residual program sales invoiced in CY2019 and as a result omni-directional LEDs are included in CY2019 program sales.

Table 8-1 shows the volume of bulbs, by bulb type, incentivized through the Residential Lighting Discounts Program in PY3 through CY2019 (PY9 numbers represent sales over a 19-month period).

**Table 8-1. PY3 – CY2019 Volumetric Findings Detail**

| Program Year | Standard CFLs | Specialty CFLs | CFL Fixtures | LED Omni-Dir | LED Dir | LED Specialty | LED Fixtures | Coupons | Total |
|---|---|---|---|---|---|---|---|---|---|
| CY2019 Sales | 0 | 0 | 0 | 570,619 | 1,781,459 | 1,296,725 | 1,004,484 | 0 | 4,653,287 |
| CY2018 Sales | 0 | 0 | 0 | 7,800,621 | 1,905,419 | 866,560 | 679,049 | 0 | 11,251,649 |
| PY9 Sales† | 2,625,479 | 0 | 0 | 11,905,275 | 3,309,608 | 1,388,782 | 831,268 | 0 | 20,060,412 |
| PY8 Sales | 7,205,656 | 0 | 0 | 3,896,077 | 1,578,687 | * | 302,241 | 0 | 12,982,661 |
| PY7 Sales | 10,347,580 | 989,999 | 0 | 471,710 | 427,824 | * | 0 | 0 | 12,237,113 |
| PY6 Sales | 8,965,546 | 2,125,179 | 0 | 0 | 0 | * | 0 | 0 | 11,090,725 |
| PY5 Sales | 9,633,227 | 1,197,896 | 8,767 | 9,472 | 18,758 | * | 24,268 | 5,506 | 10,897,894 |
| PY4 Sales | 11,419,752 | 1,097,670 | 84,539 | 2,592 | 22,327 | * | 16,551 | 5,599 | 12,649,030 |
| PY3 Sales | 9,893,196 | 1,217,723 | 86,943 | 0 | 0 | * | 0 | 0 | 11,197,862 |

* Prior to PY9 LED specialty bulbs were included in the LED directional category. PY7 was the first program year to included specialty LED bulbs.
† PY9 consisted of a 19-month program year, all prior program years consisted of 12 months.
*Source: ComEd tracking data and Navigant team analysis.*

# 9. Appendix 3. Total Resource Cost Detail

Table 9-1 shows the Total Resource Cost (TRC) cost-effectiveness analysis inputs available at the time of finalizing this impact evaluation report. Additional required cost data (e.g., measure costs, program level incentive and non-incentive costs) are not included in this table and will be provided to the evaluation team later.

**Table 9-1. Total Resource Cost Savings Summary**

| End Use Type | Research Category | Units | Quantity | EUL (years) | ER Flag | Verified Gross Electric Energy Savings (kWh) | Verified Gross Peak Demand Reduction (kW) | Verified Gross Gas Savings (Therms) | Gross Heating Penalty (kWh) | Gross Heating Penalty (Therms) | NTG (kWh) | NTG (kW) | NTG (Therms) | Verified Net Electric Energy Savings (kWh) | Verified Net Peak Demand Reduction (kW) | Verified Net Gas Savings (Therms) | Net Heating Penalty (kWh) | Net Heating Penalty (Therms) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lighting | Omni-Directional LED (Residential) | Lamp | 553,500 | 10.0 | No | 18,708,972 | 2,266 | NA | NA | (425,162) | 0.67 | 0.67 | NA | 12,535,011 | 1,518 | NA | NA | (284,858) |
| Lighting | Omni-Directional LED (Non-Residential) | Lamp | 17,119 | 4.7 | No | 1,968,001 | 394 | NA | NA | (39,721) | 0.67 | 0.67 | NA | 1,318,561 | 264 | NA | NA | (26,613) |
| Lighting | Directional LED (Residential) | Lamp | 1,692,386 | 10.0 | No | 87,172,268 | 10,353 | NA | NA | (1,990,461) | 0.61 | 0.61 | NA | 53,175,084 | 6,315 | NA | NA | (1,214,181) |
| Lighting | Directional LED (Non-Residential) | Lamp | 89,073 | 5.8 | No | 16,628,068 | 3,331 | NA | NA | (335,612) | 0.61 | 0.61 | NA | 10,143,121 | 2,032 | NA | NA | (204,724) |
| Lighting | Specialty LED (Residential) | Lamp | 1,231,889 | 10.0 | No | 43,527,346 | 5,169 | NA | NA | (993,888) | 0.53 | 0.53 | NA | 23,069,493 | 2,740 | NA | NA | (526,761) |
| Lighting | Specialty LED (Non-Residential) | Lamp | 64,836 | 4.3 | No | 8,302,820 | 1,663 | NA | NA | (167,580) | 0.53 | 0.53 | NA | 4,400,495 | 882 | NA | NA | (88,817) |
| Lighting | LED Fixtures and Kits(Residential) | Lamp | 974,349 | 15.0 | No | 63,112,141 | 8,446 | NA | NA | (1,377,894) | 0.67 | 0.67 | NA | 42,285,134 | 5,659 | NA | NA | (923,189) |
| Lighting | LED Fixtures and Kits (Non-Residential) | Lamp | 30,135 | 14.2 | No | 5,941,781 | 1,254 | NA | NA | (118,171) | 0.67 | 0.67 | NA | 3,980,993 | 840 | NA | NA | (79,175) |
| Lighting | Carryover (Residential) | Lamp | 892,342 | 8.2 | No | 34,876,629 | 4,045 | NA | NA | (808,757) | 0.58 | 0.58 | NA | 20,280,714 | 2,354 | NA | NA | (470,611) |
| Lighting | Carryover (Non-Residential) | Lamp | 26,991 | 3.8 | No | 3,729,264 | 746 | NA | NA | (76,854) | 0.59 | 0.59 | NA | 2,185,400 | 437 | NA | NA | (45,016) |
| Lighting | Total | | 5,572,620 | NA | NA | 283,967,289 | 37,668 | NA | NA | (6,334,101) | NA | NA | NA | 173,374,006 | 23,041 | NA | NA | (3,863,945) |

Note: The CY2019 contribution to CPAS for these measures varies over time. See the CPAS tables in Section 4.
*Source: ComEd tracking data and evaluation team analysis*