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ComEd Residential Lighting Discounts Program Impact Evaluation Report

Energy Efficiency/Demand Response Plan: Program Year 2021 (CY2021) (1/1/2021-12/31/2021)

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FINAL

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Table of Contents

1. Introduction 1
2. Program Description 2
3. Program Savings Detail 4
4. Cumulative Persisting Annual Savings 5
5. Program Savings by Measure 8
6. Impact Analysis Findings and Recommendations 10
Appendix A. Impact Analysis Methodology A-1
A.1 Verified Gross Program Savings Analysis Approach Estimates A-1
A.1.1 Connected LED Savings Approach. A-1
A.2 Verified Net Program Savings Analysis Approach A-2
A.3 Carryover Savings Analysis Approach A-2
A.3.1 CY2021 Carryover Savings A-2
A.3.2 CY2022 Preliminary Carryover Savings A-3
A.3.3 CY2023 Preliminary Partial Carryover Savings from CY2021 ..... A-3
Appendix B. Carryover Savings Results B-1
Appendix C. Impact Findings Detailed Results C-1
C.1 Differences in Gross Parameter Estimates C-1
C.1.1 Baseline Wattages C-1
C.1.2 Retail Channel Connected LED Parameter Assignments C-2
C.1.3 Market Place 2.0 HOU for Task/Undercabinet Fixtures C-2
Appendix D. Total Resource Cost Detail D-1

List of Tables, Figures, and Equations

Figure 2-1. Share of Measures Installed 3
Figure 4-1. Cumulative Persisting Annual Savings 7
Figure 5-1. Verified Net Savings by Measure – Electric 8

Table 2-1. CY2021 Volumetric Findings Detail 2
Table 2-2. Number of Measures by Type 2
Table 3-1. Total Annual Incremental Electric Savings 4
Table 4-1. Cumulative Persisting Annual Savings – Electric and Total 6
Table 5-1. Number of Measures by Type 8
Table 5-2. Energy Savings by Measure – Electric and Total 9
Table 5-3. Summer Peak Demand Savings by Measure 9

Table B-1. CY2021 Carryover Savings from CY2019 and CY2020 Program Sales B-1

Table B-2. CY2022 Preliminary Carryover Savings Estimates from CY2020 and CY2021 Bulb Sales....B-2
Table B-3. CY2023 Preliminary Carryover Savings Estimates from CY2021 Bulb Sales....B-2
Table D-1. Total Resource Cost Savings Summary....D-1

Equation A-1. Gross Savings Equation (kWh) Connected LED Control Savings....A-1

1. Introduction

This report presents the results of the CY2021 Residential Lighting Discounts Program impact evaluation.

It summarizes the total energy and demand impacts for the program broken out by relevant measure and program structure details. The appendices provide the impact analysis methodology and details of the total resource cost (TRC) analysis inputs. CY2021 covers January 1, 2021 through December 31, 2021.

2. Program Description

The primary goal of the Residential Lighting Discounts Program is to increase the market penetration of energy efficient lighting by providing product incentives through various delivery channels. The program also seeks to increase customer awareness and acceptance of energy efficient lighting technologies by distributing educational materials. In CY2021, the program offered incentives for the purchase of directional and specialty light-emitting diode (LED) lamps, LED fixtures and retrofit kits, connected LEDs, and LED nightlights. The Residential Lighting Discounts Program is referred to as the Residential Lighting program in the NTG workbook[1].

The CY2021 Residential Lighting Discounts Program incentivized over 5.5 million high efficiency lighting measures, as shown in Table 2-1 and Figure 2-1. An additional 612,315 carryover LED lamps and fixtures are expected to be installed from CY2019 and CY2020 program sales (246,917 from CY2019 sales and 365,398 from CY2020).

Table 2-1. CY2021 Volumetric Findings Detail

Participation	Directional LEDs	Specialty LEDs	LED Fixtures and Kits	LED Night Lights	Connected LEDs	Omni-Directional LEDs
CY2021 Incentivized Measures	1,657,595	2,207,654	1,376,499	257,360	94,972	0
CY2021 1st Year Installed Measures	1,336,864	1,780,397	1,359,694	211,910	92,361	0
CY2019 Carryover - CY2021 Installs	112,344	81,775	2,125	0	0	50,673
CY2020 Carryover - CY2021 Installs	171,749	177,053	3,616	12,980	0	0
Total Installed Measures in CY2021	1,620,957	2,039,225	1,365,435	224,890	92,361	50,673

Source: ComEd tracking data and evaluation team analysis

The measures sold through the program in CY2021 are shown in Table 2-2 and Figure 2-1. This table does not include carryover bulbs sold through the program in CY2019 and CY2020 that are expected to have been installed in CY2021. As shown, specialty and directional LEDs accounted for more than half of CY2021 program sales.

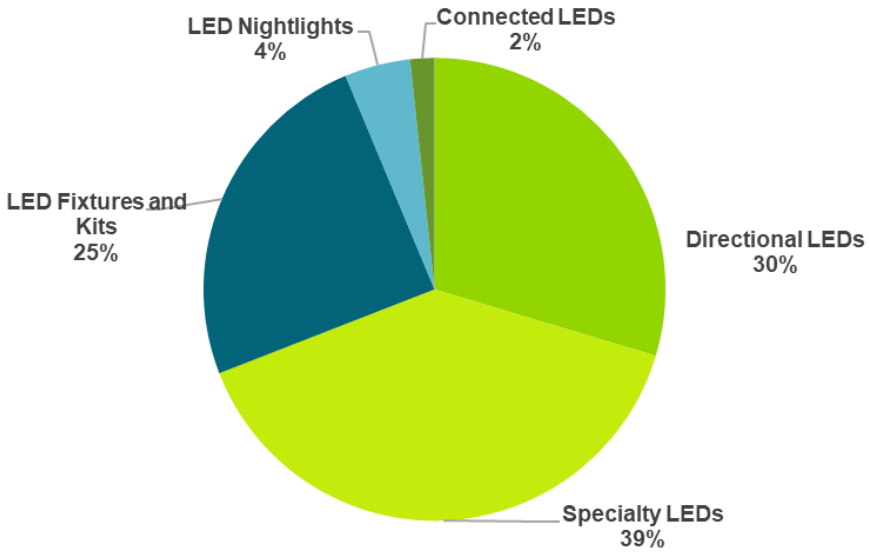
Table 2-2. Number of Measures by Type

End Use Type	Research Category	Quantity	Unit
Lighting	Directional LEDs	1,657,595	Lamps
Lighting	Specialty LEDs	2,207,654	Lamps
Lighting	LED Fixtures and Kits	1,376,499	Fixtures
Lighting	LED Nightlights	257,360	Lamps
Lighting	Connected LEDs	94,972	Lamps and Fixtures
	Total	**5,594,080**	

Source: ComEd tracking data and evaluation team analysis

[1] NTG workbook source: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**

Figure 2-1. Share of Measures Installed



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 CY2021. This program does not produce any gas savings.

Table 3-1. Total Annual Incremental Electric Savings

Savings Category	Units	Ex Ante Gross Savings*	Program Gross Realization Rate ¥	Verified Gross Savings	Program Net-to-Gross Ratio (NTG)‡	CY2019 Net Carryover Savings	CY2020 Net Carryover Savings	Verified Net Savings†
Electric Energy Savings - Direct	kWh	281,013,394	1.00	281,471,972	Varies	8,957,681	12,048,178	176,705,487
Electric Energy Savings - Converted from Gas	kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Electric Energy Savings	kWh	281,013,394	1.00	281,471,972	Varies	8,957,681	12,048,178	176,705,487
Summer Peak§ Demand Savings	kW	NR	N/A	37,501	0.62	1,245	1,594	23,326

N/A = not applicable (refers to a piece of data that cannot be produced or does not apply).

NR = not reported.

* Ex ante and verified gross savings exclude gross carryover savings from CY2019 and CY2020..

‡ NTG varies due to differing program year NTG values associated CY2021 program sales and CY2019 and CY2020 carryover.¥ The overall program realization rate does not include ex ante carryover savings.

† Verified net savings includes net carryover savings from CY2019 and CY2020.

§ The coincident summer peak period is defined as 1:00-5:00 p.m. Central Prevailing Time on non-holiday weekdays, June through August.

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 Discounts Program and the cumulative persisting annual savings (CPAS) for the measures installed in CY2021. The electric CPAS across all measures installed in 2021 is shown in Table 4-1. The historic rows in each table are the CPAS contribution back to CY2018. The Program Total Electric CPAS is the sum of the CY2021 contribution and the historic contribution. Figure 4-1 shows the savings across the effective useful life (EUL) of the measures. There are no gas savings for this program, so electric CPAS is equivalent to total CPAS.

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

End Use Type	Research Category	EUL	CY2021 Verified Gross Savings (kWh)	NTG*	Lifetime Net Savings (kWh)†	Verified Net kWh Savings (Including Those Converted from Gas Savings) 2018	2019	2020	2021	2022	2023	2024	2025	2026
Lighting	Directional LEDs (Residential)	10.0	81,412,256	0.52	321,741,235				42,334,373	42,334,373	42,334,373	42,334,373	25,400,624	25,400,624
Lighting	LED Fixtures and Kits (Residential)	15.0	80,196,085	0.52	442,040,819				41,701,964	41,701,964	41,701,964	41,701,964	25,021,178	25,021,178
Lighting	Specialty LEDs (Residential)	10.0	76,805,152	0.59	347,113,203				45,315,040	45,315,040	45,315,040	45,315,040	27,642,174	27,642,174
Lighting	Directional LEDs (Non-Residential)	5.3	12,432,495	0.52	30,856,079				6,464,897	6,464,897	6,464,897	6,464,897	3,878,938	1,117,551
Lighting	Specialty LEDs (Non-Residential)	4.6	11,802,507	0.59	30,293,042				6,963,479	6,963,479	6,963,479	6,963,479	2,439,126	-
Lighting	LED Fixtures and Kits (Non-Resident	14.2	7,638,952	0.52	40,154,282				3,972,255	3,972,255	3,972,255	3,972,255	2,383,353	2,383,353
Lighting	LED Nightlights (Residential)	8.0	6,488,305	0.80	41,525,154				5,190,644	5,190,644	5,190,644	5,190,644	5,190,644	5,190,644
Lighting	Connected LEDs (Residential)	10.0	4,696,220	0.80	25,496,140				3,756,976	3,756,976	3,756,976	3,756,976	1,744,706	1,744,706
Lighting	Carryover (Residential)	10.0	30,510,799	0.57	131,811,829				17,467,000	17,467,000	17,467,000	17,467,000	10,369,289	10,369,289
Lighting	Carryover (Non-Residential)	7.1	6,260,788	0.57	20,719,463				3,538,859	3,538,859	3,538,859	3,538,859	2,112,611	2,112,611
CY2021 Program Total Contribution to CPAS			**318,243,559**		**1,431,751,246**				**176,705,487**	**176,705,487**	**176,705,487**	**176,705,487**	**106,182,644**	**100,982,131**
Historic Program Total Contribution to CPAS‡						**301,534,004**	**474,908,010**	**655,644,669**	**469,953,843**	**462,564,034**	**447,282,011**	**284,341,349**	**277,708,992**	**274,667,467**
Program Total CPAS						**301,534,004**	**474,908,010**	**655,644,669**	**646,659,330**	**639,269,521**	**623,987,498**	**461,046,837**	**383,891,636**	**375,649,598**
CY2021 Program Incremental Expiring Savings§										-	-	-	**70,522,843**	**5,200,513**
Historic Program Incremental Expiring Savings‖									**185,690,827**	**7,389,809**	**15,282,023**	**162,940,661**	**6,632,357**	**3,041,526**
Program Total Incremental Expiring Savings#									**185,690,827**	**7,389,809**	**15,282,023**	**162,940,661**	**77,155,200**	**8,242,038**

Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Directional LEDs (Residential)	25,400,624	25,400,624	25,400,624	25,400,624	-	-	-	-	-	-	-	-
LED Fixtures and Kits (Residential)	25,021,178	25,021,178	25,021,178	25,021,178	25,021,178	25,021,178	25,021,178	25,021,178	25,021,178	-	-	-
Specialty LEDs (Residential)	27,642,174	27,642,174	27,642,174	27,642,174	-	-	-	-	-	-	-	-
Directional LEDs (Non-Residential)	-	-	-	-	-	-	-	-	-	-	-	-
Specialty LEDs (Non-Residential)	-	-	-	-	-	-	-	-	-	-	-	-
LED Fixtures and Kits (Non-Resident	2,383,353	2,383,353	2,383,353	2,383,353	2,383,353	2,383,353	2,383,353	2,383,353	431,731	-	-	-
LED Nightlights (Residential)	5,190,644	5,190,644	-	-	-	-	-	-	-	-	-	-
Connected LEDs (Residential)	1,744,706	1,744,706	1,744,706	1,744,706	-	-	-	-	-	-	-	-
Carryover (Residential)	10,369,289	10,369,289	10,369,289	10,097,383	-	-	-	-	-	-	-	-
Carryover (Non-Residential)	2,112,611	226,194	-	-	-	-	-	-	-	-	-	-
Total Contribution to CPAS	**99,864,580**	**97,978,163**	**92,561,325**	**92,289,419**	**27,404,531**	**27,404,531**	**27,404,531**	**27,404,531**	**25,452,910**	**-**	**-**	**-**
Total Contribution to CPAS‡	**267,320,847**	**150,428,466**	**130,628,926**	**70,629,876**	**69,493,907**	**65,318,126**	**35,510,283**	**25,358,356**	**-**	**-**	**-**	**-**
'AS	**367,185,427**	**248,406,629**	**223,190,250**	**162,919,295**	**96,898,438**	**92,722,657**	**62,914,814**	**52,762,888**	**25,452,910**	**-**	**-**	**-**
Incremental Expiring Savings§	**1,117,551**	**1,886,417**	**5,416,838**	**271,906**	**64,884,887**	**-**	**-**	**-**	**1,951,622**	**25,452,910**	**-**	**-**
Incremental Expiring Savings‖	**7,346,619**	**116,892,382**	**19,799,540**	**59,999,050**	**1,135,969**	**4,175,781**	**29,807,843**	**10,151,927**	**25,358,356**	**-**	**-**	**-**
cremental Expiring Savings#	**8,464,171**	**118,778,798**	**25,216,379**	**60,270,956**	**66,020,856**	**4,175,781**	**29,807,843**	**10,151,927**	**27,309,978**	**25,452,910**	**-**	**-**

Note: The green highlighted cell shows program total first-year electric savings. The gray cells are blank, indicating values irrelevant to the CY2021 contribution to CPAS.

* A deemed value. Source: Illinois Stakeholder Advisory Group (SAG) website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**. Program NTG values are referenced under the Residential Lighting program.

† Lifetime savings are the sum of CPAS savings through the EUL.

‡ Historic savings go back to CY2018.

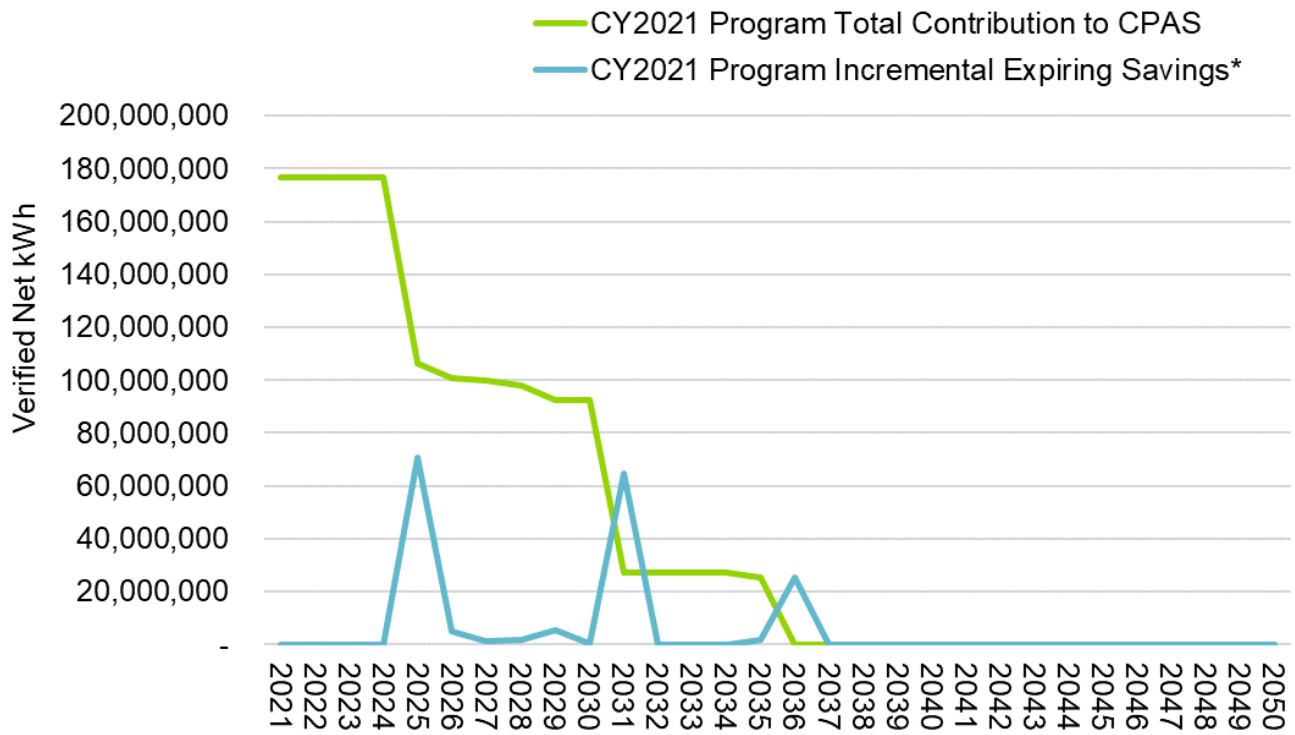
§ Incremental expiring savings are equal to CPAS Yn-1 - CPAS Yn.

|| Historic incremental expiring savings are equal to Historic CPAS Yn-1 – Historic CPAS Yn

Program total incremental expiring savings is equal to current year total incremental expiring savings plus historic total incremental expiring savings.

Source: Evaluation team analysis

Figure 4-1. Cumulative Persisting Annual Savings



* 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 six distinct lighting measure groups, as the following table shows. These groups include directional LEDs, specialty LEDs (globe, candelabra, and 3-way lamps), LED fixtures and kits, connected LEDs, LED nightlights, and carryover lamps from purchases in CY2019 and CY2020 that the Illinois Technical Reference Manual v9.0 (IL-TRM)[2] projects participants will install in CY2021.

Table 5-1 and Figure 5-1 present the first-year installations and first-year verified net savings from CY2021 program sales, respectively. First-year installations of directional LEDs, specialty LEDs, and LED fixtures and retrofit kits contributed the majority of CY2021 sales and first-year CY2021 verified net savings.

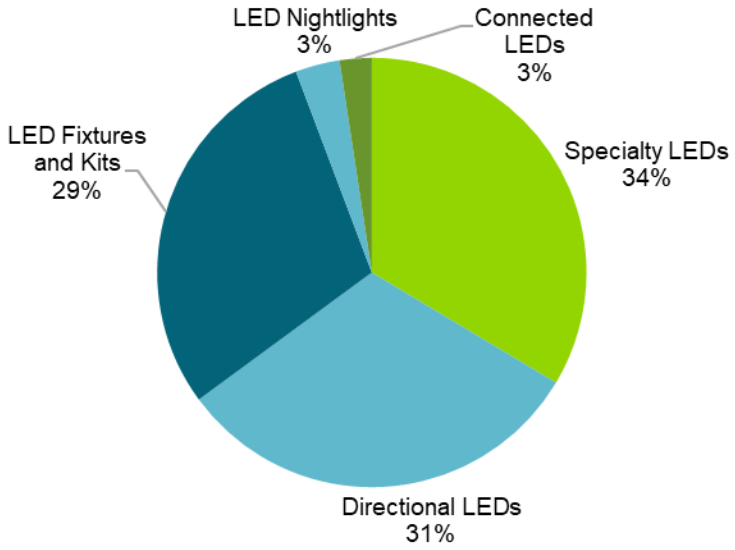
Table 5-1. Number of Measures by Type

End Use Type	Research Category	Quantity	Unit
Lighting	Directional LEDs	1,657,595	Lamps
Lighting	Specialty LEDs	2,207,654	Lamps
Lighting	LED Fixtures and Kits	1,376,499	Fixtures
Lighting	LED Nightlights	257,360	Lamps
Lighting	Connected LEDs	94,972	Lamps and Fixtures
	Total	**5,594,080**	

Note: This is the same table as Table 2-2.

Source: ComEd tracking data and evaluation team analysis

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



Source: ComEd tracking data and evaluation team analysis

[2] In this report, unless stated otherwise, IL-TRM refers to version 9.0 (v9.0).

Table 5-2 and Table 5-3 present energy and summer peak demand savings by measure group for the Residential Lighting Discounts Program. The evaluation team split all measure groups into residential and non-residential savings to highlight where savings are realized.

Table 5-2. Energy Savings by Measure – Electric and Total

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	Directional LEDs (Residential)	80,988,575	1.01	81,412,256	0.52	42,334,373	10.0
Lighting	LED Fixtures and Kits (Residential)	81,036,348	0.99	80,196,085	0.52	41,701,964	15.0
Lighting	Specialty LEDs (Residential)	76,862,096	1.00	76,805,152	0.59	45,315,040	10.0
Lighting	Directional LEDs (Non-Residential)	12,366,848	1.01	12,432,495	0.52	6,464,897	5.3
Lighting	Specialty LEDs (Non-Residential)	11,802,850	1.00	11,802,507	0.59	6,963,479	4.6
Lighting	LED Fixtures and Kits (Non-Residential)	7,737,873	0.99	7,638,952	0.52	3,972,255	14.2
Lighting	LED Nightlights (Residential)	6,488,294	1.00	6,488,305	0.80	5,190,644	8.0
Lighting	Connected LEDs (Residential)	3,730,509	1.26	4,696,220	0.80	3,756,976	10.0
Lighting	Carryover (Residential)	NR	N/A	30,510,799	0.57	17,467,000	10.0
Lighting	Carryover (Non-Residential)	NR	N/A	6,260,788	0.57	3,538,859	7.1
	Total	**281,013,394**	**1.13**	**318,243,559**	**0.56**	**176,705,487**	

NR = not reported (refers to a piece of data that was not reported).
N/A = not applicable (refers to a piece of data that cannot be produced or does not apply).
* A deemed value. Source: Illinois SAG website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**. Program NTG values are referenced under the Residential Lighting program.
¥ 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 1.0.

Source: ComEd tracking data and evaluation team analysis

Table 5-3. Summer Peak Demand Savings by Measure

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)
Directional LEDs (Residential)	NR	N/A	9,669	0.52	5,028
LED Fixtures and Kits (Residential)	NR	N/A	10,912	0.52	5,674
Specialty LEDs (Residential)	NR	N/A	9,122	0.59	5,382
Directional LEDs (Non-Residential)	NR	N/A	2,776	0.52	1,443
Specialty LEDs (Non-Residential)	NR	N/A	2,635	0.59	1,555
LED Fixtures and Kits (Non-Residential)	NR	N/A	1,807	0.52	940
LED Nightlights (Residential)	NR	N/A	0	N/A	0
Connected LEDs (Residential)	NR	N/A	580	0.80	464
Carryover (Residential)	NR	N/A	3,581	0.57	2,040
Carryover (Non-Residential)	NR	N/A	1,415	0.57	800
Total	**NR**	**N/A**	**42,498**	**0.55**	**23,326**

NR = not reported (refers to a piece of data that was not reported).
N/A = not applicable (refers to a piece of data that cannot be produced or does not apply).
* A deemed value. Source: Illinois SAG website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**. Program NTG values are referenced under the Residential Lighting program.

Source: ComEd tracking data and evaluation team analysis

6. Impact Analysis Findings and Recommendations

Overall, the evaluation team found minimal discrepancies between verified and ex ante savings. The issues that contributed to the largest adjustments of ex ante gross savings were discrepancies between ex ante and verified baseline wattage assignments and differences between parameter assignments used for connected LED fixtures and task/undercabinet fixtures.

The evaluation team developed several recommendations for ComEd and the implementation team based on findings from the CY2021 evaluation.

Finding 1. The overall program gross realization rate for the Residential Lighting Discounts Program is 1.00 (exclusive of carryover savings, 1.13 with carryover).

Finding 2. The retailer channel ex ante parameters for connected LED fixtures are mapped to specialty connected LED parameter values. Connected LED fixtures should be mapped to the fixture-specific parameter values found in Section 5.5.9 of the IL-TRM.

> **Recommendation 1.** Apply fixture-specific parameters to connected LED fixtures. This will align the connected LED fixture parameter assignments with the methodology employed by other connected LED bulb types and with the method used in the Marketplace 2.0 channel data.

Finding 3. The Marketplace 2.0 data erroneously identifies some fixtures and lamps as connected LEDs. As a result, the reported in-service rates (ISRs) and residential/non-residential splits are not appropriately assigned.

> **Recommendation 2.** Only assign connected LED parameter assignments to measures with Bluetooth or Wi-Fi connections that allow for the measure to be remotely controlled through a smart device. The Marketplace 2.0 tracking system should be updated to accurately assign parameters to connected and non-connected LEDs.

Finding 4. There are discrepancies between ex ante and verified baseline wattages in 37,379 records in the final tracking data. These discrepancies primarily occurred with connected LEDs and indoor, downlight, and task/under cabinet fixtures. Further details can be found in Appendix C.

> **Recommendation 3.** While these discrepancies are related to the application of the IL-TRM baseline wattage assignments, the IL-TRM v10.0 introduces a number of updates to baseline wattages for CY2022.Review the IL-TRM v10.0 closely and implement appropriate updates to the eTRACK database to accurately assign baseline wattages in CY2022.

Finding 5. The ex ante hours of use (HOU) for all Marketplace 2.0 fixtures designed for interior use (indoor, downlight, and task/undercabinet) are assigned an HOU value of 926. However, per the IL-TRM, the HOU for task/undercabinet fixtures is 730. The evaluation team applied the 730 HOU value in accordance with the IL-TRM.

> **Recommendation 4.** Going forward, assign task/undercabinet LED fixtures to the task/undercabinet specific parameter assignments in the eTRACK database.

Appendix A. Impact Analysis Methodology

A.1 Verified Gross Program Savings Analysis Approach Estimates

The evaluation team determined verified gross savings for each program measure by:

- Reviewing the savings algorithm inputs in the measure workbook for agreement with the IL-TRM and IL-TRM Errata, where applicable.
- Validating the savings algorithm was applied correctly.
- Cross-checking per-unit savings values in the program tracking data with the verified values in the measure workbook or in Guidehouse's calculations if the workbook did not agree with the IL-TRM.
- Multiplying the verified per-unit savings value by the quantity reported in the tracking data.

The team calculated verified net energy and demand (coincident peak and overall) savings by multiplying the verified gross savings estimates by a NTG ratio. In CY2021, NTG estimates used to calculate the net verified savings were based on past evaluation research and defined by a consensus process through the Illinois SAG.

The evaluation team used the methodologies outlined in the IL-TRM and IL-TRM Errata to estimate verified gross program savings. Given that the methodologies are presented in the IL-TRM and IL-TRM Errata they are not listed here. However, savings for connected LEDs are more nuanced than what is presented in the IL TRM. As a result, a brief discussion on Connected LEDs are discussed below.

A.1.1 Connected LED Savings Approach.

Connected LEDs generate savings through the measure's control capabilities and the LED wattage efficiency savings over a baseline wattage lamp. As a result, connected LED derive saving though two different impact equations, one representing control savings and another representing LED efficiency savings as detailed in Equation A-1. The first part of the equation, the lighting control savings, is specified in the IL-TRM for connected LEDs. The second portion of the equation, the LED efficiency savings for LED lamps and fixtures as specified in the IL TRM.

Equation A-1. Gross Savings Equation (kWh) Connected LED Control Savings

Annual ∆kWh = Lighting Control Savings + LED Efficiency Savings

Where:

- **Lighting Control Savings =** ((WattsEE/1,000 * HOU * SVGe * WHFe) - StandbykWh) * ISR * (1 – Leakage) * Lamps
- **LED Efficiency Savings =** ((WattsBase-WattsEE)/1,000) * ISR * (1-Leakage) * HOU* WHFe

Where:

- **WattsEE** = Wattage of the connected LED based on program tracking data.
- **Lamps** = Quantity of lamps sold through the CY2021 program based on program tracking data.
- **HOU** = Annual hours of use, deemed in IL-TRM.
- **SVGe** = Percentage of annual lighting energy saved by the lighting control, deemed in IL-TRM.
- **WHFe** = Water heat factor – energy, deemed in IL-TRM.
- **StandbykWh** = Standby power draw of the controlled lamp, deemed in IL-TRM.
- **ISR** = First-year in-service rate, deemed in IL-TRM.
- **Leakage** = Percentage of program lamps installed outside of ComEd service territory, deemed in IL-TRM.

LED efficiency savings utilize the lamp type specific sections of the IL TRM and their associated parameter estimates. For example, omnidirectional connected LEDs use parameter assignments from section 5.5.8 of the IL TRM, whereas specialty and directional LEDs use parameter assignments form section 5.5.6 of the TRM. Connected LEDs use HOU and WHFe values derived from their respective lamp type specific section of the TRM rather than the deemed connected LED values listed in section 5.5.12 for both control and efficiency savings estimates. This is done to keep parameter estimates consistent and aligns with the methodology agreed upon by ComEd, the implementation team and evaluation team.

A.2 Verified Net Program Savings Analysis Approach

Verified net energy and peak demand savings are calculated by multiplying the verified gross savings estimates by a net-to-gross (NTG) ratio. For the CY2021 Residential Lighting Discounts Program, the NTG ratio estimates are 0.52 for omnidirectional LEDs, directional LEDs, and LED fixtures and kits; 0.59 for specialty LEDs; and 0.80 for connected LEDs and LED nightlights. These NTG ratios are approved through the Illinois SAG consensus process.

A.3 Carryover Savings Analysis Approach

The evaluation team calculated carryover savings for CY2021, preliminary carryover for CY2022 and preliminary partial carryover for CY2023. This section details the methodology used for CY2021 carryover and preliminary carryover in CY2022 and CY2023. Details on the calculated CY2021 carryover and CY2022 and CY2023 preliminary carryover are presented in Appendix B.

A.3.1 CY2021 Carryover Savings

The evaluation team calculated the CY2021 carryover savings estimates using the IL-TRM (v7.0, v8.0, and v9.0) and the CY2019 and CY2020 impact evaluation reports. The energy and demand savings from second-year CY2020 and third-year CY2019 installations are calculated based on the following parameters:

- **Delta watts:** Verified delta watts for bulbs installed in CY2021 based on the baseline wattage values associated with the installation year (source: IL-TRM)
- **Residential/non-residential split:** Verified residential/non-residential split from the year the bulbs were purchased (source: IL-TRM v7.0 and 8.0)

- **HOU and summer peak coincidence factor (CF):** Verified HOU and summer peak CF from the installation year (source: IL-TRM)
- **Energy and demand waste heat factors (WHFs):** Verified WHFs from the year the bulbs are installed (source: IL-TRM)
- **ISR:** Verified installation rate from the year the bulbs were purchased (source: IL-TRM v7.0 and v8.0)
- **NTG:** Deemed NTG based on evaluation research from the year the bulbs were purchased (source: SAG consensus)

A.3.2 CY2022 Preliminary Carryover Savings

The evaluation team calculated a preliminary CY2022 carryover savings estimate using the IL-TRM (v8.0, v9.0, and v10.0) and the CY2020 and CY2021 impact evaluation reports. The energy and demand savings from these CY2020 third-year and CY2021 second-year installations are calculated based on the following parameters:

- **Delta watts:** Verified delta watts for bulbs installed in CY2022 based on the baseline wattage values associated with the installation year (source: IL-TRM v10.0)
- **Residential/non-residential split:** Verified residential/non-residential split from the year the bulbs were purchased (source: IL-TRM v8.0 and v9.0)
- **HOU and summer peak CF:** Verified HOU and summer peak CF from the installation year (source: IL-TRM v10.0)
- **Energy and demand WHFs:** Verified WHFs from the year the bulbs are installed (source: IL-TRM v10.0)
- **ISR:** Verified installation rate from the year the bulbs were purchased (source: IL-TRM v8.0 and v9.0)
- **NTG:** Deemed NTG based on evaluation research from the year the bulbs were purchased (source: SAG consensus)

A.3.3 CY2023 Preliminary Partial Carryover Savings from CY2021

The evaluation team calculated a preliminary partial CY2023 carryover savings estimate based on the bulbs sold during CY2021 (CY2022 sales are not known at this time) that are estimated to be installed in CY2022. This estimate is preliminary because several of the parameters used to estimate these CY2023 carryover savings are based on deemed parameters from the year of install (delta watts, HOU and peak CF, and WHFs of energy and demand), which would be based on IL-TRM v11.0 for CY2023. Because IL-TRM v11.0 is not yet finalized, the team used v10.0 of the IL-TRM to estimate these parameters. The preliminary parameters for the partial CY2023 carryover savings are based on the following:

- **Delta watts:** Verified savings estimate from the installation year (source: IL-TRM v10.0); this value is subject to change and will use the values from IL-TRM v11.0.
- **Residential/non-residential split:** Verified savings from the purchase year (source: IL-TRM); this value is not subject to change.

- **HOU and peak CF:** Verified savings estimate from the installation year (source: IL-TRM v10.0); this value is subject to change and will use the values from IL-TRM v11.0.
- **Energy and demand WHFs:** Verified savings estimate from the installation year (source: IL-TRM v10.0); this value is subject to change and will use the values from IL-TRM v11.0.
- **Installation rate:** Verified savings estimate from the purchase year (source: IL-TRM); this value is not subject to change.
- **NTG:** Deemed NTG values from the purchase year; this value is not subject to change.

Appendix B. Carryover Savings Results

As stated previously, the program has carryover savings from lighting measure purchased in prior program years. This section provides details on CY2021 carryover savings, in addition to preliminary carryover estimates for the CY2022 and CY2023 program years

Table B-1 presents the details for CY2021 carryover savings. As shown, 246,917 lighting measures purchased in CY2019 and 365,398 measures purchased in CY2020 were expected to be installed in ComEd's service territory in CY2021. The table provides the gross and net energy and summer peak demand savings from these carryover bulbs that are counted in CY2021. Total CY2021 net carryover savings are estimated to be 21,005,859 kWh and 2,839 summer peak kW.

Table B-1. CY2021 Carryover Savings from CY2019 and CY2020 Program Sales

CY2021 Carryover Savings	CY2019 Bulbs	CY2020 Bulbs	Total CY2021 Carryover
Carryover Bulbs Installed During CY2021	246,917	365,398	612,315
Gross Energy Savings (kWh)	14,984,751	21,786,837	36,771,587
Gross Peak Summer Peak Demand Savings (kW)	2,085	2,912	4,996
Net-to-Gross Ratio	0.60	0.55	0.57
Net Energy Savings (kWh)	8,957,681	12,048,178	21,005,859
Net Summer Peak Demand Savings (kW)	1,245	1,594	2,839
EUL Res	10.0	10.0	10.0
EUL NonRes	6.9	7.3	7.1

Source: ComEd tracking data and evaluation team analysis

Table B-2 shows the details for preliminary CY2022 carryover savings. As seen, 671,696 bulbs purchased in CY2020 or CY2021 are expected to be installed in ComEd's service territory in CY2022 (carryover). The table provides the gross and net energy and demand savings from these carryover bulbs. Total preliminary net carryover savings is estimated to be 22,894,733 kWh and 2,975 summer peak kW.

Table B-2. CY2022 Preliminary Carryover Savings Estimates from CY2020 and CY2021 Bulb Sales

CY2022 Carryover Savings	CY2020 Bulbs	CY2021 Bulbs	Total CY2022 Preliminary Carryover
Carryover Bulbs Installed During CY2022	309,625	362,071	671,696
Gross Energy Savings (kWh)	18,992,089	22,029,848	41,021,937
Gross Peak Summer Peak Demand Savings (kW)	1,076	2,910	3,986
Net-to-Gross Ratio	0.56	0.56	0.56
Net Energy Savings (kWh)	10,541,883	12,352,850	22,894,733
Net Summer Peak Demand Savings (kW)	1,366	1,610	2,975
EUL Res	10.0	9.9	9.9
EUL NonRes	5.9	7.1	6.8

Source: Evaluation team analysis

Table B-3 shows the details for the preliminary partial CY2023 carryover savings. As shown, 308,816 bulbs purchased in CY2021 are expected to be installed in ComEd's service territory in CY2023. The table provides the gross and net energy and demand savings from these carryover bulbs. Total preliminary CY2023 partial net carryover energy savings is estimated to be 10,526,884 kWh and 1,371 summer peak kW.

Table B-3. CY2023 Preliminary Carryover Savings Estimates from CY2021 Bulb Sales

Preliminary Partial CY2023 Carryover Savings	CY2021 Bulbs
Carryover Bulbs Installed During CY2023	308,816
Gross Energy Savings (kWh)	18,775,712
Gross Peak Summer Peak Demand Savings (kW)	2,478
Net-to-Gross Ratio	0.56
Net Energy Savings (kWh)	10,526,884
Net Summer Peak Demand Savings (kW)	1,371
EUL Res	9.9
EUL NonRes	7.1

Source: Evaluation team analysis

Appendix C. Impact Findings Detailed Results

C.1 Differences in Gross Parameter Estimates

This section discusses the differences the evaluation team observed between the ex ante and evaluation verified gross parameter estimates.

C.1.1 Baseline Wattages

The evaluation team calculated the baseline wattage for each program model in the tracking data according to the deemed methods provided in the IL-TRM.

Overall, the evaluation team found 38,253 records where the ex ante baseline wattages did not align with the verified baseline wattages. The majority of these discrepancies occurred with connected LEDs (13,343 records), downlight fixtures (6,327 records), indoor fixtures (7,479 records), and task/under cabinet fixtures (3,896 records). Although connected LEDs are included as their own reporting category in the main body of the report, connected LEDs and non-connected LEDs of the same lamp and fixture type employ the same baseline wattage assignment methodologies. As a result, the baseline wattage discrepancy discussion that follows includes connected and non-connected LEDs of a given bulb type into a single group. For example, all PAR lamps, regardless of connected LED status, are referred to as PAR lamps in the baseline wattage discussion.

LED fixtures make up the majority of baseline wattage discrepancies. In total, 21,824 records of LED fixtures (connected and non-connected) did not have baseline wattages that aligned with Section 5.5.9 of the IL-TRM. This section specifies baseline wattages for LED fixtures based on the fixture classification (indoor, task and under cabinet, outdoor, and downlight). The evaluation team applied the appropriate classifications to downlight, indoor, and task/under cabinet fixtures.

The team also identified several other discrepancies related to BR and R directional LEDs. For BR30 lamps, the evaluation found 9,010 records where lamps were lumen mapped to the correct reflector type but did not include the exceptions for BR30 LEDs with lumen ranges between 650 lumens and 1,419 lumens listed in the IL-TRM lumen mapping tables.

For R-shaped directional LEDs, the evaluation team found differences between the ex ante and verified baseline wattages for 3,048 records. These differences appeared to result from the lumen mappings that were applied. The IL-TRM specifies two distinct lumen mappings for R-shaped medium-screw based directional lamps: for those with a diameter less than or equal to 2.25 inches and for those with a diameter greater than 2.25 inches. All R-shaped directional lamps sold through the program in CY2020 had a diameter of 2.5 inches or greater[3] and should have been mapped to lamps greater than 2.25 inches. However, it appears that a number of R-shaped directional lamps were incorrectly mapped with the mapping for lamps less than 2.25

[3] The diameter of a directional lamp can be calculated based on the numeric portion of the measure type. The number is a measurement in eighths of an inch—i.e., an R20 is 20/8 = 2.5''.

inches.[4] R20 lamps with less than 720 lumens should be mapped with the R, ER, and BR exceptions provided in the IL-TRM.

The team found baseline wattage discrepancies for 2,772 specialty LED records. The majority of these discrepancies resulted from decorative and globe connected LEDs being lumen mapped to omnidirectional LED baseline wattages. Additional discrepancies were a result of decorative or globe lamps being mapped to the incorrect base type per the data included in the tracking data. For example, decorative lamps with candelabra bases were given the baseline wattage values of decorative lamps with medium bases. The evaluation team recommends that these lamps' base types be reviewed and the baseline wattages be corrected as needed.

Additionally, the evaluation team found baseline wattage discrepancies for 577 A-lamp records. The omni connected LED baseline wattage appear to be erroneously entered where the baseline wattages were assigned the same value as their assigned lumen value.

C.1.2 Retail Channel Connected LED Parameter Assignments

The evaluation team found discrepancies between verified and ex ante parameter values for connected LED fixtures assigned in the retail channel dataset. Ex ante parameters for connected LED fixtures are mapped to specialty connected LED parameter values whereas the team mapped connected LED fixtures to the fixture-specific parameter values found in Section 5.5.9 of the IL-TRM. As described previously, the evaluation team recommends the fixture-specific parameters be applied to connected LED fixtures. This will align the connected LED fixture parameter assignments with the methodology employed by other connected LED bulb types and with the method used within the Marketplace 2.0 channel data.

C.1.3 Market Place 2.0 HOU for Task/Undercabinet Fixtures

The ex ante HOU for all Marketplace 2.0 fixtures designed for interior use (indoor, downlight, and task/undercabinet) were assigned an HOU value of 926. However, per the IL-TRM, the verified HOU for task/undercabinet fixtures is 730. This resulted in discrepancies between the ex ante and verified HOU parameter assignments for Marketplace 2.0 task/undercabinet fixtures.

[4] The category variable was assigned correctly for these lamps and did correctly identify them as diameter less than 2.25".

Appendix D. Total Resource Cost Detail

Table D-1 shows the TRC cost-effectiveness analysis inputs available at the time of finalizing this impact evaluation report. This table does not include additional required cost data (e.g., measure costs, program-level incentives, and non-incentive costs). ComEd will provide this data to the evaluation team later.

Table D-1. Total Resource Cost Savings Summary

End Use Type	Research Category	Units	Quantity	EUL (years)*	ER Flag†	Gross Electric Energy Savings (kWh)	Gross Peak Demand Reduction (kW)	Gross Gas Savings (Therms)	Gross Secondary Savings due to Water Reduction (kWh)	Gross Heating Penalty (kWh)	Gross Heating Penalty (Therms)	NTG (kWh)	NTG (kW)	NTG (Therms)	Net Electric Energy Savings (kWh)	Net Peak Demand Reduction (kW)	Net Gas Savings (Therms)	Net Secondary Savings due to Water Reduction (kWh)	Net Heating Penalty (kWh)	Net Heating Penalty (Therms)
Lighting	Directional LEDs (Residential)	Lamp	1,591,892	10.0	No	81,412,256	9,669	N/A	N/A	N/A	-1,858,939	0.52	0.52	0.52	42,334,373	5,028	N/A	N/A	N/A	-966,648
Lighting	LED Fixtures and Kits (Residential)	Lamp	1,335,219	15.0	No	80,196,085	10,912	N/A	N/A	N/A	-1,772,637	0.52	0.52	0.52	41,701,964	5,674	N/A	N/A	N/A	-921,771
Lighting	Specialty LEDs (Residential)	Lamp	2,119,709	10.0	No	76,805,152	9,122	N/A	N/A	N/A	-1,753,742	0.59	0.59	0.59	45,315,040	5,382	N/A	N/A	N/A	-1,034,708
Lighting	Directional LEDs (Non-Residential)	Lamp	65,703	5.3	No	12,432,495	2,776	N/A	N/A	N/A	-346,500	0.52	0.52	0.52	6,464,897	1,443	N/A	N/A	N/A	-180,180
Lighting	Specialty LEDs (Non-Residential)	Lamp	87,945	4.6	No	11,802,507	2,635	N/A	N/A	N/A	-403,783	0.59	0.59	0.59	6,963,479	1,555	N/A	N/A	N/A	-238,232
Lighting	LED Fixtures and Kits (Non-Residential)	Fixtures	41,280	14.2	No	7,638,952	1,807	N/A	N/A	N/A	-340,588	0.52	0.52	0.52	3,972,255	940	N/A	N/A	N/A	-177,106
Lighting	LED Nightlights (Residential)	Lamp	257,360	8.0	No	6,488,305	0	N/A	N/A	N/A	0	0.80	0.80	0.80	5,190,644	0	N/A	N/A	N/A	0
Lighting	Connected LEDs (Residential)	Lamps/Fixtures	94,972	10.0	No	4,696,220	580	N/A	N/A	N/A	-101,232	0.80	0.80	0.80	3,756,976	464	N/A	N/A	N/A	-80,986
Lighting	Carryover (Residential)	Lamp	581,461	10.0	No	30,510,799	3,581	N/A	N/A	N/A	-696,370	0.57	0.57	0.57	17,467,000	2,040	N/A	N/A	N/A	-398,662
Lighting	Carryover (Non-Residential)	Lamp	30,855	7.1	No	6,260,788	1,415	N/A	N/A	N/A	-86,728	0.57	0.57	0.57	3,538,859	800	N/A	N/A	N/A	-49,023
	Total			**10.9**		**318,243,559**	**42,498**	**N/A**	**N/A**	**N/A**	**-7,360,519**	**N/A**	**N/A**	**N/A**	**176,705,487**	**23,326**	**N/A**	**N/A**	**N/A**	**-4,047,315**

Note: To avoid double counting, the verified gross kWh and net kWh used in the TRC analysis exclude secondary energy savings from water reduction measures.
N/A = not applicable (refers to a piece of data that cannot be produced or does not apply).
* The total of the EUL column is the weighted average measure life (WAML) and is calculated as the sum product of EUL and measure savings divided by total program savings.
† Early replacement (ER) measures are flagged as YES, otherwise a NO is indicated in the column.
Source: ComEd tracking data and evaluation team analysis