**BEFORE**
**THE PUBLIC UTILITIES COMMISSION OF OHIO**

| | | |
|---|---|---|
| In the Matter of The Dayton Power and Light Company's d/b/a AES Ohio Portfolio Performance Report | ) ) | Case No. 21-0051-EL-POR |

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**THE DAYTON POWER AND LIGHT COMPANY'S D/B/A AES OHIO COMBINED NOTICE OF FILING PORTFOLIO PERFORMANCE REPORT AND APPLICATION TO ADJUST BASELINES**

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The Dayton Power and Light Company ("DP&L" or "the Company") hereby submits its annual Portfolio Performance Report pursuant to Section 4901:1-39-05(A) of the Ohio Administrative Code ("O.A.C."), addressing the performance of all of DP&L's approved energy efficiency and peak demand reduction programs over calendar year 2020. As shown in the attached Portfolio Performance Report, DP&L has met its statutory benchmarks for energy efficiency and peak demand reduction.

DP&L also makes application pursuant to Section 4928.66(A)(2)(c) of the Ohio Revised Code ("O.R.C.") and O.A.C. §4901:1-39-04(D) to adjust its sales and demand baselines to normalize for weather. As described in the 2020 Benchmark Report, included within the Portfolio Performance Report as Appendix B, the changes requiring adjustments to the baselines were outside of DP&L's reasonable control. Appendix B contains all assumptions, rationales, and calculations, and proposes methodologies and practices to be used in the proposed adjustments or normalizations to support DP&L's application to adjust baselines, as required by O.A.C. §4901:1-39-04(D).

1. DP&L is a public utility and electric light company as defined by Sections 4905.02 and 4905.03(C) of the O.R.C. respectively, and an electric distribution utility as defined by O.R.C. §4928.01(A)(6).

2. Pursuant to O.R.C §4928.66(A)(1)(a), DP&L was required to "implement energy efficiency programs that achieve energy savings equivalent to at least three-tenths of one per cent of the total, annual average, and normalized kilowatt-hour sales of the electric distribution utility during the preceding three calendar years to customers in this state. An energy efficiency program may include a combined heat and power system placed into service or retrofitted on or after the effective date of the amendment of this section by S.B. 315 of the 129th general assembly, September 10, 2012, or a waste energy recovery system placed into service or retrofitted on or after September 10, 2012, except that a waste energy recovery system described in division (A)(38)(b) of section 4928.01 of the Revised Code may be included only if it was placed into service between January 1, 2002, and December 31, 2004. For a waste energy recovery or combined heat and power system, the savings shall be as estimated by the public utilities commission. The savings requirement, using such a three-year average, shall increase to an additional five-tenths of one per cent in 2010, seven-tenths of one per cent in 2011, eight-tenths of one per cent in 2012, nine-tenths of one per cent in 2013, and one per cent in 2014. In 2015 and 2016, an electric distribution utility shall achieve energy savings equal to the result of subtracting the cumulative energy savings achieved since 2009 from the product of multiplying the baseline for energy savings, described in division (A)(2)(a) of this section, by four and two-tenths of one per cent. If the result is zero or less for the year for which the calculation is being made, the utility shall not be required to achieve additional

energy savings for that year, but may achieve additional energy savings for that year. Tthe annual savings requirements shall be, for years 2017, 2018, 2019, and 2020, an additional one per cent of the baseline."

3. O.R.C. §4928.66(A)(1)(b) requires that DP&L "implement peak demand reduction programs designed to achieve a one per cent reduction in peak demand in 2009 and an additional seventy-five hundredths of one per cent reduction each year through 2014. In 2015 and 2016, an electric distribution utility shall achieve a reduction in peak demand equal to the result of subtracting the cumulative peak demand reductions achieved since 2009 from the product of multiplying the baseline for peak demand reduction, described in division (A)(2)(a) of this section, by four and seventy-five hundredths of one per cent. If the result is zero or less for the year for which the calculation is being made, the utility shall not be required to achieve an additional reduction in peak demand for that year, but may achieve an additional reduction in peak demand for that year. In 2017 and each year thereafter through 2020, the utility shall achieve an additional seventy-five hundredths of one per cent reduction in peak demand."

4. O.R.C. §4928.66(A)(2)(a) provides: "The baseline for energy savings under division (A)(1)(a) of this section shall be the average of the total kilowatt hours the electric distribution utility sold in the preceding three calendar years, and the baseline for a peak demand reduction under division (A)(1)(b) of this section shall be the average peak demand on the utility in the preceding three calendar years."

5. As more fully described and supported in DP&L's 2020 Benchmark Report, included with the Portfolio Performance Report as Appendix B, DP&L applies to

make adjustments to its baseline to normalize for weather changes, reasonable arrangements, statutory portfolio plan opt-outs, and mercantile customers.

6. As more fully explained in the 2020 Benchmark Report and supported by Schedule 1 and the corresponding Workpapers A, C, D, and E, DP&L's 2020 normalized energy efficiency baseline is 12,665,340MWh and DP&L's 2020 incremental normalized energy efficiency reduction benchmark is 126,653MWh. DP&L's cumulative energy efficiency reduction benchmark is 1,097,541MWh.

7. DP&L's 2020 normalized peak demand reduction baseline, as fully explained in its 2020 Benchmark Report, and supported by Schedule 2 and the corresponding Workpapers B, C, D, and E is 2,575MW and DP&L's 2020 normalized peak demand reduction benchmark is 199.6MW.

8. DP&L's energy efficiency and demand reduction programs, designed to achieve the required energy savings and demand reductions from 2018 through 2020, were filed as part of a comprehensive energy efficiency and peak-demand reduction program portfolio. A Stipulation and Recommendation in Case No. 17-1398-EL-POR, *In the Matter of the Application of The Dayton Power and Light Company for Approval of Its Energy Efficiency and Demand Reduction Program Portfolio Plan for 2018 through 2020* was approved by a Commission Order dated December 20, 2017.

9. O.A.C. §4901:1-39-05(A) provides: "by May fifteenth of each year, each electric utility shall file a portfolio performance report addressing the performance of its energy efficiency and peak-demand reduction programs in its program portfolio plan over

the previous calendar year. . ." The Commission further directed all electric distribution utilities to file finalized numbers in their annual status reports by May 15, 2021.[1]

10. DP&L timely submits the attached Portfolio Performance Report ("Report") which includes the following components:

(1) A Compliance Demonstration which details the Company's achieved annualized energy savings, achieved demand reductions, and the demand reductions that its programs were reasonably designed to achieve, relative to its corresponding energy and peak demand reduction baselines.

(2) A Program Performance Assessment, including: (a) a description of each approved energy efficiency or peak-demand reduction program implemented in the previous calendar year (Report, Residential Programs, Non-Residential Programs, Cross Sector Programs, and Customer Education); and (b) an evaluation, measurement, and verification report by The Cadmus Group, Inc. ("Cadmus Report", Exhibit 1)

12. As described in the Report, DP&L has met its 2020 statutory benchmarks for energy efficiency and peak demand reduction.

WHEREFORE, DP&L respectfully requests that the Commission issue an order finding that DP&L has complied with its 2020 statutory energy efficiency and peak demand reduction benchmark requirements and acknowledging DP&L compliance with the Program Portfolio Performance Report requirements found in O.A.C. § 4901:1-39-05(A).

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[1] *In the matter of the application of The Dayton Power and Light Company for Approval of Its Energy Efficiency and Peak Reduction Program Portfolio Plan for 2018 through 2020, Case No. 17-1398-EL-POR*, Finding and Order at ¶ 13 (February 24, 2021)

Respectfully submitted,

_*/s/ Michael J. Schuler*_____

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# Dayton Power and Light

February 5

2021

# 2020 Energy Efficiency and Demand Reduction/Response Portfolio Performance Report

DP&L

# TABLE OF CONTENTS

# EXECUTIVE SUMMARY

## OVERVIEW

In June 2017, DP&L filed a three-year Portfolio Plan in Case No. 17-1398-EL-POR and 17-1399-EL-WVR.  A Stipulation was filed in October 2017 and the case was approved by the Commission in December 2017.

It should be noted that actual energy and demand savings have been reported in each of the previous years as follows:

- 2009 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on March 12, 2010, in Case No. 10-0303-EL-POR.
- 2010 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on March 15, 2011, in Case No. 11-1276-EL-POR.
- 2011 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on May 15, 2012, in Case No. 12-1420-EL-POR.
- 2012 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on May 15, 2013, in Case No. 13-1140-EL-POR.
- 2013 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on May 15, 2014, in Case No. 14-0738-EL-POR.
- 2014 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on May 15, 2015, in Case No. 15-0777-EL-POR.
- 2015 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on May 15, 2016, in Case No. 16-0851-EL-POR
- 2016 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on May 15, 2017, in Case No. 17-1092-EL-POR
- 2017 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on May 15, 2018, in Case No. 18-0742-EL-POR
- 2018 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on May 15, 2019, in Case No. 19-0775-EL-POR
- 2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report filed on May 15, 2020, in Case No. 20-0916-EL-POR

## SAVINGS CALCULATIONS

The energy and demand savings calculations are based mainly on the State of Ohio Energy Efficiency Technical Reference Manual (TRM), filed August 6, 2010 under Case No. 09-0512-GE-UNC. However, there are exceptions for measures not included in the TRM or where evaluations resulted in a valid alternate calculation. A discussion of calculation methodology is included in the Cadmus EM&V report, attached as Exhibit 1.

## COMPLIANCE SUMMARY

From 2009 through 2019, DP&L reported cumulative energy efficiency program savings of 1,962,189 MWh and mercantile program savings of 74,535 MWh. The 2020 energy efficiency programs generated 227,314 MWh and mercantile programs generated 2,458 MWh. Therefore, cumulative annualized energy savings for 2009 through 2020 less 2019 Residential Behavior change of 6,239 MWh are 2,260,257 MWh.

From 2009 through 2019, DP&L reported cumulative demand savings from energy efficiency programs of 298.23 MW and 19.57 MW of cumulative demand savings from mercantile commitments. The 2020 energy efficiency programs generated 34.00 MW and mercantile programs generated 0.36 MW of energy efficiency demand for integration with DP&L's program portfolio. Therefore, total 2020 cumulative demand savings less 2019 Residential Behavior change of 1.08 MW are 351.08 MW.

Based on this performance, DP&L surpassed its 2020 cumulative benchmark targets of 1,097,541 MWh and 199.6 MW. A more detailed analysis is provided in the Compliance Demonstration portion of this report.

| | **MWh** | **MW** |
|---|---|---|
| Cumulative 2009 – 2019 Total Savings | 2,036,724 | 317.80 |
| 2020 Energy Efficiency Actuals | 227,314 | 34.00 |
| 2020 Mercantile Commitments | 2,458 | 0.36 |
| 2019 Residential Behavior Change | -6,239 | -1.08 |
| Cumulative 2009 – 2020 Total Savings | 2,260,257 | 351.08 |
| Cumulative 2020 Benchmarks | 1,097,541 | 199.60 |

## 2020 PROGRAM SUMMARY

***2020 Annualized Program Results***

| Program | 2020 Energy (MWh) | 2020 Demand (MW) |
|---|---|---|
| Residential Efficient Products | 49,773 | 5.95 |
| Residential HVAC Rebates | 6,458 | 1.31 |
| Residential Appliance Recycling | 1,959 | 0.33 |
| Residential Income Eligible Efficiency | 842 | 0.09 |
| Residential School Education* | 3,430 | 0.21 |
| Residential Behavior Change | 8,358 | 1.44 |
| Residential Energy Savings Kits | 5,252 | 0.58 |
| Residential Multi-Family | 288 | 0.03 |
| Residential Smart Thermostats | 4,954 | 0.42 |
| Residential Behavior Change Uplift | -819 | -0.07 |
| Non-Residential Prescriptive Rebates | 114,489 | 18.70 |
| Non-Residential Custom Rebates | 29,287 | 4.33 |
| Small Business Direct Install | 3,043 | 0.68 |
| Mercantile Self-Direct Program | 2,458 | 0.36 |
| Education and Marketing | 0 | 0 |
| Pilot Program | 0 | 0 |
| Stakeholder Initiatives | 0 | 0 |
| Transmission and Distribution Infrastructure Improvements | 0 | 0 |
| Total | 229,772 | 34.36 |

*Savings are from the 2019-2020 school year.

**Impact of COVID-19 Pandemic**

As a result of the COVID-19 pandemic as well as the passage of Ohio House Bill 6, some programs were not available to customers for the entirety of the 2020 program year. Each program is unique and therefore, the impacts varied. Some programs' savings goals were met or even exceeded despite the challenges, whereas some programs' goals could not be achieved. For example, despite a limited-time retail shutdown, customers purchased enough discounted LED bulbs when retail was open to achieve the savings targets of the Residential Efficient Products Program. On the contrary, the Small Business Direct Install program was initially suspended due to Covid. While the program resumed with new safety protocols, there was not enough time to catch up and meet savings goals prior to the program termination on September 30, 2020. The table below details the impact of the COVID-19 pandemic.

***Impact of COVID-19 Pandemic***

| Program | Suspended Due to COVID-19 | Change in Implementation due to COVID-19 Pandemic |
|---|---|---|
| Res Efficient Products | No | In-store retail visits temporarily suspended |
| Res HVAC Rebates | No | None |
| Res Appliance Recycling | Yes | All appliance pick-ups and recycling temporarily suspended; program resumed with outdoor pickups only |
| Res Income Eligible Efficiency | Yes | All in-home audits temporarily suspended |
| Res School Education | No | None |
| Res Behavior Change | No | Messaging changed to offer COVID-sensitive energy savings tips |
| Res Energy Savings Kits | No | Increased marketing and increased kit distribution to offer safe and easily accessible energy savings kit |
| Res Multi-Family Direct Install | Yes | Direct installations suspended and program did not resume |
| Res Smart Thermostats | No | In-store retail visits temporarily suspended |
| Non-Res Prescriptive Rebates | No | In-person verification audits temporarily suspended |
| Non-Res Custom Rebates | No | In-person verification audits temporarily suspended |
| Small Business Direct Install | Yes | All direct installations temporarily suspended |
| Mercantile Self-Direct Program | No | N/A |

## BANKED ENERGY SAVINGS

At the conclusion of energy efficiency programs in 2020, the total amount of banked energy savings was 1,162,716 MWh and is calculated as follows:

2020 Actual Cumulative Energy Savings – 2020 Cumulative Benchmark = Banked Energy Savings

2,260,257 MWh – 1,097,541 MWh = 1,162,716 MWh

## EVALUATION, COST EFFECTIVENESS

Attached to this report, as Exhibit 1, is the 2020 evaluation, measurement, and verification report produced by The Cadmus Group (Cadmus).

In addition, Cadmus performed cost effectiveness tests for each of the programs and for the portfolio as a whole. These are the Total Resource Cost Test (TRC), the Utility Cost Test (UCT), the Participant Cost Test (PCT), the Ratepayer Impact Measure (RIM), and the Societal Test (SCT). DP&L's portfolio was cost effective as measured by the TRC. A detailed review of the cost effectiveness tests, and program-specific results can be found in the cost effectiveness section of the EM&V report, included as Exhibit 1.

| | Primary | Secondary | | | |
|---|---|---|---|---|---|
| | **Total Resource Cost Test** | **Utility Cost Test** | **Ratepayer Impact Measure Test** | **Participant Cost Test** | **Societal Cost Test** |
| DP&L Portfolio | 2.17 | 5.24 | 0.57 | 3.59 | 2.92 |

## 2020 PROGRAM COST SUMMARY

| PROGRAM | 2020 Filed | 2020 Actual* |
|---|---|---|
| Residential Efficient Products | | |
| Incentive Costs | $2,251,970 | $2,229,477 |
| Marketing & Administration | $964,799 | $876,665 |
| Program Total | $3,216,769 | $3,106,142 |
| Residential HVAC Rebates* | | |
| Incentive Costs | $931,595 | $927,335 |
| Marketing & Administration | $474,267 | $437,943 |
| Program Total | $1,405,862 | $1,365,278 |
| Residential Appliance Recycling | | |
| Incentive Costs | $222,490 | $83,060 |
| Marketing & Administration | $407,622 | $163,800 |
| Program Total | $630,112 | $246,860 |
| Residential Income Eligible Efficiency | | |
| Incentive Costs | $997,891 | $668,746 |
| Marketing & Administration | $297,243 | $175,886 |
| Program Total | $1,295,134 | $844,632 |
| Residential School Education | | |
| Incentive Costs | $221,030 | $115,083 |
| Marketing & Administration | $181,459 | $141,575 |
| Program Total | $402,489 | $256,658 |
| Residential Behavior Change | | |
| Incentive Costs | $0 | $0 |
| Marketing & Administration | $579,285 | $326,588 |
| Program Total | $579,285 | $326,588 |
| Residential Energy Savings Kits | | |
| Incentive Costs | $322,200 | $255,543 |
| Marketing & Administration | $79,281 | $101,560 |
| Program Total | $401,481 | $357,103 |
| Residential Multi-Family* | | |
| Incentive Costs | $263,097 | $48,186 |
| Marketing & Administration | $149,275 | $29,662 |
| Program Total | $412,372 | $77,848 |
| Residential Smart Thermostats* | | |
| Incentive Costs | $625,000 | $552,142 |
| Marketing & Administration | $151,827 | $103,851 |
| Program Total | $776,827 | $655,993 |
| Non-Residential Prescriptive Rebates* | | |
| Incentive Costs | $7,032,955 | $7,740,319 |
| Marketing & Administration | $1,474,629 | $1,881,567 |
| Program Total | $8,507,584 | $9,621,886 |
| | | |

| | | |
|---|---|---|
| Non-Residential Custom Rebates | | |
| Incentive Costs | $3,509,089 | $2,872,132 |
| Marketing & Administration | $1,398,639 | $882,653 |
| Program Total | $4,907,728 | $3,754,785 |
| Small Business Direct Install* | | |
| Incentive Costs | $535,000 | $388,355 |
| Marketing & Administration | $117,729 | $232,645 |
| Program Total | $652,729 | $621,000 |
| Non-Residential Mercantile Program* | | |
| Incentive Costs | $50,000 | $87,418 |
| Marketing & Administration | $64,256 | $14,698 |
| Program Total | $114,256 | $102,116 |
| Education and Marketing | $1,628,420 | $652,731 |
| Pilot Programs | | |
| Incentive Costs | $434,217 | $0 |
| Marketing & Administration | $186,092 | $0 |
| Program Total | $620,309 | $0 |
| Stakeholder Initiatives | $645,000 | $0 |
| Transmission & Distribution Infrastructure Improvements | $0 | $0 |
| Evaluations, Measurement & Verification | $1,108,243 | $853,937 |
| | | |
| **Total Program Costs** | **$27,304,600** | **$22,843,557** |

*Reflects transfers of $75,000 from Residential Multifamily to Residential HVAC Rebates; $175,000 from Residential Multi-Family to Residential Smart Thermostats; $70,000 from Non-Residential Mercantile Program to Non-Residential Prescriptive Rebates; and $375,000 from Small Business Direct Install to Non-Residential Prescriptive Rebates.

# COMPLIANCE DEMONSTRATION

## BENCHMARK REPORT UPDATE

In accordance with O.A.C. Section 4901:1-39-05©(1)(a) DP&L is filing its 2020 Benchmark Report, included in this filing as Appendix B.

DP&L's 2020 cumulative energy and peak demand reduction benchmark targets are as follows:

| | |
|---|---|
| Normalized Energy Reduction Benchmark (MWh) | 1,097,541 |
| Normalized Peak Demand Reduction Benchmark (MW) | 199.6 |

For informational purposes, included below are Schedules 1 and 2 from DP&L's 2020 Benchmark Report.

Schedule 1

**THE DAYTON POWER & LIGHT COMPANY**

**2020 Benchmark Report**

Energy Efficiency Baseline and Benchmark Calculation

| | | 2017 | 2018 | 2019 | |
|---|---|---|---|---|---|
| 1 | **Baseline Calculation Components** | | | | |
| 2 | Retail MWh Sales [1] | 13,778,247 | 14,579,712 | 13,980,211 | |
| 3 | | | | | |
| 4 | **Normalizing Adjustments** | | | | |
| 5 | Reasonable Arrangement Adjustment [2] | 425,549 | 419,095 | 622,061 | |
| 6 | Opt-Out Customer Adjustment [3] | 902,524 | 890,865 | 1,068,617 | |
| 7 | Mercantile Customer Adjustment [4] | 70,052 | 72,382 | 74,420 | |
| 8 | Total Adjusted Retail Sales (2+7)-(5+6) | 12,520,226 | 13,342,134 | 12,363,953 | |
| 9 | Weather Normalization Factor [5] | 1.02467 | 0.97247 | 0.9861 | |
| 10 | Normalized Retail Energy Sales (8)*(9) | 12,829,100 | 12,974,825 | 12,192,094 | |
| 11 | | | | | |
| 12 | **2020 Normalized Energy Efficiency Baseline** | | | | |
| 13 | 3 Year Normalized Average (MWh) | | | | 12,665,340 |
| 14 | | | | | |
| 15 | **Calculation of 2020 Energy Efficiency Reduction Benchmark** | | | | |
| 16 | Normalized Preceding 3 Year Average Sales (13) | | | | 12,665,340 |
| 17 | 2020 Incremental Energy Efficiency Reduction Benchmark % [6] | | | | 1.00% |
| 18 | 2020 Incremental Energy Efficiency Reduction Benchmark (16)*(17) | | | | 126,653 |
| 19 | 2019 Energy Efficiency Reduction Benchmark [7] | | | | 970,888 |
| 20 | **2020 Cumulative Energy Efficiency Reduction Benchmark (18)+(19)** | | | | **1,097,541** |

[1] Retail sales for the period 2017-2019 are reported in PUCO Form FE-D1 (Case No. 20-0916-EL-POF
See Workpaper A, Column (6).

[2] Adjusted in compliance with O.R.C. §4928.66(A)(2)(a)(i).

[3] Adjusted in compliance with O.R.C. §4928.66(A)(2)(a)(ii).

[4] See Workpaper C for calculation of Mercantile Customer Adjustment.

[5] See Workpaper E for calculation of the weather normalization factor.

[6] Energy Efficiency benchmark as established in O.R.C. §4928.66(A)(1)(a).

[7] 2019 Cumulative Energy Efficiency Reduction Benchmark as established in Case No. 20-0916-EL-POR, Schedule 1, line 20.

Schedule 2

**THE DAYTON POWER & LIGHT COMPANY**
**2020 Benchmark Report**
Peak Demand Baseline and Benchmark Calculation

| | | 2017 | 2018 | 2019 | |
|---|---|---|---|---|---|
| 1 | **Baseline Calculation Components** | | | | |
| 2 | Peak MW Demand [1] | 2,771 | 2,859 | 2,805 | |
| 3 | | | | | |
| 4 | **Normalizing Adjustments** | | | | |
| 5 | Reasonable Arrangement Adjustment [2] | 66 | 76 | 102 | |
| 6 | Opt-Out Customer Adjustment [3] | 136 | 104 | 140 | |
| 7 | Mercantile Customer Adjustment [4] | 19 | 20 | 20 | |
| 8 | Total Adjusted Peak Demand (2+7)-(5+6) | 2,588 | 2,699 | 2,583 | |
| 9 | Weather Normalization Factor [5] | 1.04583 | 0.96817 | 0.93048 | |
| 10 | Normalized Peak Demand (8)*(9) | 2,707 | 2,613 | 2,404 | |
| 11 | | | | | |
| 12 | **2020 Normalized Peak Demand Reduction Baseline** | | | | |
| 13 | 3 Year Normalized Average (MW) | | | | 2,575 |
| 14 | | | | | |
| 15 | **Calculation of Normalized 2020 Peak Demand Reduction Benchmark** | | | | |
| 16 | Normalized Preceding 3 Year Average Peak Demand (13) | | | | 2,575 |
| 17 | 2020 Peak Demand Reduction Benchmark % [6] | | | | 7.75% |
| 18 | **2020 Peak Demand Reduction Benchmark (16)*(17)** | | | | **199.6** |

[1] Peak demand for the period 2017-2019 is reported in PUCO Form FE-D3. See Workpaper B.

[2] Adjusted in compliance with O.R.C. §4928.66(A)(2)(a)(i).

[3] Adjusted in compliance with O.R.C. §4928.66(A)(2)(a)(ii).

[4] See Workpaper C for calculation of Mercantile Customer Adjustment.

[5] See Workpaper E for calculation of weather normalization factor.

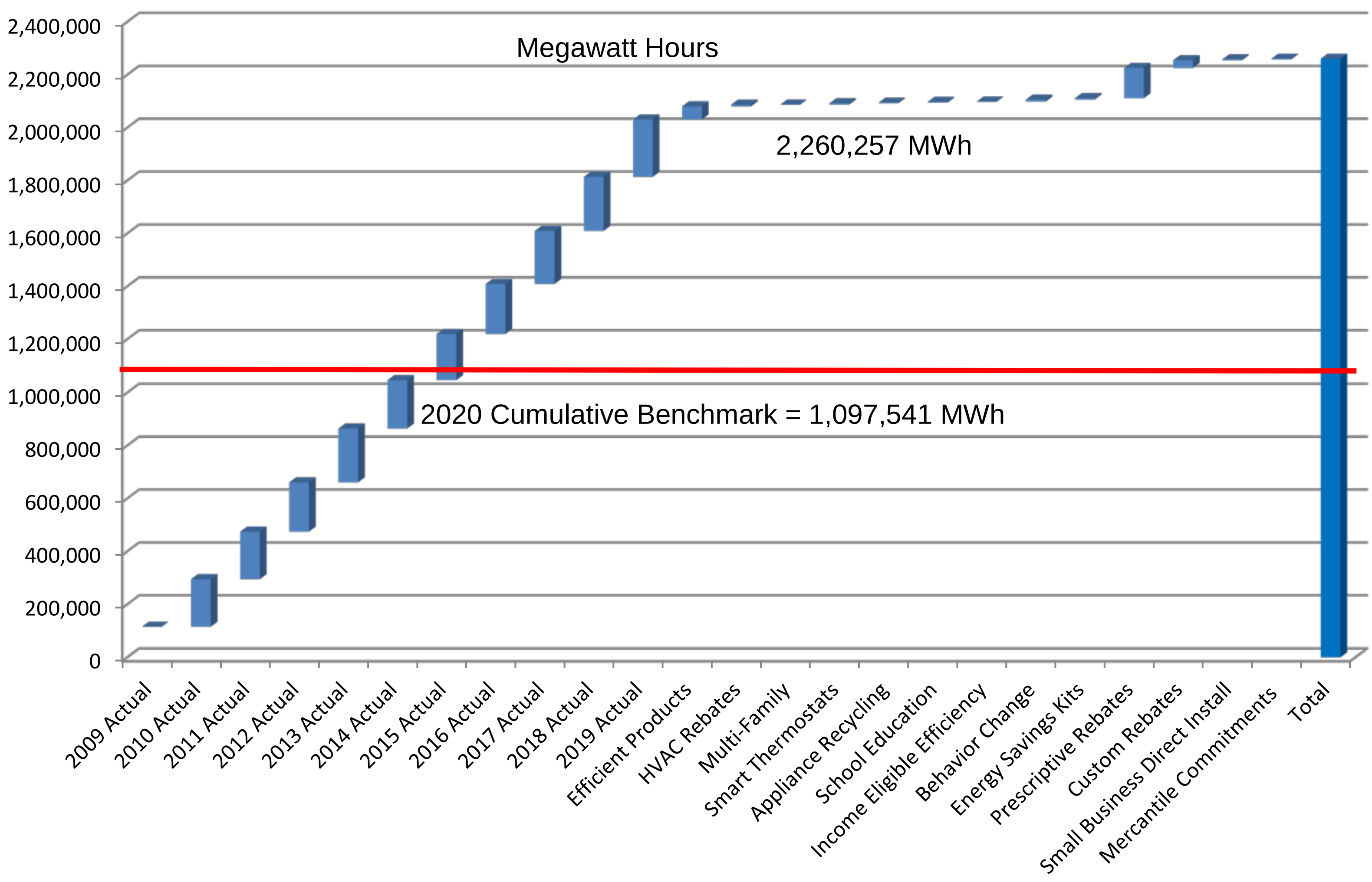
[6] Peak Demand Reduction benchmark as established in O.R.C §

## 2020 FILED VERSUS ACTUAL ENERGY SAVINGS

Below, in tabular and graph form, are the programs' energy and demand savings as filed, as well as the corresponding energy and demand actual 2020 program performance. The actual performance is then compared to the 2020 energy and peak demand reduction benchmarks to demonstrate DP&L's compliance.

| PROGRAM | 2020 Filed (MWh) | Annualized 2020 Actual (MWh) | Variance (MWh) |
|---|---|---|---|
| Residential Efficient Products | 47,467 | 49,773 | 2,306 |
| Residential HVAC Rebates | 7,754 | 6,458 | -1,296 |
| Residential Appliance Recycling | 3,410 | 1,959 | -1,451 |
| Residential Income Eligible Efficiency | 1,217 | 842 | -375 |
| Residential School Education | 3,846 | 3,430 | -416 |
| Residential Behavior Change | 18,700 | 8,358 | -10,342 |
| Residential Energy Savings Kits | 3,881 | 5,252 | 1,371 |
| Residential Multi-Family | 3,451 | 288 | -3,163 |
| Residential Smart Thermostats | 2,075 | 4,954 | 2,879 |
| Residential Behavior Change Uplift | 0 | -819 | -819 |
| Non-Residential Prescriptive Rebates | 79,991 | 114,489 | 34,498 |
| Non-Residential Custom Rebates | 35,492 | 29,287 | -6,205 |
| Small Business Direct Install | 5,000 | 3,043 | -1,957 |
| Non-Residential Mercantile Commitments | 4,750 | 2,458 | -2,292 |
| Education and Marketing | 0 | 0 | 0 |
| Pilot Programs | 0 | 0 | 0 |
| Stakeholder Initiatives | 0 | 0 | 0 |
| Transmission & Distribution Infrastructure Improvements | 0 | 0 | 0 |
| Evaluation, Measurement and Verification | 0 | 0 | 0 |
| **Total** | **217,034** | **229,772** | **12,738** |

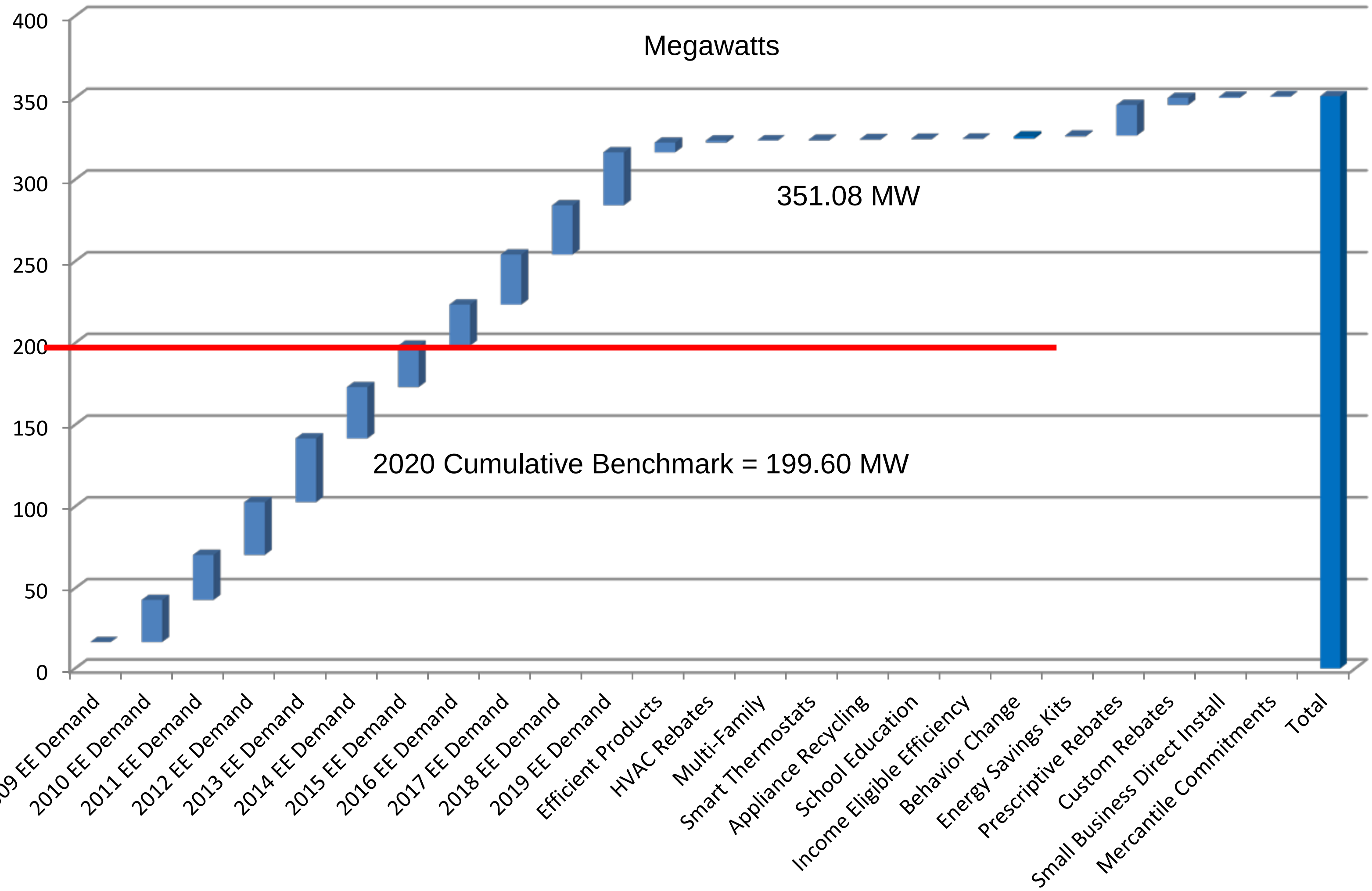
## 2020 ENERGY ACTUALS COMPARED TO CUMULATIVE BENCHMARKS



## 2020 FILED VERSUS ACTUAL DEMAND SAVINGS

| PROGRAM | 2020 Filed (MW) | Annualized 2020 Actual (MW) | Variance (MW) |
|---|---|---|---|
| Residential Efficient Products | 7.86 | 5.95 | -1.91 |
| Residential HVAC Rebates | 1.38 | 1.31 | -0.07 |
| Residential Appliance Recycling | 0.75 | 0.33 | -0.42 |
| Residential Income Eligible Efficiency | 0.15 | 0.09 | -0.06 |
| Residential School Education | 0.26 | 0.21 | -0.05 |
| Residential Behavior Change | 3.17 | 1.44 | -1.73 |
| Residential Energy Savings Kits | 0.43 | 0.58 | 0.15 |
| Residential Multi-Family | 0.71 | 0.03 | -0.68 |
| Residential Smart Thermostats | 0.30 | 0.42 | 0.12 |
| Residential Behavior Change Uplift | 0.00 | -0.07 | -.07 |
| Non-Residential Prescriptive Rebates | 12.15 | 18.70 | 6.55 |
| Non-Residential Custom Rebates | 7.17 | 4.33 | -2.84 |
| Small Business Direct Install | 1.25 | 0.68 | -0.57 |
| Non-Residential Mercantile Commitments | 1.11 | 0.36 | -0.75 |
| Education and Marketing | 0.00 | 0.00 | 0.00 |
| Pilot Programs | 0.00 | 0.00 | 0.00 |
| Stakeholder Initiatives | 0.00 | 0.00 | 0.00 |
| Transmission & Distribution Infrastructure Improvements | 0.00 | 0.00 | 0.00 |
| Evaluation, Measurement and Verification | 0.00 | 0.00 | 0.00 |
| Total | 36.69 | 34.36 | -2.33 |

## 2020 DEMAND ACTUALS COMPARED TO CUMULATIVE BENCHMARKS



# RESIDENTIAL PROGRAMS

## RESIDENTIAL EFFICIENT PRODUCTS

### PROGRAM DESCRIPTION

The Residential Efficient Products Program offers two methods for customers to receive incentives for the purchase of energy efficient products: 1) through an upstream, manufacturer buy-down of light-emitting diode bulbs (LED) and other efficient products sold at the retail level.  No coupon or rebate form is required; the customer receives the discount at the register at the time of purchase and 2) through an online marketplace where customers can perform account validation and receive instant rebates on products shipped to their home.

The objective of the program is to increase the number of long-life, Energy Star qualified LEDs and other energy-efficient products sold to DP&L customers by providing incentives to decrease consumer costs.  The program increases consumer awareness and acceptance of energy-efficient products.

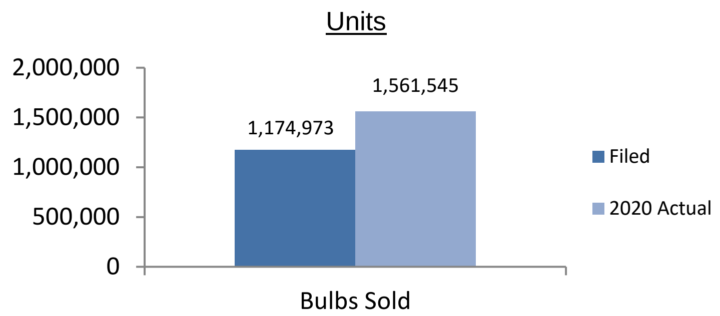
The Residential Efficient Products Program is designed for all DP&L residential customers who purchase efficient products through retail channels.  All customers taking delivery service from DP&L are eligible for this program regardless of their choice of generation supplier.

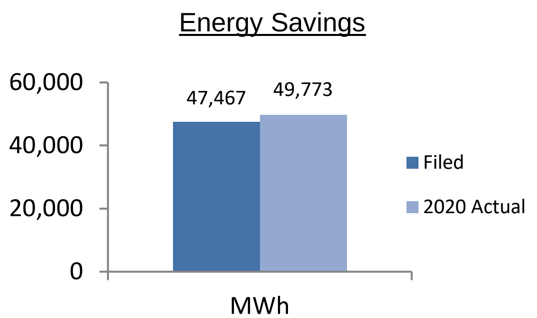
This upstream lighting discount program started in February 2009 and continued through 2020.  The online marketplace launched in June 2018.

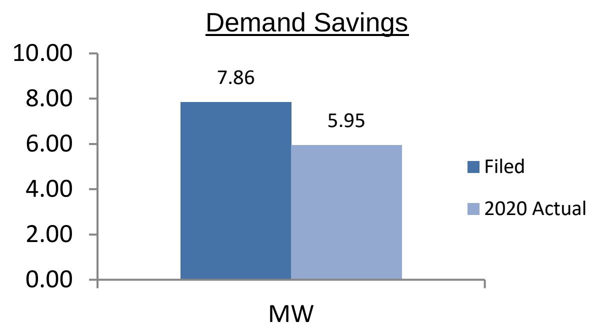
### PERFORMANCE SUMMARY

During 2020, a total of 1,561,545 efficient products were sold to residential customers throughout the DP&L service territory, resulting in gross annualized energy savings of 49,773 MWh and peak demand savings of 5.95 MW.  Keys to the program's success include offering customers a wide variety of lighting choices with attractive discounts as well as a broad, and convenient, retail distribution network.

### *2020 Performance*

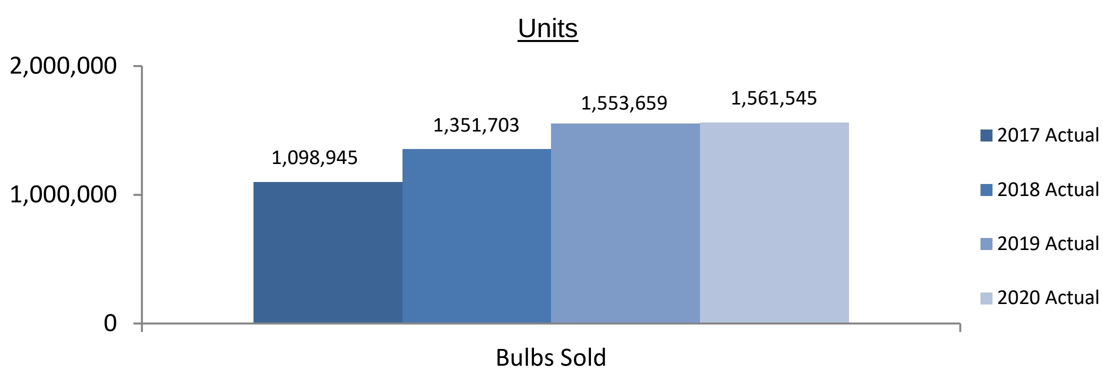


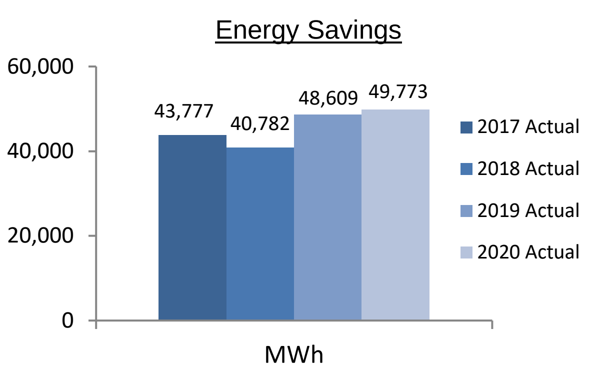



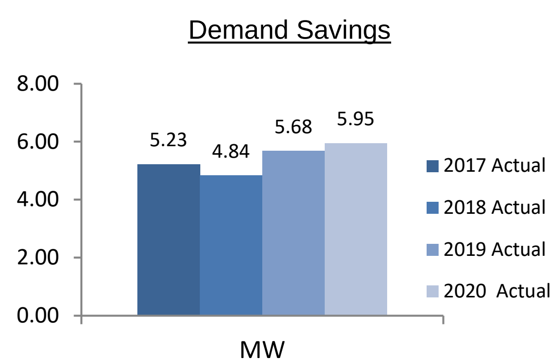




All “filed” numbers are taken from DP&L’s program portfolio filing; Case No. 17-1398-EL-POR.

### *Four-Year Trend Analysis*



*Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $2,251,970 | $2,229,477 |
| Marketing & Admin | $964,799 | $876,665 |
| Total Costs | $3,216,769 | $3,106,142 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

With a lighting discount program, a third-party implementation vendor offers significant value due to its experience running similar programs as well as existing lighting manufacturer and retailer relationships. As such, DP&L determined that program implementation would be most effectively managed by a third-party implementation partner.

At the conclusion of a Request for Proposal (RFP) process, CLEAResult (formerly Applied Proactive Technologies), based in Springfield, Massachusetts, was selected as the implementation partner. In its proposal, CLEAResult demonstrated a sound process for quickly and effectively implementing programs based on its fifteen-year track record of successfully implementing similar programs for utility clients, including AEP Ohio, in 20 states throughout the country.

Similarly, with an online marketplace, it is of great benefit to work with a third-party implementation vendor with experience implementing other similar utility marketplaces. Uplight (formerly Simple Energy), based in Boulder, Colorado, was selected as the implementation partner. In its proposal, Uplight demonstrated a sound process for quickly and effectively implementing marketplaces based on its track record of successfully implementing similar programs for utility clients like Georgia Power, Xcel Energy and National Grid.

### *Targeted Products*

DP&L's Residential Efficient Products Program is designed to provide customers with an extensive choice of products, so customers can select the types of products that best meet their needs. In total, the 2020 upstream lighting program offered customers a choice of 767 different LED products. The most popular products by type included: 9-watt A19 LEDs (standard LEDs) and 5.5-watt Candelabra LEDs (specialty LEDs). DP&L offers soft white, bright white and daylight colored bulbs. Customers could choose between the following LED bulb types: 3-way, dimmable, globe, A-line, reflector, candelabra, smart bulbs and retrofit kits. For standard LEDs, the average discount was $1.16 per bulb with discounts ranging from $0.25 to $1.75. For specialty LEDs, the average discount offered was $1.48 per bulb with discounts ranging from $0.63 to $1.73, depending on the type of bulb.

Customers also had a choice of 20 pipe wrap products and 27 door sweep products at Home Depot and Lowe's stores. The pipe wrap discount was $1.00 per 6-foot section, and the door sweep discount was $3.00 per unit. Six air purifier models and 8 dehumidifier models were discounted in Home Depot and Lowe’s stores at $25.00 per unit, and advanced power strips were discounted at Dollar Tree stores at $10.00 per unit.

The DP&L Marketplace offered customers the opportunity to purchase discounted LED products, as well as advanced power strips, air purifiers, dehumidifiers, and smart thermostats. Costs and savings for smart thermostats sold through the DP&L Marketplace are counted in the Residential Smart Thermostats Program.

***Participating Retailers, Locations***

To make the upstream lighting program convenient and accessible for all customers, DP&L’s program enlisted the participation of the traditional “big box” retailers as well as independent hardware and specialty locations. Both big box and independent retailers add value to the program, but big box retailers sell significant volume, allowing the program to reach the largest number of DP&L customers as quickly as possible.

The primary participating retail outlets were concentrated in the Dayton metropolitan area to match the location of the highest volume of DP&L residential customers. DP&L also offered the program in outlying areas, giving all residential customers the opportunity to participate. The online DP&L Marketplace was included in the program to provide an additional convenient option for customers.

Retail locations were carefully selected to minimize the potential for participation from non-DP&L customers. The highest concentration of retailer locations coincides with geographic areas that have the highest concentration of DP&L customers. Retailer locations outside of the DP&L service territory were excluded. In communities served by municipal utilities or on the edge of the DP&L service territory, store locations were minimized.

| Retailer | # of Locations |
|---|---|
| Ace Hardware | 7 |
| Batteries Plus | 3 |
| Costco | 1 |
| Dickman Supply | 4 |
| Dollar General | 35 |
| Dollar Tree | 29 |
| Home Depot | 7 |
| Kroger | 30 |
| Lowe’s | 12 |
| Meijer | 6 |
| Menards | 4 |
| Sam’s Club | 3 |
| Target | 4 |
| Walmart | 17 |
| **Total** | **162** |

### *Staffing*

For the upstream lighting program, two CLEAResult staff members managed the program and served as DP&L's direct points-of-contact. These experienced managers supported three local field staff members. The local field staff was responsible for visiting participating retail outlets to ensure that discounted products were stocked on the shelves, priced and labeled correctly, so customers received the discounts at the register. The local field staff was also responsible for promoting the program at a number of community events.

For the DP&L Marketplace, one Uplight program manager managed the program and served as DP&L's direct point-of-contact. This manager coordinated all staff members and tasks involved with implementing the DP&L Marketplace from sourcing products, designing and developing the marketplace, customer service, and order fulfillment.

### *Marketing*

In order to promote LEDs and the lighting program discounts to its customers, DP&L employed a breadth of marketing methods. Starting with the assumption that the majority of lighting purchasing decisions are made in the store at the time of purchase, the core of the marketing efforts focused on point-of-purchase (POP) materials. For instance, DP&L created a special sticker which is placed next to the standard price sticker to alert customers to program discounts. A "vertical beam sign" protrudes into the aisle and calls attention to the available discounts and the benefits of efficient lighting. CLEAResult works with retail management staff at the national level to create approved templates for in-store signage. And, local field staff work with local store managers to position the discounted bulbs and signage in highly visible areas whenever possible.

For the DP&L Marketplace, the primary form of marketing was outbound email communication directly to customers' inboxes.

*Point-of-Purchase Material Samples*

Vertical Beam Sign

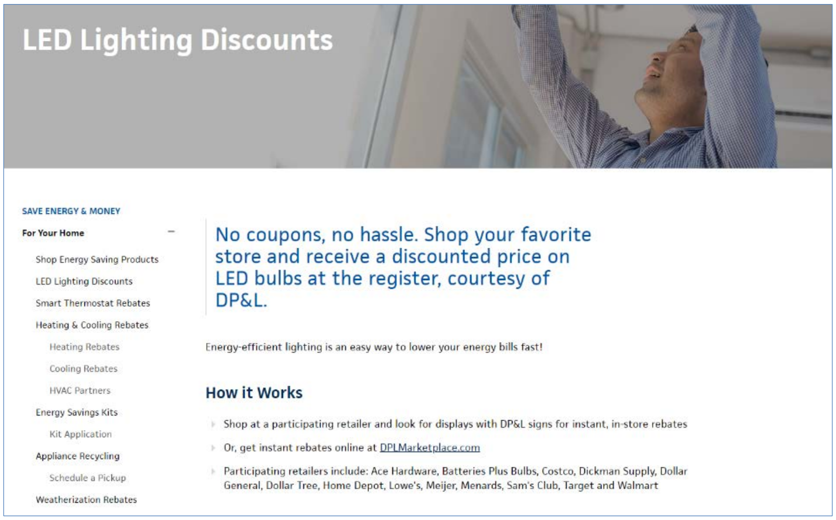

Shelf Sticker


8x10 Shelf Sign


Beyond the POP materials, DP&L also promotes the Residential Efficient Products Program to customers via a web site, bill inserts, presence at special events, and mass media advertising.

The Residential Efficient Products program's web pages on the DP&L company web site provide a description of bulb types and their applications, conversions of wattages from incandescent to LED, and answers to frequently asked questions.

Customers can also access the DP&L Marketplace to place an online order for discounted LED bulbs and other efficient products for the home.




*Web Site*

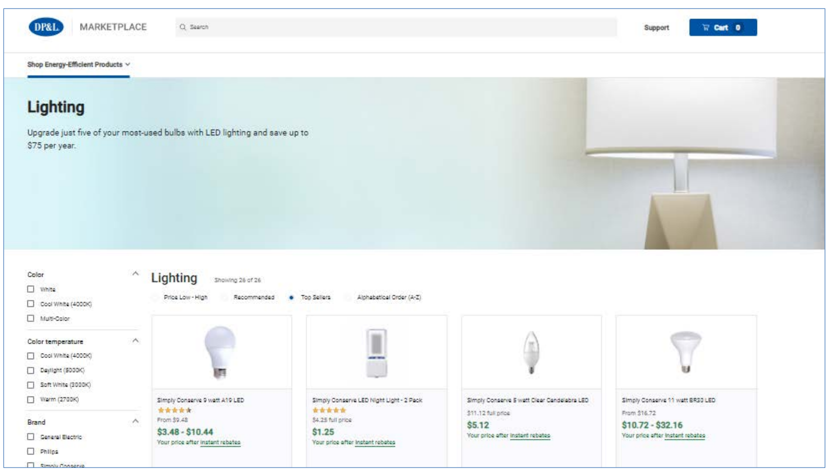
The Residential Efficient Products program page provides an overview of how to participate in the program.


*Bill Insert*

Bill inserts were mailed to 450,000 residential customers in February, June, and September.


*Community Outreach Events*

The CLEAResult local field staff attended 11 local community and in-store events to discuss the Residential Lighting program. (Photo of a pre-Covid event.)




*DP&L Marketplace*

DPLMarketplace.com is available to all residential customers. Customers can purchase energy efficient products, complete quick customer validation and receive instant rebates on qualified products.

### ***Customer Service***

In all programs, customer service is a critical element of program success. As such, DP&L designed a number of customer service elements into its programs, some of which have been previously discussed.

The program web pages (discussed in the Residential Efficient Products Program Marketing section) allow DP&L to provide a breadth of information for all customers with internet access. The web pages not only educate about LEDs, but also help customers locate available discounts near their home.

For those without internet access, or who want to speak to a representative, DP&L set up a program hotline number staffed by CLEAResult employees.  The staff has been trained to answer detailed questions about the upstream lighting program and help customers locate available discounts.

DP&L maintains its own customer service center, accepting calls regarding all functions of DP&L.  DP&L management staff continues to update customer service center staff regarding program details as needed.

The CLEAResult local field staff continues to be a large component of DP&L's customer service, ensuring the accuracy of prices and products in stores, which helps to meet customers' expectations.  In a retail environment, it is possible for POP materials to be inadvertently removed or placed next to products that may or may not be discounted as restocking occurs.  Regular, in-person store visits are an essential element of the program.  CLEAResult performed more than 1,900 store visits in 2020.  In addition, the local field staff was in direct contact with customers at 11 local community events and in-store events in 2020, answering questions and helping to educate customers about the program.

Uplight also staffs a customer service department to handle DP&L customer questions pertaining to the DP&L Marketplace.  Customers can submit questions via email, online chat, or phone.  The staff has been trained to answer detailed questions about the products sold on the marketplace, customer validation, rebate redemption, and order fulfillment.

## RESIDENTIAL HVAC REBATES

### PROGRAM DESCRIPTION

The Residential HVAC Rebates Program offers rebates for the installation of new or replacement, high efficiency central air conditioning and heat pump systems. The participating HVAC contractor submits the rebate for the customer, and the customer receives a rebate check in the mail.

The objective of the program is to reduce energy consumption and peak demand savings by incentivizing customers to purchase efficient HVAC equipment that goes above and beyond the current minimum standard for efficiency.

This program is designed for any homeowner or landlord purchasing a new or replacement HVAC unit that will be installed at a residence within the DP&L service territory. All customers taking delivery service from DP&L are eligible for this program regardless of their choice of generation supplier.

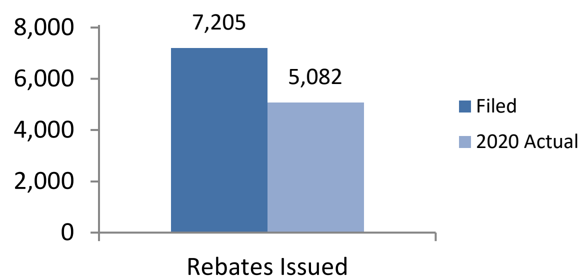
The program started in June 2009 with a core group of 23 participating contractors and has increased to 129 participating contractors by the end of 2020.

### PERFORMANCE SUMMARY

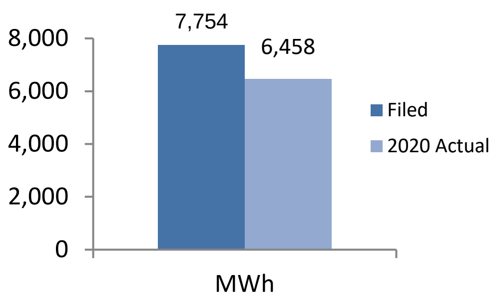
During 2020, a total of 5,082 HVAC rebates were issued throughout the DP&L service territory, resulting in gross annualized energy savings of 6,458 MWh and peak demand savings of 1.31 MW. Keys to the program's success include offering customer rebates on a wide variety of HVAC products and insulation and weatherization services through an extensive contractor network. In 2020 DP&L requested and was granted permission from the PUCO to transfer $75,000 from the *Multi-Family Direct Install* program to the *HVAC Equipment* program to provide additional incentives to meet high customer demand in the *HVAC Equipment* program. Transfer of these funds is reflected in the filed program budgets.

### *2020 Performance*

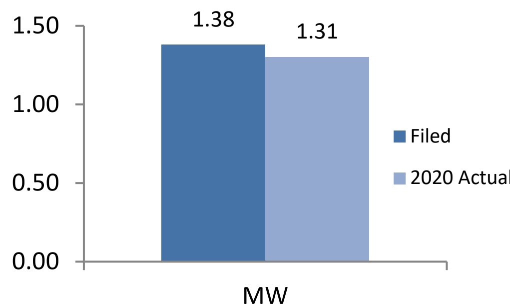
Units




Energy Savings




Demand Savings

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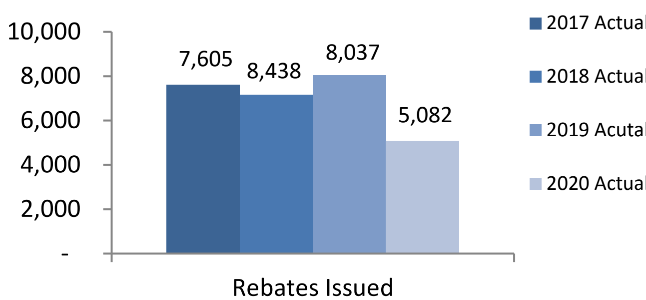
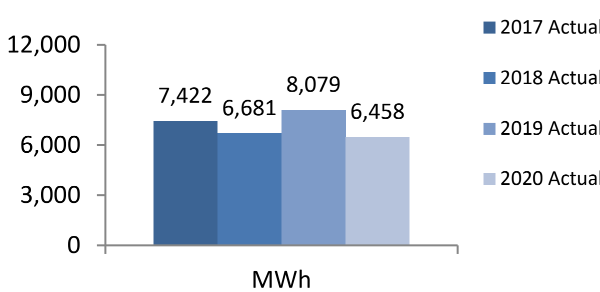
### *Four-Year Trend Analysis*

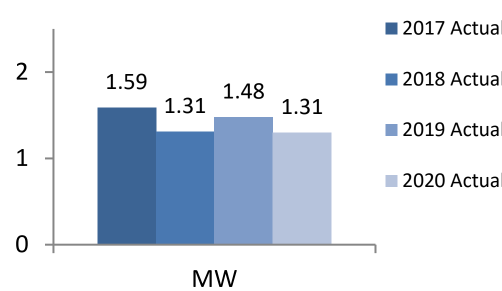
Units




Energy Savings




Demand Savings



### *Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $931,595 | $927,335 |
| Marketing & Admin | $474,267 | $437,943 |
| Total Costs | $1,405,862 | $1,365,278 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

With a Residential HVAC Rebate Program, it is valuable to have a third-party implementation vendor with experience running similar programs that require building a network of HVAC contractors. Therefore, DP&L determined that program implementation would be most effectively managed by a third-party implementation partner.

At the conclusion of a 2017 RFP process, CLEAResult won the bid to implement the Residential HVAC Rebate Program from 2018-2020.

### *Targeted Products*

DP&L offered rebates for central HVAC systems in two categories: New Construction and Replacement, with tiers for higher efficiency levels. DP&L customers can select the system manufacturer and model of their choice but are only eligible to receive a rebate if the system meets the Seasonal Energy Efficiency Rating (SEER) requirements, or the Energy Efficiency Ratio (EER) requirements for ground source heat pumps. DP&L also offers rebates for the installation of electronically commutated motors (ECM) used in high efficiency gas furnaces. In 2020, the most popular central system rebate was for replacement air conditioners at SEER 16+, followed by replacement air conditioners at SEER 14/15. DP&L issued 1,666 rebates for smart and wi-fi thermostats. Additionally, DP&L offered incentives for home insulation and weatherization on electrically heated homes.

***Rebates Offered***

Central Air Conditioning

| SEER Efficiency Rating | New Construction | Replacement |
|---|---|---|
| 14-15 | $100 | $100 |
| 16+ | $150 | $300 |

Air-Source Heat Pumps

| SEER Efficiency Ratio | New Construction | Replacement |
|---|---|---|
| 15 | $150 | $150 |
| 16+ | $250 | $400 |

Mini-Splits

| SEER Efficiency Ratio | New Construction | Replacement |
|---|---|---|
| 14+ | $150 | $150 |
| 15+ | $200 | $200 |

Ground-Source Heat Pumps

| EER Efficiency Ratio | New Construction | Replacement |
|---|---|---|
| 16-18 | $800 | $800 |
| 19+ | $1,000 | $1,000 |

Electronically Commutated Motors

| Cooling Type | New Construction | Replacement |
|---|---|---|
| Furnace only | $50 | $50 |
| Air conditioner | $50 | $50 |
| Heat pump | $25 | $25 |

Thermostats

| Cooling Type | Wi-Fi w/Air Conditioner | Wi-Fi w/Heat Pump | Smart Thermostat |
|---|---|---|---|
| | $20 | $30 | $75 |

Heat Pump Water Heater

| Heating Type | Gas Furnace | Heat Pump |
|---|---|---|
| | $400 | $400 |

The following are descriptions of the different rebate categories for HVAC equipment.

*New Construction* – High-efficiency, new equipment installed in an existing home, a new home, or a home addition where there is no previously existing central air conditioning or heat pump system.

*Replacement* – High-efficiency, new equipment installed as a replacement for existing equipment not meeting early retirement eligibility requirements.

In 2018, DP&L removed the rebate incentive for *Early Retirement* equipment.

***Rebates Issued***

| Technology | 2020 Rebates Issued |
|---|---|
| Air Conditioners | 2,224 |
| Air Source Heat Pumps | 675 |
| Ductless Mini-Splits | 165 |
| Ground Source Heat Pumps | 103 |
| Thermostats | 1,666 |
| Heat Pump Water Heaters | 12 |
| Air Sealing and Insulation | 237 |
| **TOTAL** | **5,082** |

***Targeted Contractors***

CLEAResult recruited a network of contractors to market, recommend, and install eligible HVAC equipment. Contractors must be certified by DP&L to participate in the program and must sign a partnership agreement. Certification qualifications include: a valid HVAC license; minimum levels of insurance; Environmental Protection Agency-certified technicians; and a Better Business Bureau rating higher than B-. Large contractors were targeted first, which allowed the program to reach the greatest number of DP&L customers as quickly as possible. Continually, smaller, independent contractors were recruited, so that by the end of 2020, the program had 129 participating contractors located throughout the DP&L service territory.

To make the program convenient and accessible for all customers, customers may purchase an eligible HVAC system from their choice of DP&L certified contractor. If a customer's existing contractor is not already a certified contractor, CLEAResult will work to recruit the contractor into the program so the customer does not have to switch contractors.

When purchasing qualifying equipment, participating contractors complete the rebate application on the customers' behalf. DP&L customers then receive the rebate via a check mailed to their home.

*Staffing*

CLEAResult's local staff members manage the program and serve as DP&L's direct point-of-contact. The local field staff, consisting of a program manager, account manager, administrative coordinator, data entry specialist, and part-time quality control auditor, is responsible for maintaining relationships with HVAC contractors to ensure the program is mutually beneficial and successful. For contractors to be most successful in the program, they need to have a thorough understanding of program guidelines and buy-in to the DP&L program design and processes. CLEAResult maintains regular contact with contractors to discuss program issues, potential solutions, and opportunities for improvement.

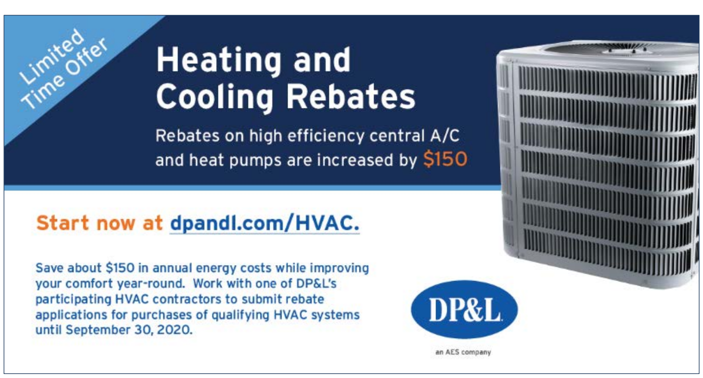
CLEAResult closely monitors rebate applications for accuracy of rebate values and eligibility of equipment. CLEAResult also performs quality control checks on a portion of all system installations and accompanying paperwork to ensure contractors adhere to the program guidelines. Contractors who exhibit a track record of poor quality work or customer complaints are removed from the program. The local staff is supported by the experienced managers and support team located in the CLEAResult main office.

*Marketing*

The program is designed to be marketed largely through participating HVAC contractors. Since contractors work directly with DP&L customers, they are able to offer rebates at the point-of-sale. Participating contractors are motivated to offer the rebates as a sales tool, providing a discount that non-participating contractors cannot. To support contractors and help advertise the program, DP&L created a series of marketing pieces including web pages, fliers, bill inserts, and mass media marketing.

The HVAC rebate program web pages on the DP&L company web site provide an overview of the program, a list of eligible equipment, and answers to frequently asked questions. One page is dedicated to helping customers find a participating contractor. Customers can search by their home county and see a list of all contractors serving that area. This page also mentions the ability to recruit the customer's preferred contractor.

The web portal contains a special log-in section for participating contractors. The portal displays program news and answers to frequently asked questions.

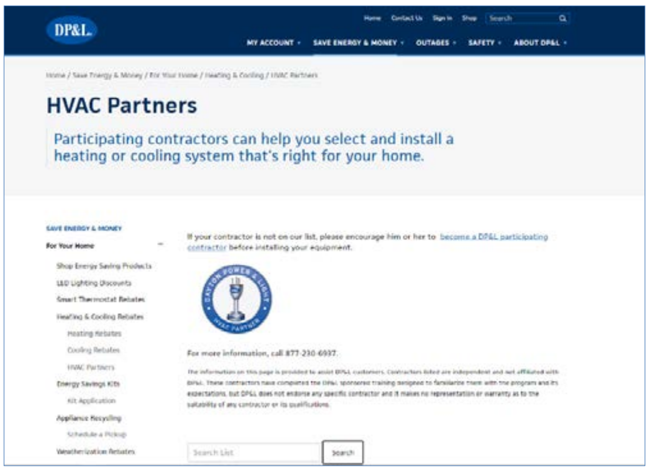



*Bill Insert*

*Bill inserts were mailed to 450,000 customers in July, August and September.*


*Customer Web Pages*

The HVAC program landing page gives a description of the residential HVAC rebates program and allows customers to navigate to other pages for more information.




*Web Site Contractor Locator*

The contractor locator allows customers to search for participating contractors by their home county.


*Education and General Awareness*

DP&L conducted a mass media education and general awareness campaign promoting the value of energy efficiency and the available residential programs, including HVAC rebates. A complete discussion of this campaign can be found in the Education, Awareness Building & Market Transformation Activities section.

### *Customer Service*

In all programs, customer service is a critical element of program success. As such, DP&L designed a number of customer service elements into its program, some of which have been previously discussed.

The web pages and contractor locator (discussed in the Residential HVAC Rebates Marketing section) allow DP&L to provide a breadth of information for all customers with internet access. The contractor locator allows customers to conveniently access a way to participate in the program.

For those without internet access, or who want to speak to a representative, DP&L set up a program hotline number staffed by CLEAResult employees. The staff has been trained to answer detailed questions about the Residential HVAC Rebates Program and help customers locate participating contractors in their area.

DP&L maintains its own customer service center, accepting calls regarding all functions of DP&L. DP&L management staff continues to update customer service center staff regarding program details as needed.

The large number of participating contractors is an important component of DP&L's customer service. The contractors are located throughout DP&L's service territory, making the rebates accessible to all customers. In addition, the ability to recruit a customer's current contractor is a large source of satisfaction for both the customer and the contractor.

The CLEAResult local staff is another significant element of DP&L's customer service, serving both the contractors and the customers. For contractors to be most successful in the program, they need to have a thorough understanding of program guidelines and buy-in to the program design and processes. CLEAResult maintains regular contact with contractors to discuss program issues, potential solutions, and opportunities for improvement.

In addition, CLEAResult's quality control of contractors' work allows DP&L customers to receive their rebates, as promised. CLEAResult performs quality control checks on five percent of all system installations. Equipment is reviewed along with the accompanying paperwork to ensure contractors adhere to the program guidelines. CLEAResult's oversight ensures the program's integrity is maintained and customers are treated properly and fairly. Contractors who exhibit a track record of poor-quality work or customer complaints are removed from the program.

## RESIDENTIAL APPLIANCE RECYCLING

### PROGRAM DESCRIPTION

The Residential Appliance Recycling Program allowed for the collection of working refrigerators, freezers, room air conditioners, and dehumidifiers. The appliances were picked up directly from customers' homes, at no cost to the customer, and were transported to a facility in Lima, Ohio to be deconstructed and recycled according to the Environmental Protection Agency's (EPA) best practices. Customers participating in the program in 2020 received a $50 rebate check for each refrigerator and freezer recycled, and $20 for each room air conditioner and dehumidifier recycled.

The objective of the program was to promote the retirement and recycling of inefficient appliances from households by offering an incentive for working equipment as well as information and education on the cost of keeping an inefficient unit in operation.

The Residential Appliance Recycling Program was designed for any residential customer with working refrigerators or freezers. The appliances were required to be plugged in and in working condition. All targeted customers taking delivery service from DP&L were eligible for this program regardless of their choice of generation supplier.

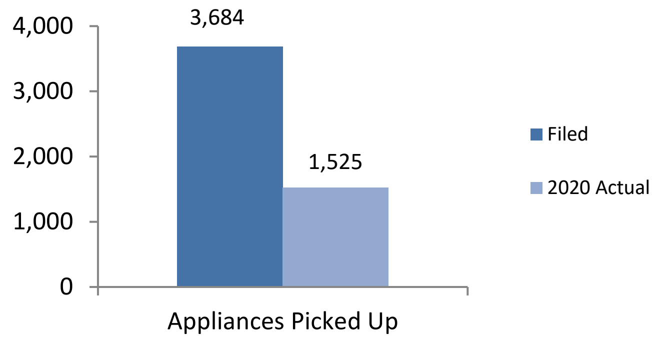
This program started in May 2009 and continued through 2020.

### PERFORMANCE SUMMARY

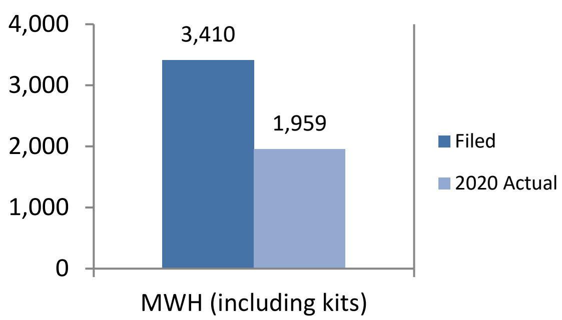
During 2020, 1,525 appliances were collected throughout the DP&L service territory, resulting in annualized energy savings of 1,876 MWh and peak demand savings of 0.32 MW. Additionally, DP&L continued distributing energy savings kits to customers when picking up their appliance to be recycled. Energy kit savings resulted in annualized energy savings of 83 MWh and peak demand savings of 0.01 MW. Therefore, the total gross annualized energy savings for the Residential Appliance Recycling Program were 1,959 MWh and peak demand savings of 0.33 MW.

## *2020 Performance*

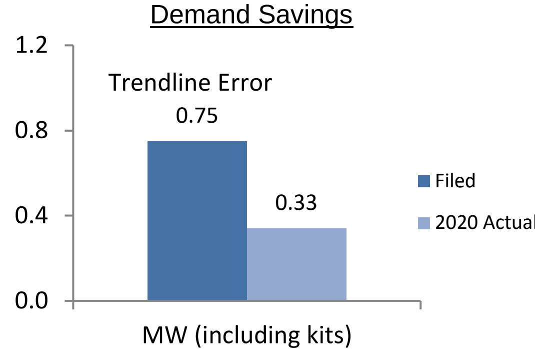
Units




Energy Savings




Demand Savings

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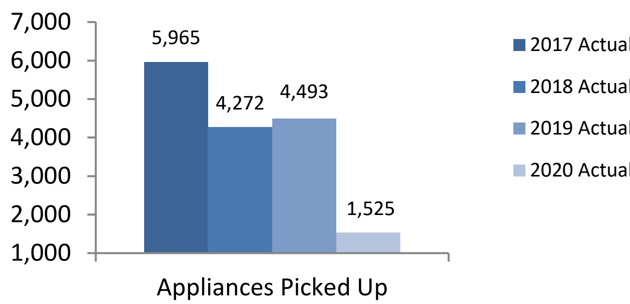
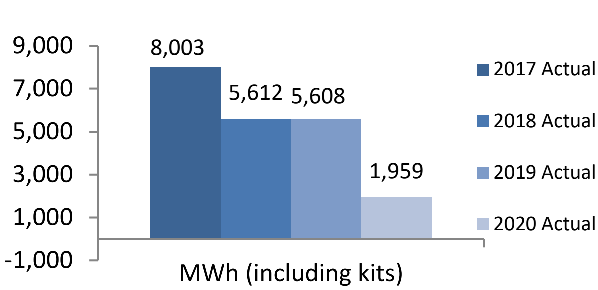
## *Four-Year Trend Analysis*

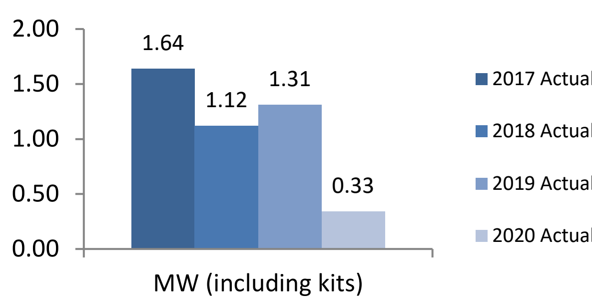
Units




Energy Savings




Demand Savings



***Budget, Cost Summary***

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $222,490 | $83,060 |
| Marketing & Admin | $407,622 | $163,800 |
| Total Costs | $630,112 | $246,860 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

Appliance recycling and proper disposal of materials require technical expertise, available recycling facilities, and qualified crews in the field. As such, DP&L determined a third-party implementation partner, specializing in this area, provided the best means of effectively managing the program.

At the conclusion of a 2016 Request for Proposal (RFP) process, Recleim, based in Atlanta, Georgia was selected as the implementation partner. In its proposal, Recleim demonstrated a sound process for efficiently and properly collecting and deconstructing appliances, as well as the recycling and disposal of appliance components. Recleim had experience implementing programs for clients like ComEd, PPL Electric Utilities and UGI Utilities. Key program management personnel also had many years of experience working for clients throughout the country, including DP&L, on an appliance recycling program with a former vendor.

### *Targeted Products*

DP&L offered rebates for working refrigerators and freezers functioning both as secondary units and primary units, which were likely on their way to becoming secondary units in a garage or basement. The unit was required to be 10 to 30 cubic feet in size, which is the traditional size for units used in a residential setting. DP&L also collected working room air conditioners and dehumidifiers that were picked up along with a refrigerator or freezer.

Before an appliance was removed from the home, Recleim inspected the appliance to ensure it was in working condition and was plugged in. Non-working appliances or those that are unplugged are not eligible for removal.

The rebate amount was $50 per refrigerator and freezer collected and $20 for each room air conditioner and dehumidifier collected. Customers were paid via digital check, pre-paid Visa card, or check mailed directly to their homes.

### *Home Energy Savings Kits*

In 2020, DP&L continued distributing two LED light bulbs to customers when picking up their appliance to be recycled. This customer service element enabled customers to save more energy at home and increased program savings.

Each participating customer was offered the light bulbs, but customers could choose whether to accept them. In 2020, 1,216 LED bulbs were distributed.

### *Targeted Locations*

To make the Residential Appliance Recycling Program convenient and accessible to all residential customers, Recleim crews were available to pick up appliances from every geographic area of the DP&L service territory. Recleim scheduled pick-up dates and routes according to geography, targeting one region of the service territory each day.

### *Staffing*

A senior program manager served as the DP&L point-of-contact. The Recleim program manager regularly communicated with the DP&L program manager to discuss program implementation. The Recleim program manager also coordinated all the project's tasks and served as the hub of communication to Recleim support staff in technical support, customer service, check processing, and operations.

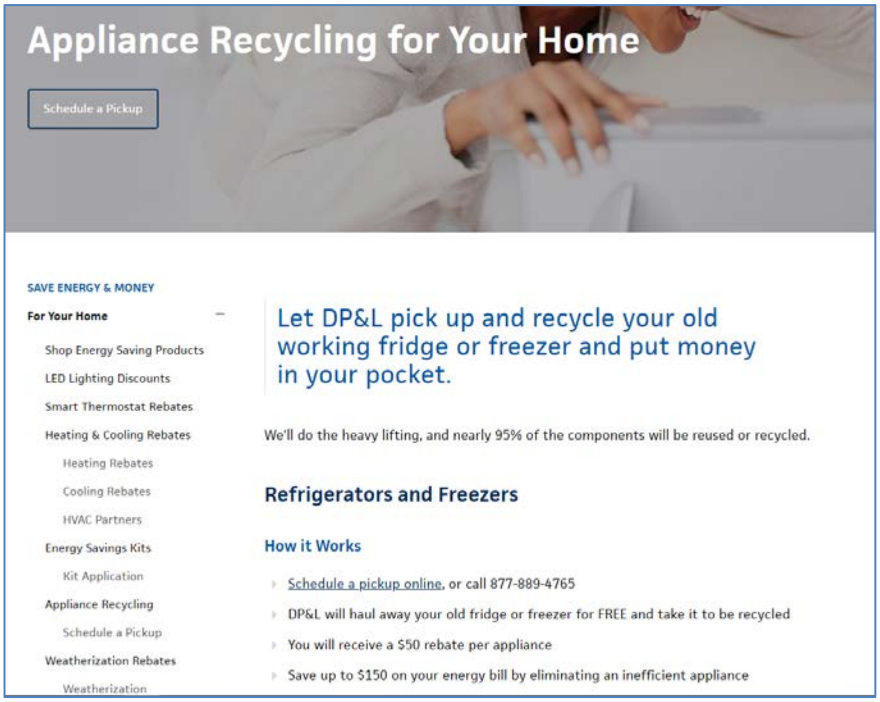
The collection logistics facility in Columbus, Ohio was managed by an on-site facility manager who planned the crew's pick-up routes and managed the collection and tracking of units. Crews of two were dispatched each day from the facility to the pick-up routes. Three times per week, collected units were transported from the logistics facility to Recleim's state-of-the-art de-manufacturing plant in Lima, Ohio, opened in Fall 2017. Recleim safely disposed of toxins and chlorofluorocarbon (CFC-11) gases from foam insulation. After capturing toxins (oils, mercury, PCBs) and other substances (CFC-11 and other foam insulation blowing agents and CFC-12 and other refrigerants), Recleim recycled all the plastic, metals and glass in the appliances. Nearly 100 percent of a refrigerator's components were reused rather than going to the landfill. The facility manager was responsible for ensuring all material handling processes complied with the best practices of the U.S. Environmental Protection Agency (EPA).

DP&L is a utility partner in the EPA's Responsible Appliance Disposal Program. Recleim tracked and reported all program activity required by the RAD program.

### *Marketing*

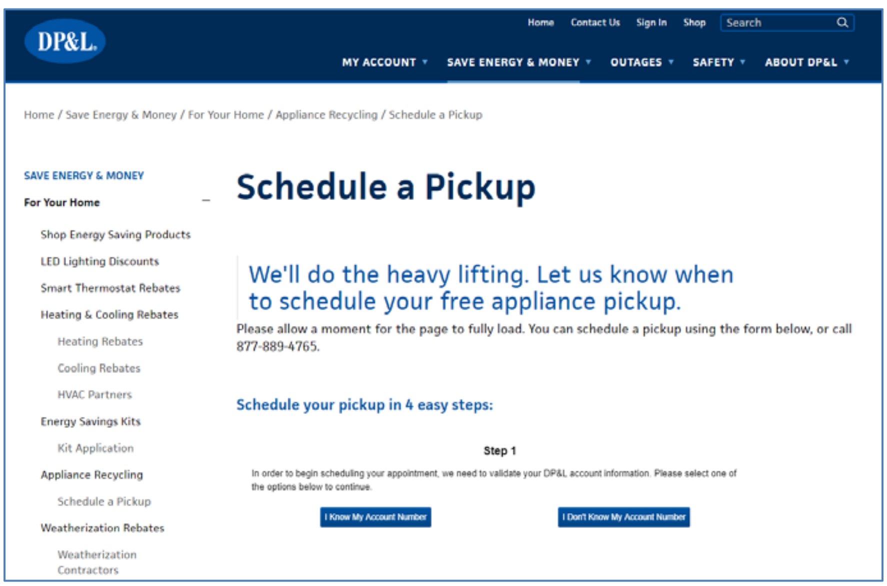
DP&L utilized a variety of marketing methods to promote the appliance recycling program to customers. The marketing collateral emphasized the cost of operating a second refrigerator or freezer and the rebate offered to program participants.

The customer web pages on the DP&L web site informed customers of program eligibility requirements, answers to frequently asked questions, and an overview of the recycling process. In addition, customers were able to register and schedule a pick-up via a web interface.




*Customer Web Pages*

The appliance recycling program landing page gave a description of the program and allowed customers to navigate to other pages for more information.




*Online Registration*

Online registration allowed customers to schedule a pick-up at their home.

### *Customer Service*

In all programs, customer service is a critical element of program success. As such, DP&L designed a number of customer service elements into its program, some of which have been previously discussed.

The web portal and online registration tool served as a convenient way for customers to learn about the program and schedule a pick-up of their appliance. Customers were able to search for times when a Recleim crew would be working in their area and select the date of their choice for a pick-up.

For those without internet access, or for customers who wanted to talk to a representative, DP&L set up a program hotline number staffed by Recleim employees. The staff was trained to answer detailed questions about the Residential Appliance Recycling Program and to assist customers in scheduling appointments.

DP&L maintains its own customer service center, accepting calls regarding all functions of DP&L. DP&L management staff continued to update customer service center staff regarding program details as needed.

For the customer’s convenience, Recleim crews called 24 to 48 hours before the appointment date to confirm a four-hour window for the pick-up. On the day of the appointment, Recleim crews called the customer 30 minutes prior to the expected arrival time.

Recleim crews conveniently retrieved the appliances from hard-to-access locations, like basements; the customer needed only to clear a path to the appliance. Customers were paid via digital check, pre-paid Visa card, or check mailed directly to their homes. Rebate processing was managed by Recleim.

## RESIDENTIAL INCOME ELIGIBLE EFFICIENCY

### PROGRAM DESCRIPTION

Through the Residential Income Eligible Efficiency Program, home energy audits and inspections are conducted, and cost-effective efficiency measures are installed for qualifying customers. Eligible measures are available to customers depending on whether their home is heated or cooled with electricity. A limited number of health and safety measures may also be addressed through the program.

The objective of the Income Eligible Efficiency Program is to identify and implement energy efficiency measures for qualifying homes, reducing the homeowners' electric bill and saving energy. The program has the secondary benefit of reducing customer arrearages, which can help save money for all customers.

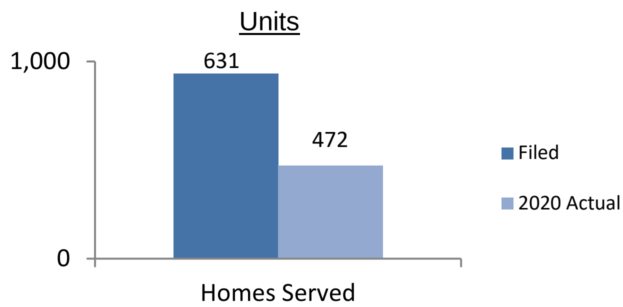
This program is available to income eligible residential electric customers within the DP&L service territory with household incomes equal to or less than 200 percent of the federal poverty level or who are qualified and approved for one of the following: the Ohio Home Weatherization Assistance Program (HWAP), the Percentage of Income Payment Plan (PIPP), or the Home Energy Assistance Program (HEAP). Eligible households include single-family and multi-family homes. This program is available to all qualifying electric customers taking delivery service from DP&L, regardless of their choice of generation supplier.

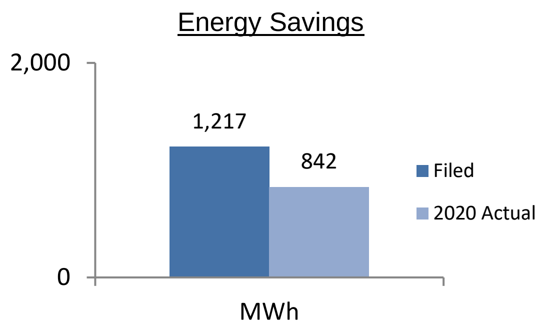
A portion of the program is implemented by the Ohio Partners for Affordable Energy (OPAE) through community action agencies located in DP&L's service area. A portion of the program is implemented by People Working Cooperatively (PWC).

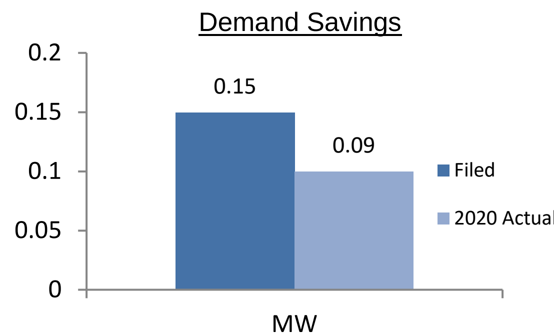
### PERFORMANCE SUMMARY

During 2020, 472 unique customers' homes throughout the DP&L service territory were served through this program, resulting in gross annualized energy savings of 842 MWh and peak demand savings of 0.09 MW.

### *2020 Performance*

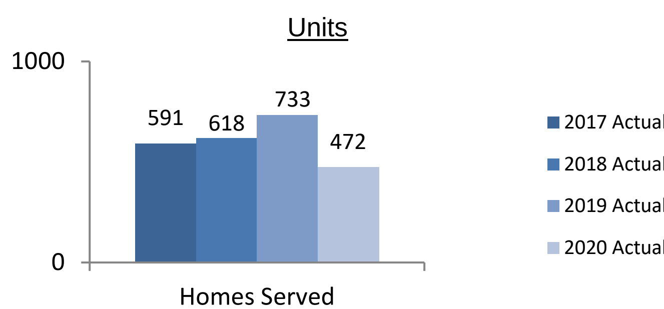


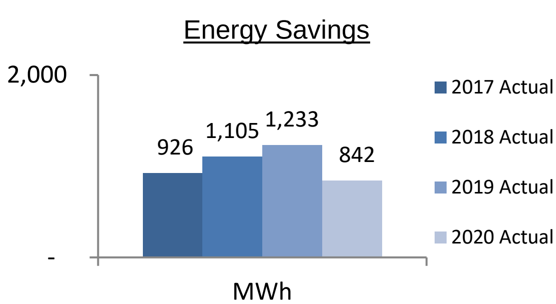



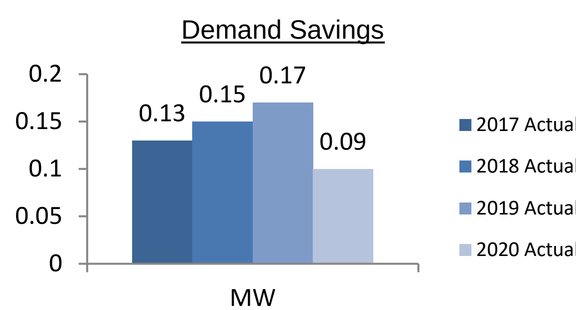




All "filed" numbers are taken from DP&L's program portfolio filing; Case No. 17-1398-EL-POR.

### *Four-Year Trend Analysis*



### *Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---:|---:|
| Incentive Costs | $997,891 | $668,746 |
| Marketing & Admin | $297,243 | $175,886 |
| Total Costs | $1,295,134 | $844,632 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

DP&L partners with OPAE, based in Findlay, Ohio, and PWC, based in Cincinnati, Ohio, to bring eligible customers the benefits of this program. OPAE implements this same type of program for FirstEnergy and AEP. PWC serves customers in southern Ohio and Indiana.

The program is provided to eligible customers in conjunction with OPAE's subcontracting agencies' and PWC's use of other state, utility, and community-based weatherization and energy efficiency services funding. The consolidation of funding sources is designed to save administrative costs and provide more benefits to more customers in a timely, cost-effective manner.

### *Targeted Products*

Implementers may begin their work with a home audit to determine necessary measures. For all customers, eligible measures may include installation of energy efficient light fixtures and light bulbs, and metering and replacement of inefficient or inoperable refrigerators and freezers. In addition, for the customers who heat or cool their homes with electricity, eligible measures may also include ceiling and perimeter insulation and duct sealing or insulation.

DP&L places a high priority on safety. We recognize certain weatherization and energy efficiency measures cannot be completed or installed because of unsafe conditions such as faulty outlets or overloaded circuits. Therefore, electrical safety and health measures are available to eligible customers, regardless of the fuel used as the primary heating source. Health and safety measures may include replacement of outlets, switches, fuse boxes, circuit breaker boxes, and wiring; repair or replacement of roofs, sump pumps, and well pumps; hot water tank replacement; and replacement of inefficient electric stoves and electric dryers.

### *Targeted Locations*

OPAE delivers the program through the community action agencies located in the DP&L service area. These agencies include Miami Valley CAP; Clinton County Community Action Program; Bridges Community Action Partnership; Community Action Commission of Fayette County; Highland County Community Action Organization; and Pickaway County Community Action Organization. PWC delivers the program utilizing internal staff. The extensive list of providers ensures customers throughout the DP&L service area will be reached through the program.

PWC's "whole house" critical repairs, energy conservation and modification programs are enhanced through funding provided by DP&L. Electric conservation services assist low income homeowners and renters who pay for their electric utility services with needed electric energy conservation services. These electric services are often performed as part of a more extensive mix of services for DP&L's customers aimed at assisting the customer to remain successfully in a safer, more secure environment, while simultaneously reducing unnecessary electric usage.

***Staffing***

OPAE manages their portion of the program through the community action agencies. OPAE is responsible for managing the relationships with the agencies to ensure approved work is being performed in eligible customers' homes. Through the agencies, OPAE ensures the participating contractors are trained and certified to complete work according to the Weatherization Program Standards. The OPAE staff processes the paperwork and documentation from contracted agencies regarding completed jobs and jobs in progress. OPAE is also responsible for monitoring and reporting program performance.

PWC manages their portion of the program utilizing internal staff. PWC is responsible for ensuring all auditors and installers are properly trained and certified. PWC administrative staff processes all job-site paperwork or documentation, in addition to providing program reporting.

***Marketing***

OPAE, the community action agencies, and PWC market this program directly to customers.

***Customer Service***

Due to the unique nature of the program, OPAE, through the community action agencies, is responsible for delivering the program in a high quality and cost-effective manner. OPAE and PWC are each responsible for ensuring all services, materials, and supplies are of good quality and installed in a professional, workmanlike way, and all contractors are trained and certified to complete work according to their respective program contract.

DP&L maintains its own customer service center, accepting calls regarding all functions of DP&L. DP&L management staff continues to update customer service center staff regarding program details as needed.

## RESIDENTIAL SCHOOL EDUCATION

### PROGRAM DESCRIPTION

The School Education Program is designed to educate students about energy and energy efficiency and reduce electricity use of program participants. Take-home energy savings kits are provided to students as well as accompanying classroom curriculum that is aligned with national and state education standards. Additional training events are held throughout the year for both teachers and students. This program is delivered jointly with the local gas company, Vectren, A CenterPoint Company (Vectren) in order to educate students about using both gas and electricity efficiently.

The objectives of the program are to: 1) reduce electricity use of program participants in selected schools; 2) educate students and their families about energy, energy efficiency, and the effects of their energy usage decisions; and 3) create energy awareness among students that will promote energy efficient habits throughout their lives.

The Residential School Education Program is available to public and private school districts in the DP&L service territory.

This portfolio status report discusses and reports savings for the 2019-2020 school year only.

### PERFORMANCE SUMMARY

During the 2019-2020 school year, 8,845 energy savings kits were distributed to teachers and taken home by students. Savings garnered via the installation of LED light bulbs, LED night lights, faucet aerators and energy efficient showerheads provided in students' take-home kits totaled gross annualized energy savings of 3,430 MWh and peak demand savings of 0.21 MW.

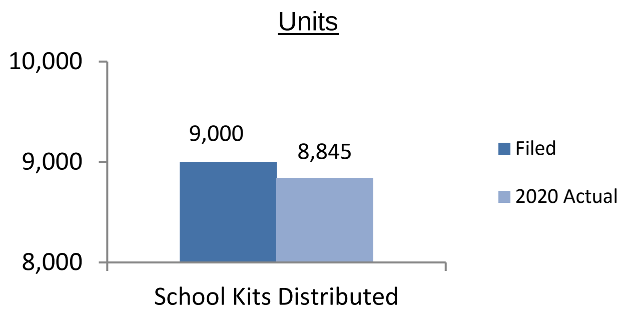
Since a central element of this program is educational, it is important to also measure the performance of the program based on participant feedback and educational impact. Ohio Energy Project (OEP) conducted surveys of participating teachers. Survey results are as follows:

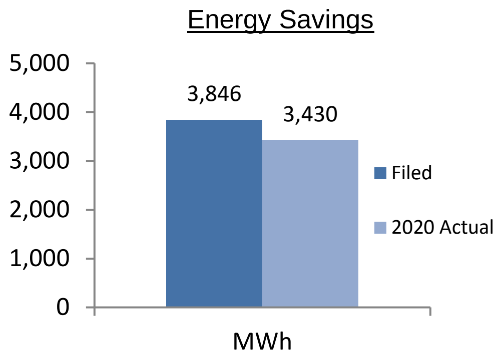
- Ninety-one percent of teachers responded they were very confident or confident the program materials aided their effort in teaching grade level energy content standards.
- Seventy-six percent of participating teachers had participated in one or more prior years of the program.
- Nearly 100 percent of teachers said they would conduct the unit again.

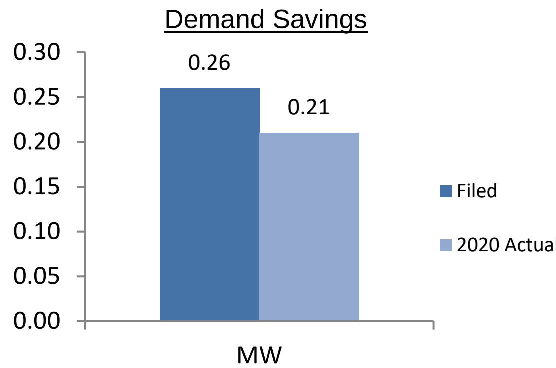
Below are comments from participating teachers regarding the program:

- I have conducted this unit every year because of its relevance to students' lives and how the standards we learn in the classroom connect to daily life in solving real world problems.
- My students gained so much from this experience.
- I have gotten my entire grade level at our school doing this! Please do not stop this program!
- The unit shows students how the science is applicable to their personal lives.
- The lessons and activities were very interesting, kept the students engaged, and helped them to remember important facts and concepts.
- I have received feedback from parents thanking me for talking to their child about energy.
- Students enjoy learning about energy and its use in their house.
- Students became more aware of the way they use energy and how to conserve. They also learned more about how energy moves and could do some hands-on activities to make the concepts come alive for them.

### *2020 Performance*

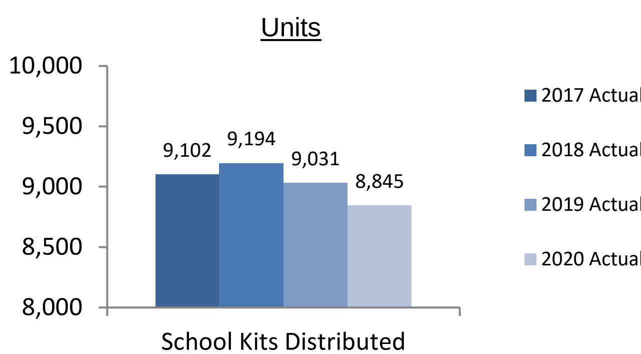


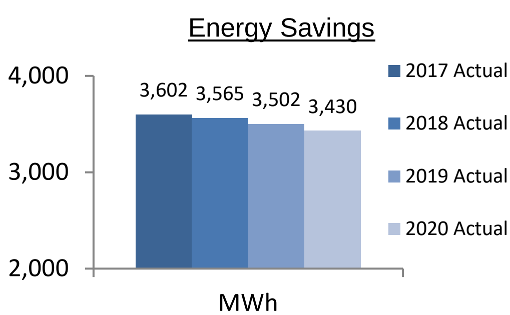



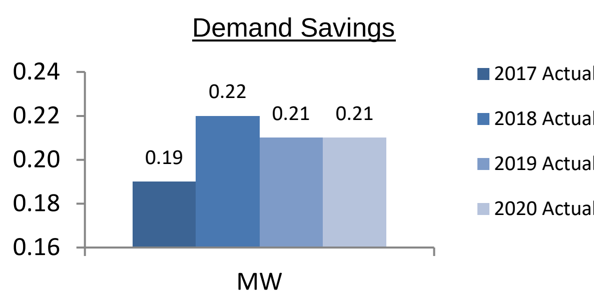




All "filed" numbers are taken from DP&L's program portfolio filing; Case No. 17-1398-EL-POR.

### *Four-Year Trend Analysis*



### *Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $221,030 | $115,083 |
| Marketing & Admin | $181,459 | $141,575 |
| Total Costs | $402,489 | $256,658 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

Implementing a school education program requires expertise of education standards and teachers' methods, as well as relationships with school district administrators and teachers.  As such, DP&L determined a third-party implementation partner, specializing in this area, provided the best means of effectively managing the program.

DP&L selected OEP as its implementation partner.  OEP is uniquely qualified to provide energy efficiency education based on its existing relationships with school districts and experience delivering similar programs throughout Ohio.  OEP is currently operating the same type of program for AEP Ohio, Vectren and Columbia Gas of Ohio.

DP&L partners with Vectren and OEP to deliver a school program which addresses both electric and natural gas savings. The joint effort with Vectren was pursued with the encouragement of DP&L's energy efficiency collaborative.

### *Targeted Products*

Participating teachers were provided energy savings kits to be sent home with each participating student.  Each component of the take-home kit was discussed in the classroom, informing students how to properly install and use the item, as well as the way it helps save energy.  As a result of our partnership with Vectren, kit components address electric, gas, and water savings.

Each teacher was provided with a complete curriculum designed to accompany and educate students about the items contained in the take-home energy savings kit.  The curriculum included classroom activities, experiments, and games, all meeting state of Ohio education standards.  The curriculum also covered subjects like properties of energy, electric generation fuel sources, home energy audit suggestions, appliance energy usage comparisons, LED versus CFL versus incandescent cost comparisons, home temperature measurement exercises, and weatherization information.

In addition, teachers were given materials needed to teach the program curriculum in their classrooms.  Teachers were given kits that contained classroom teaching tools, activities, and games that reinforce concepts such as renewable and nonrenewable resources, and energy transformations.

***Take-Home Kit Contents***

| Item | Description |
|---|---|
| 2 9W LED | Long-life light bulb with up to 90% energy savings. Lasts up to 25 times longer than an incandescent bulb. |
| Foam Weather-Strip | Adhesive backed weather stripping, good for sealing out drafts in doors and windows. |
| Self-Stick Door Sweep | Adhesive-backed PVC door sweep. Seals door gaps and prevents drafts. |
| Flow Meter Bag | Test your water faucets to see how much water they use. |
| Earth Massage Showerhead | This product saves water and the energy required to heat the water. |
| 2 Bathroom Sink Aerators | Consistent water pressure from a bathroom sink aerator. This product saves water and the energy required to heat the water. |
| 1 Kitchen Sink Aerator | Consistent water pressure from a kitchen sink aerator. This product saves water and the energy required to heat the water. |
| Refrigerator Thermometer Card | Credit card-sized measuring device to determine whether refrigerator is at an efficient temperature. |
| LED Night Light | Light Emitting Diode (LED) technology creates suitable yet energy efficient light. |
| Hot Water Temperature Card | Credit card-sized device measures the temperature of hot tap water. Card provides suggested range for setting water heater temperature to optimize efficiency. |
| DP&L Residential Energy Efficiency Programs Flyer | Handout describing DP&L's energy efficiency programs which can help save energy and money. |

### *Sample In-Class Activity*

## Comparing EnergyGuide Labels Answer Key

### Comparing EnergyGuide Labels

Your family needs to buy a new water heater. Water heaters usually last a long time—10 years or more—so you can save a lot of money using an energy-efficient one. Use the chart below to figure out which water heater to buy, comparing the information on the EnergyGuide labels.

**Water Heater 1—Purchase Price: $750.00**

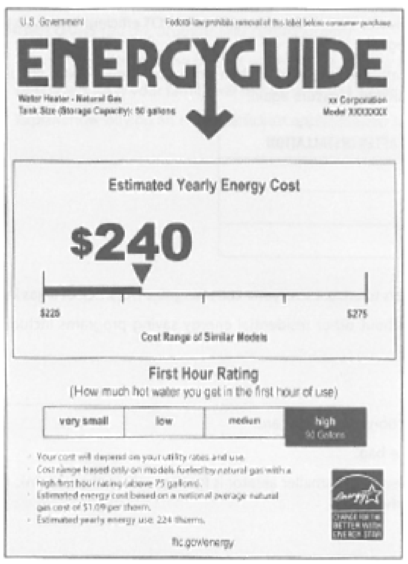
| WATER HEATER 1 | EXPENSES | COST TO DATE |
|---|---|---|
| Purchase Price | $750 | $750 |
| Year One | $240 | $990 |
| Year Two | $240 | $1,230 |
| Year Three | $240 | $1,470 |
| Year Four | $240 | $1,710 |
| Year Five | $240 | $1,950 |
| Year Six | $240 | $2,190 |
| Year Seven | $240 | $2,430 |

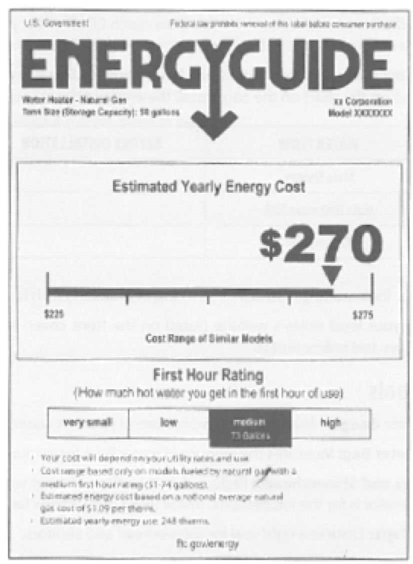
**Water Heater 2— Purchase Price: $650.00**

| WATER HEATER 2 | EXPENSES | COST TO DATE |
|---|---|---|
| Purchase Price | $650 | $650 |
| Year One | $270 | $920 |
| Year Two | $270 | $1,190 |
| Year Three | $270 | $1,460 |
| Year Four | $270 | $1,730 |
| Year Five | $270 | $2,000 |
| Year Six | $270 | $2,270 |
| Year Seven | $270 | $2,540 |

How many years will it take before you begin to save money? ***Four years***

How much money will you have saved after seven years? ***$110.00***




### *Targeted Locations*

The program was offered to school districts across DP&L's service territory, grades 4-12. One hundred and thirty teachers participated from 88 schools in 44 school districts. Participating school districts were located in 12 counties in DP&L's service territory.

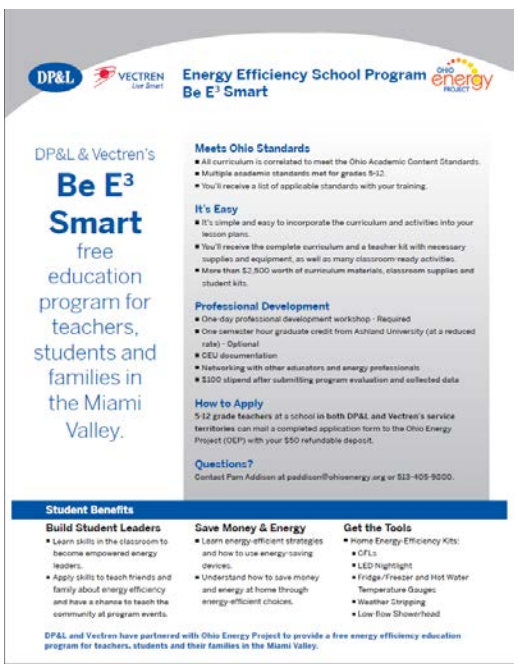
### *Staffing*

OEP is headquartered in Columbus, Ohio. The OEP program manager regularly communicated with the DP&L program manager to coordinate logistics and ensure the program is on track to meet targets. The OEP program manager also coordinates all the project's tasks and serves as the hub of communication to all OEP staff in management, accounting, and program operations.

### *Marketing*

For purposes of recruitment for program participation, limited marketing activities were performed by DP&L. OEP recruited participants by distributing a flyer and program application, produced by DP&L, to school administrators, curriculum coordinators, and teachers. OEP also promoted the program at workshops, tours, and conferences throughout the year. Recruitment efforts emphasized the educational value of the program as well as the availability of the energy savings materials.

DP&L worked with school districts to promote the activities and educational impacts of the program. Press releases were distributed throughout the year and media was invited to attend program events. DP&L also provided customizable news releases to teachers so school districts could tell their specific educational story to their local newspaper.




*Program Flyer/Application*

OEP distributed program flyers and applications to school administrators, curriculum coordinators, and teachers.

DAYTON


**Students learn how to save energy at fair**

The Dayton Power and Light Co. and Vectren Energy Delivery of Ohio held an energy fair Friday to teach young people throughout the Miami Valley about saving energy. Nearly 400 students attended the fair at the University of Dayton's River Campus building in Dayton. BOB GARLOCK / STAFF

*News Coverage*

Local media regularly responded to DP&L's invitations to attend school program events. (Photo of a pre-Covid event.)


*Grassroots Marketing*

All program materials alert students and families that DP&L and Vectren care about helping them reduce their energy consumption. (Photo of a pre-Covid event.)

### *Customer Service*

In all programs, customer service is a critical element of program success. This program lends itself well to customer service due to the breadth and depth of program elements provided for customers, at no charge. Nearly 9,000 DP&L customer families were impacted by the free energy savings measures provided through the take-home energy savings kits. Students and their families were served through the educational lessons and take-home materials designed to help them know how to make smart energy usage decisions.

Participating teachers were provided with free teaching materials to use in the classroom. All materials were laminated and ready to use, which removed the legwork for teachers. Classroom activities help teachers to “bring science to life” and connect students to the material in new ways.

Hundreds of students and teachers were provided with unique opportunities to attend trainings sessions at DP&L, Wright State University, and other energy-related facilities throughout the region.

The OEP program manager was available to participating teachers as their direct point-of-contact for questions or issues with program materials or lessons.

## RESIDENTIAL BEHAVIOR CHANGE

### PROGRAM DESCRIPTION

Through the Residential Behavior Change Program, customers receive home energy reports mailed to their homes or sent via email, access to online tools, and periodic communications from the utility.

The objective of the program is to motivate customers to better manage their energy use through education, benchmarking, and customer-specific information about how to reduce their usage. The goal is that by informing customers on how they are using energy in their home, they will become more engaged and begin to make behavioral changes that will have both an immediate and lasting impact of reducing their energy consumption.

This program started in August 2018 and continued through 2020.

### PERFORMANCE SUMMARY

During 2020, DP&L mailed paper home energy reports to approximately 103,826 residential customers eight times throughout the year. Digital home energy reports were emailed to approximately 85,762 customers 12 or 24 times throughout the year (customers receive digital reports either monthly or bi-monthly). Approximately 75,000 customers received both paper and digital home energy reports, resulting in a total of 115,000 customers receiving some format of home energy report throughout the year. The reports resulted in gross annualized energy savings of 8,358 MWh and peak demand savings of 1.44MW[1]. DP&L also applied a Behavior Change Uplift Adjustment at the portfolio level. Savings fell short of the filed goal. In addition to home energy reports, DP&L launched an online Energy Insights portal in September 2018 where all customers can access energy usage insights and analysis about their home.

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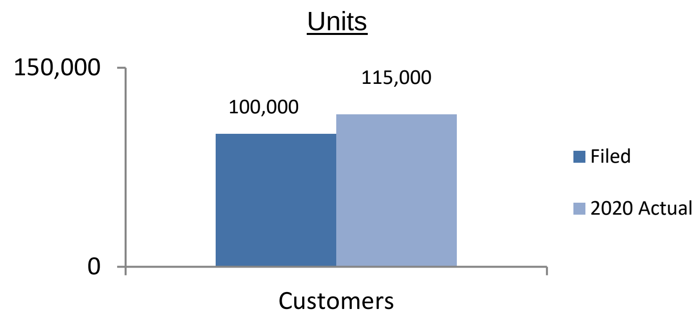
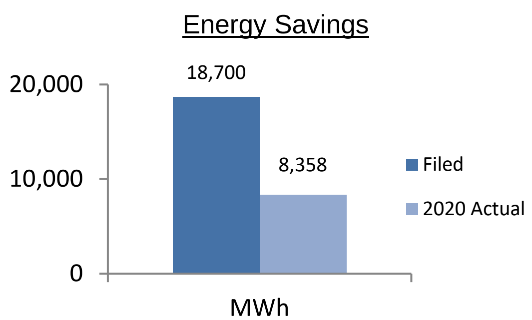
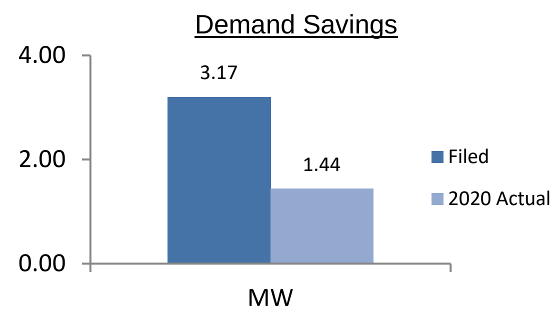
[1] As a conservative approach, DP&L is reporting *ex ante* savings numbers calculated by The Cadmus Group.

### *2020 Performance*

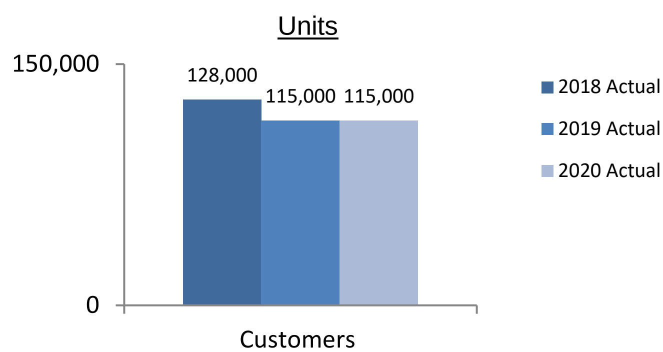


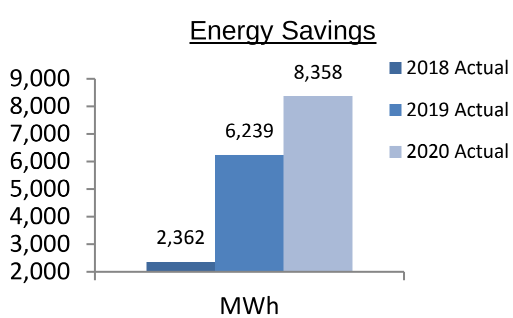



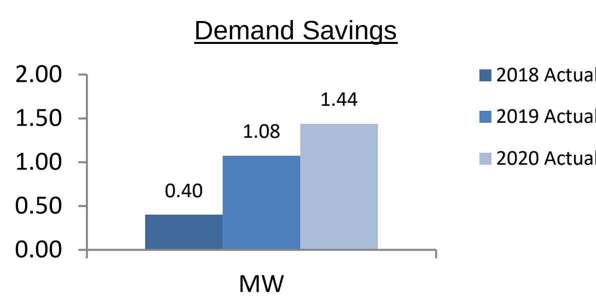




All “filed” numbers are taken from DP&L’s program portfolio filing; Case No. 17-1398-EL-POR.

### *Three-Year Trend Analysis*



### *Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $0 | $0 |
| Marketing & Admin | $579,285 | $326,588 |
| Total Costs | $579,285 | $326,588 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

With a behavior change program, a third-party implementation vendor offers significant value due to its experience running similar programs.  As such, DP&L determined that program implementation would be most effectively managed by a third-party implementation partner.

Uplight (formerly Simple Energy), based in Boulder, Colorado was selected as the implementation partner.  In its proposal, Uplight demonstrated a sound process for quickly and effectively implementing programs based on its track record of successfully implementing similar programs for utility clients like National Grid.

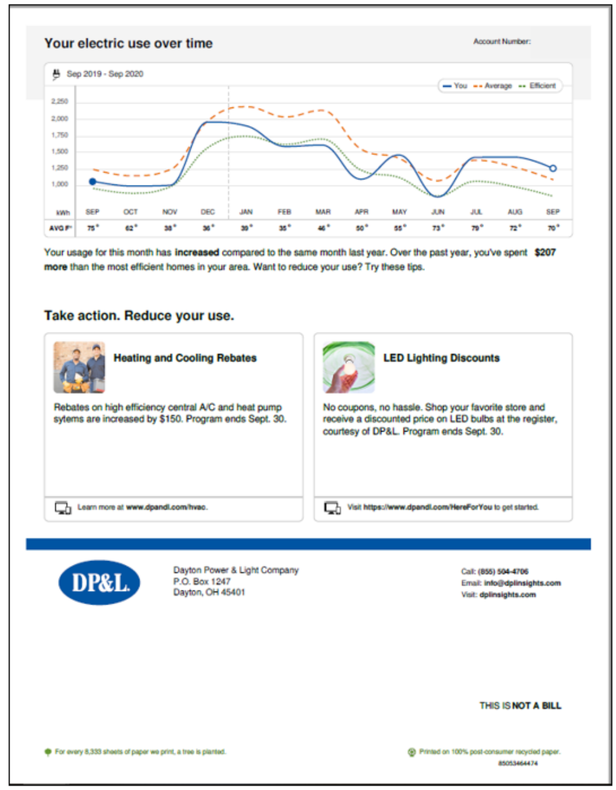
### *Targeted Products*

DP&L's home energy reports are designed to provide personalized insights about a customer's home that are informative, easy to understand, and motivate customers to take action.  The reports include a comparison of the customer's unique energy usage to that of similar households, as well as efficient households.  The customer is then given a performance ranking.  Reports are sent in a cadence that keeps customers engaged and motivated to reduce their energy usage and to allow them to track their performance over time.

Content modules rotate in each report and may include elements such as:

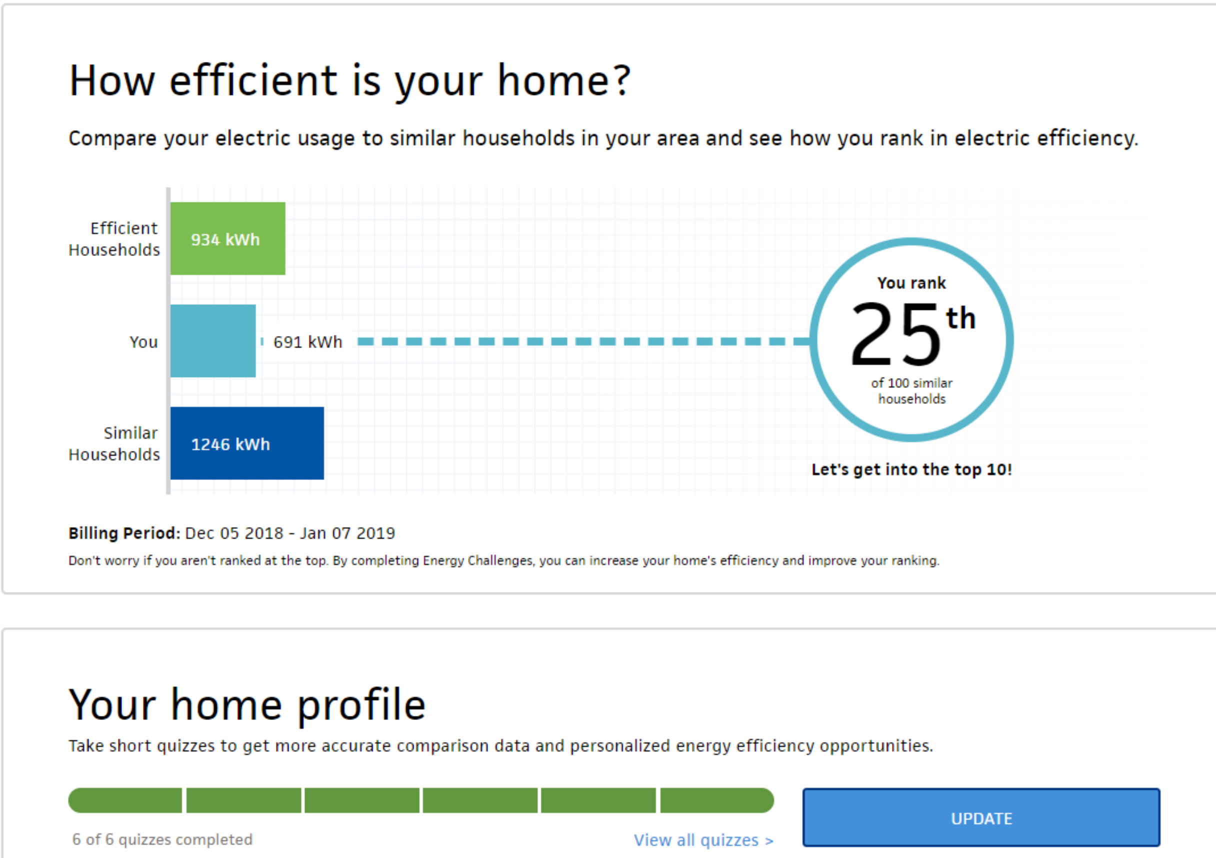
- Neighbor comparison and rank
- Actionable savings tips
- Display of customer's energy usage over time
- Disaggregated energy usage forecast
- Cross-promotion of other DP&L energy efficiency programs

*Sample Home Energy Report*



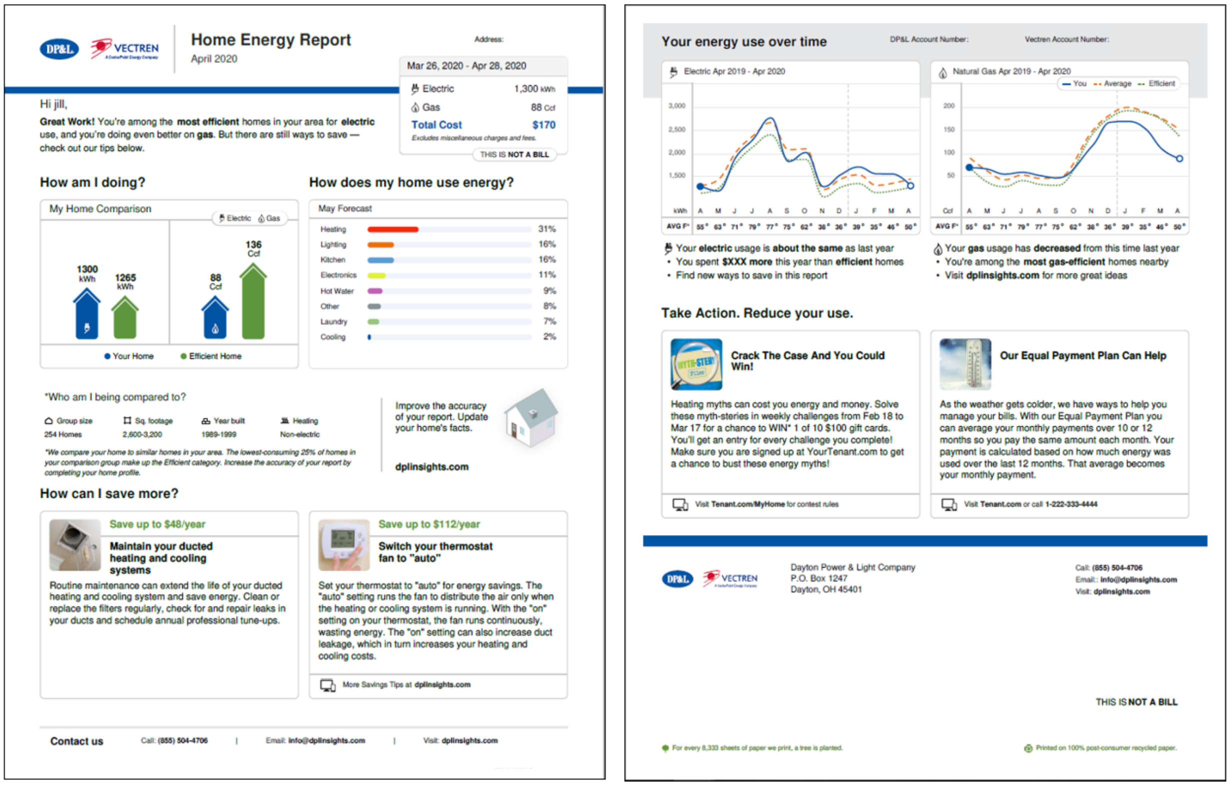
The online Energy Insights portal is available to all customers with a MyDP&L online account. The portal displays similar information to what's displayed in home energy reports, but the portal also offers opportunity for customers to receive customized recommendations by completing a home profile and participating in energy reduction challenges.

*Sample View of Energy Insights Portal*




In November 2018, DP&L and Vectren began a partnership to jointly mail home energy reports with both electric and gas energy insights. Because the DP&L and Vectren service territories have significant overlap, this partnership presents an opportunity to maximize customer service and provide customers with information about their home's wholistic energy use and eliminate confusion from receiving two separate home energy reports from two separate utilities. This partnership continued through 2020.

*Sample Joint Electric and Gas Home Energy Report*




### *Staffing*

One Uplight staff member managed the program and served as DP&L's direct point-of-contact. This experienced manager coordinated all other Uplight staff and activities including report production and distribution, online content creation and design, energy savings analysis and reporting, and customer service.

### *Marketing*

In contrast to other programs in this portfolio, DP&L did not need to solicit customer participation. Following industry best practice for behavior programs, customers were randomly selected to be in either the treatment group (receive home energy reports) or control group (do not receive home energy reports) by DP&L's third-party evaluator, The Cadmus Group. All treatment customers could opt out of receiving reports at any time. The marketing challenge was to capture customers' attention, keep them engaged, and encourage them to make behavioral changes throughout the duration of the program.

The customer opt-out rate in 2020 was two percent.

### *Customer Service*

In all programs, customer service is a critical element of program success. As such, DP&L designed a number of customer service elements into its programs, some of which have been previously discussed.

In each home energy report, DP&L communicates both an email address and a phone number available for customer service questions.

**Need help understanding this report?** Email us at info@energyinsights.com or call us at 1-855-504-4706

Uplight staff field all DP&L customer service issues.  Customers most often call with questions about the normative comparison and how it was calculated and also to request information about how they can lower their energy usage and increase their rank.

DP&L maintains its own customer service center, accepting calls regarding all functions of DP&L.  DP&L management staff continues to update customer service center staff regarding program details as needed.

# RESIDENTIAL ENERGY SAVINGS KITS

## PROGRAM DESCRIPTION

Through the Residential Energy Savings Kits program, customers can request a free energy savings kit to be mailed to their home. The kit includes LED light bulbs, an efficient showerhead, and efficient bathroom and kitchen faucet aerators.

The objective of the program is to promote the adoption of energy-efficient measures in households. The program increases consumer awareness of energy-efficient products and removes barriers of adoption by providing free products along with installation instructions.

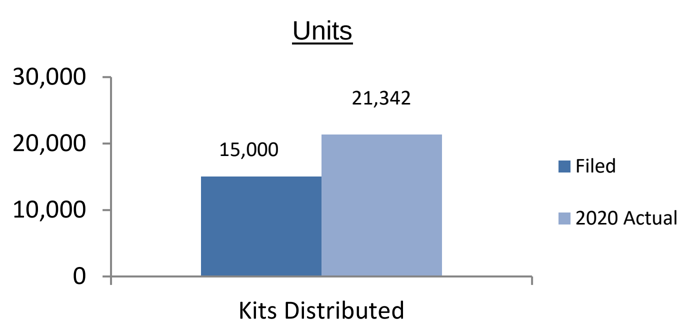
The Residential Energy Savings Kits program is targeted for all DP&L residential customers. All customers taking delivery service from DP&L are eligible for this program regardless of their choice of generation supplier. Landlords may qualify to participate in this program.

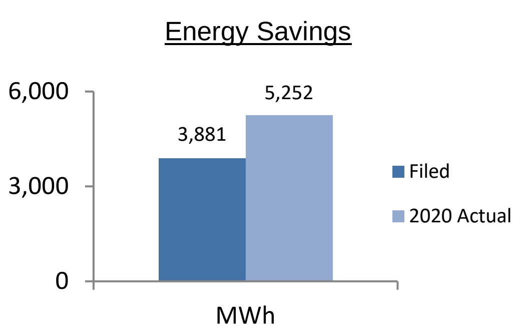
This program launched in 2018 and continued through 2020.

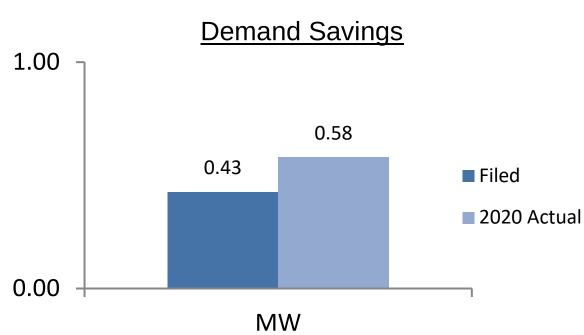
## PERFORMANCE SUMMARY

During 2020, a total of 21,342 kits were distributed to residential customers throughout the DP&L service territory, resulting in gross annualized energy savings of 5,252 MWh and peak demand savings of 0.58 MW.

***2020 Performance***

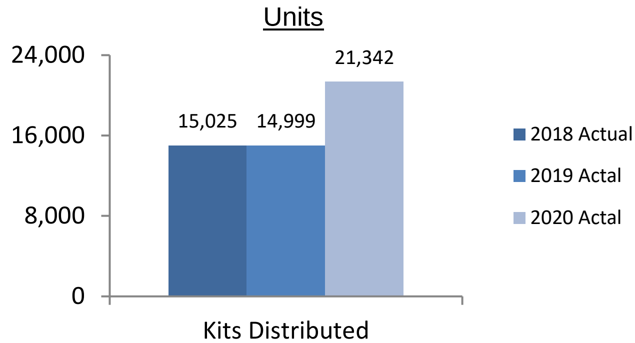


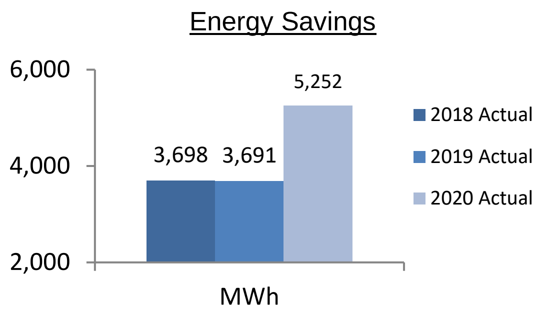



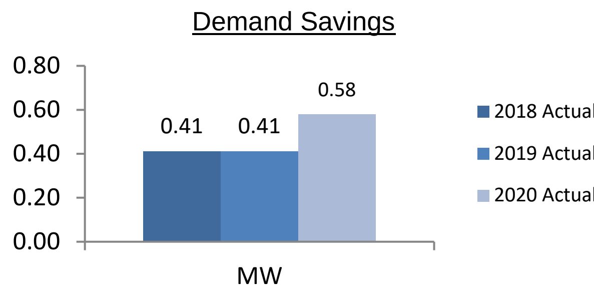




All "filed" numbers are taken from DP&L's program portfolio filing; Case No. 17-1398-EL-POR.

### *Three-Year Trend Analysis*




### *Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $322,200 | $255,543 |
| Marketing & Admin | $79,281 | $101,560 |
| Total Costs | $401,481 | $357,103 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

With an energy savings kit program, a third-party implementation vendor offers significant value due to its knowledge about efficient products, effective marketing tactics, and implementation best practices. As such, DP&L determined that program implementation would be most effectively managed by a third-party implementation partner.

At the conclusion of a Request for Proposal (RFP) process, AM Conservation (formerly Resource Action Programs), based in Sparks, Nevada, was selected as the implementation partner. In its proposal, AM Conservation demonstrated a sound process for effectively implementing programs based on its thirty-year track record of successfully implementing similar programs for utility clients such as Indiana Michigan Power, PPL Electric Utilities, and Public Service Company of New Mexico.

Vectren, the local gas utility, subsidized the cost of the showerhead and faucet aerators, which produce gas savings for customers with gas water heat.  This partnership allowed DP&L to deliver this program under the filed budget.

***Targeted Products***

DP&L offers free energy savings kits which include:

- Four LED light bulbs
- Efficient chrome showerhead
- Efficient kitchen faucet aerator
- Efficient bathroom faucet aerator
- Teflon tape to use when installing products
- Illustrated installation instructions
- QuickStart guide with useful energy savings tips

*Energy Savings Kit Box and Contents*

*Inside of Energy Savings Kit*


*Quick Start Guide Included in Kits*

### *Staffing*

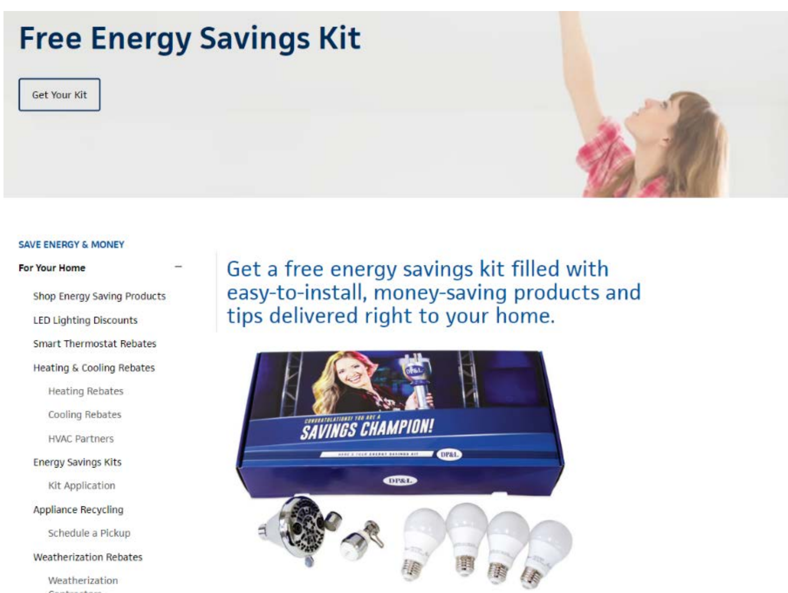
One AM Conservation staff member managed the program and served as DP&L's direct point-of-contact. This experienced manager coordinated all other AM Conservation staff and activities including sourcing kit products, producing materials like kit boxes and the Quick Start guide, and providing suggestions for program marketing. In addition, this AM Conservation staff member was responsible for managing customer program enrollments and order fulfillment and shipping.

### *Marketing*

In order to promote the energy savings kits to its customers, DP&L employed a breadth of marketing methods. The primary marketing methods utilized in 2020 were email, bill inserts, business reply cards, and mass media advertising. DP&L marketed the program to all customers who had provided their email address to DP&L. The emails and bill inserts communicated the kit contents and how to enroll in the program. Business reply cards offered the opportunity to enroll in the program by simply returning the postcard in the mail.

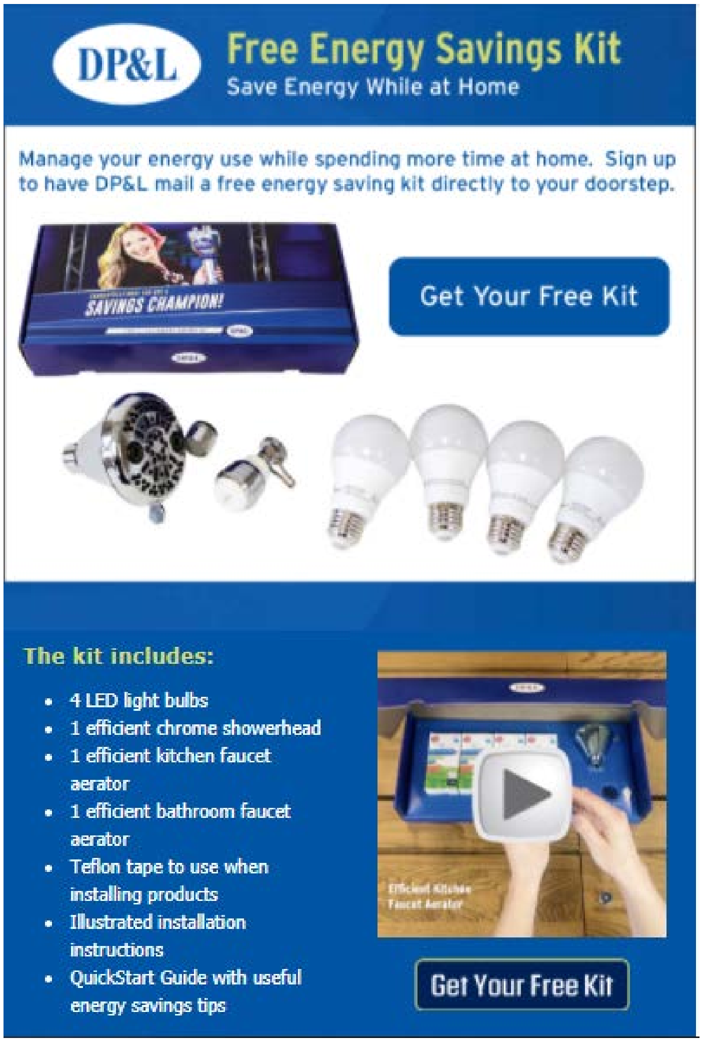
DP&L also promoted the program as a part of home energy reports distributed via DP&L's Residential Behavior Change program.

The Energy Savings Kits program's web pages on the DP&L company web site provide a description of kit contents, an overview of program eligibility and guidelines, access to the short online enrollment application, and installation instructions in both written and video form.



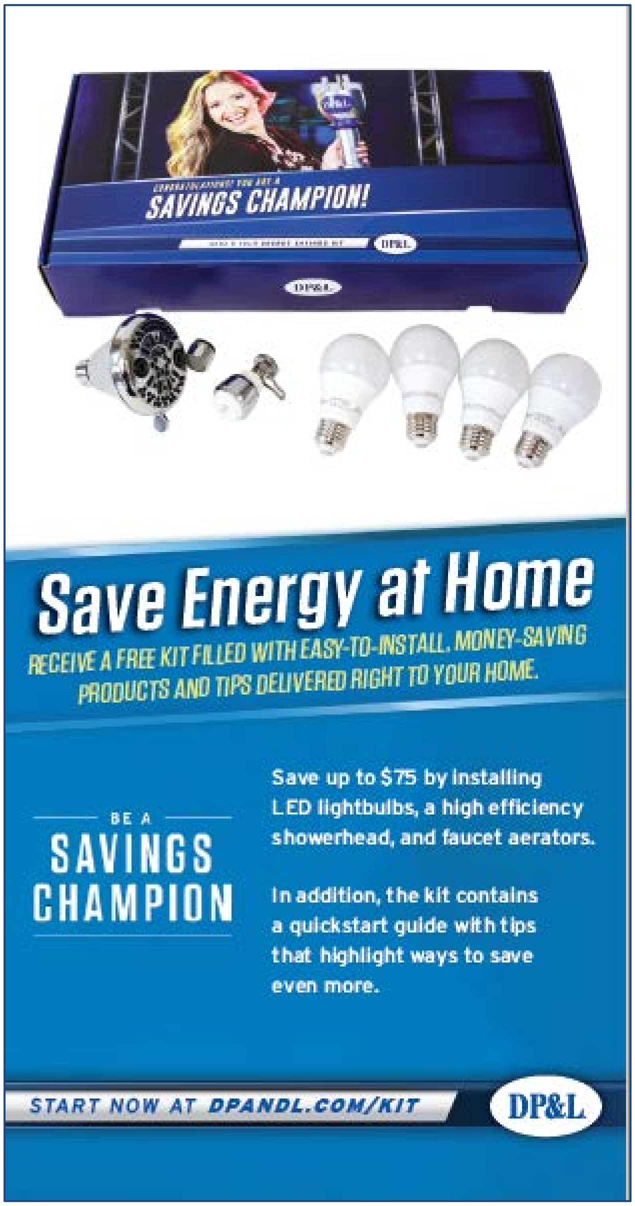

*Web Site*

The Energy Savings Kit program landing page gives a description of the program and allows customers to navigate to the enrollment application.




*Customer Emails*

Email promotions were sent to customers with a direct link to the enrollment application.

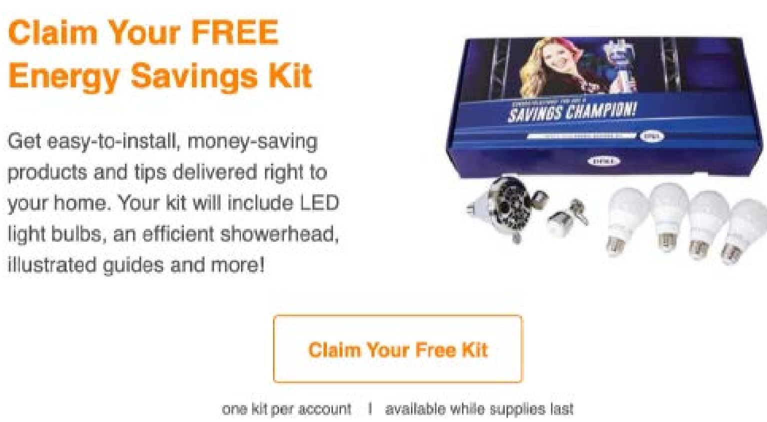



*Bill Inserts*

*Bill inserts were mailed to 450,000 customers in February and May.*


*Business Reply Cards*

Business reply cards were mailed to 30,000 customers in March and 25,000 customers in April.




*Cross Promotion on Home Energy Reports*

DP&L included a promotional coupon on home energy reports, which were mailed or emailed to 130,000 customers participating in DP&L's Behavior Change program.

***Customer Service***

In all programs, customer service is a critical element of program success. As such, DP&L designed a number of customer service elements into its programs, some of which have been previously discussed.

The program web pages (discussed in the Energy Savings Kits Program Marketing section) allow DP&L to provide a breadth of information for all customers with internet access. The web pages not only inform customers about the kit contents and how the program works, but they also provide easy access to the short online enrollment application.

For those without internet access, or who want to speak to a representative, DP&L set up a program hotline number staffed by AM Conservation employees. The staff has been trained to answer detailed questions about the Energy Savings Kit Program and help customers enroll to receive their kit.

DP&L maintains its own customer service center, accepting calls regarding all functions of DP&L. DP&L management staff continues to update customer service center staff regarding program details as needed.

## MULTI-FAMILY DIRECT INSTALL

### PROGRAM DESCRIPTION

The Residential Multi-Family Direct Install program provides targeted, cost-effective measures to multi-family households. The program targets multi-family complexes with greater than four units that are individually metered. The program is designed to go beyond providing financial incentives to multi-family households and aims to make them well-educated energy consumers. The program helps residents gain a better understanding of their home energy use and achieve savings while also improving the comfort of their homes. In addition to educating and empowering multi-family customers to make energy-efficient home improvements, the program contains a set of direct install measures.

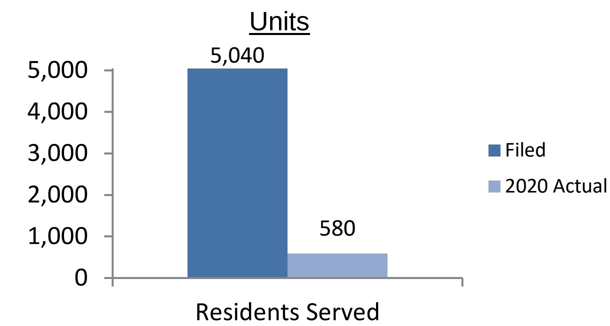
The Residential Multi-Family program has several components:

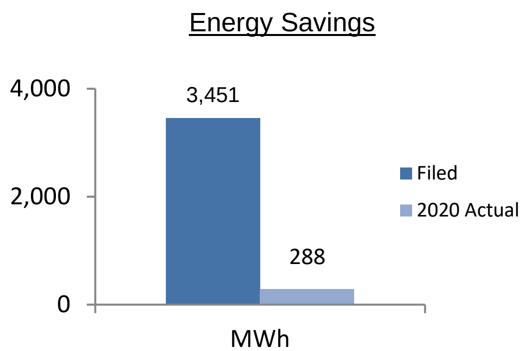
- Walk-Through Audits – On-site inspections and tests used to identify energy efficiency opportunities; audits include specific recommendations and resource referrals.
- Direct Installation of Low-Cost Measures – Installation of a package of low-cost energy-saving measures, at no additional charge to the customer, to immediately improve the energy performance of the residential unit.
- Assistance with Additional Measure Adoption – Assistance on how to access rebates under other programs.

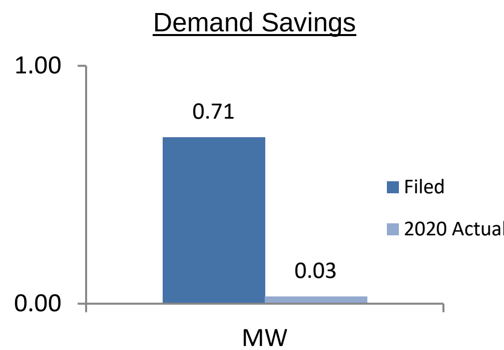
### PERFORMANCE SUMMARY

During 2020, a total of 580 apartment units were retrofitted throughout the DP&L service territory, resulting in gross annualized energy savings of 288 MWh and peak demand savings of 0.03 MW. In 2020, DP&L requested and was granted permission from the PUCO to transfer $175,000 from the Multi-Family Direct Install program to the Smart Thermostat program to provide additional incentives to meet high customer demand in the Smart Thermostat program. Transfer of these funds is reflected in the filed program budgets. In 2020, DP&L requested and was granted permission from the PUCO to transfer $75,000 from the Multi-Family Direct Install program to the HVAC Equipment program to provide additional incentives to meet high customer demand in the HVAC Equipment program. Transfer of these funds is reflected in the filed program budgets.

## *2020 Performance*

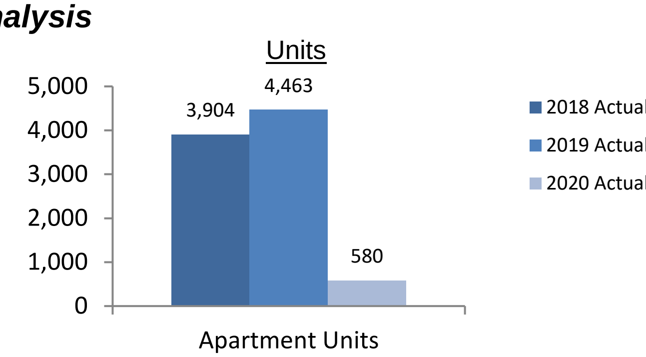


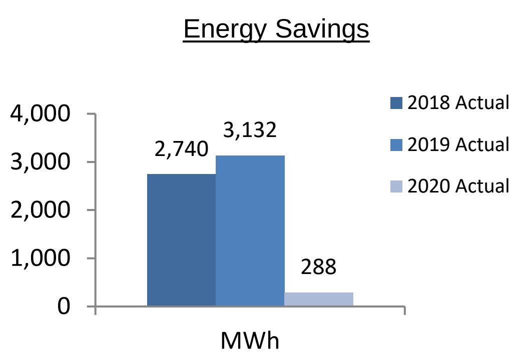



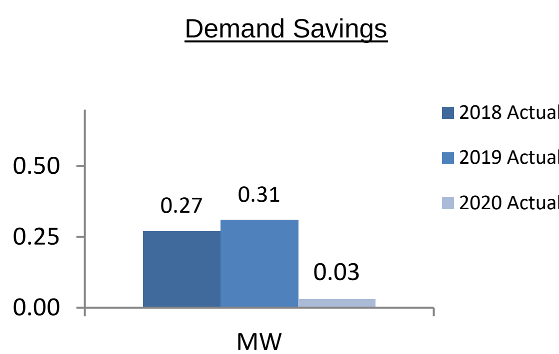




All “filed” numbers are taken from DP&L’s program portfolio filing; Case No. 17-1398-EL-POR.

## *Three-Year Trend Analysis*



### *Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $263,097 | $48,186 |
| Marketing & Admin | $149,275 | $29,662 |
| Total Costs | $412,372 | $77,848 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

At the end of the 2017 and after a RFP process, CLEAResult was selected to implement the Multi-Family Direct Install program for 2018-2020.

CLEAResult performs a walk-through assessment of sample units with the property manager, records pre-existing measures, and selects equipment replacement recommendations. Specific data points and savings calculations are collected. CLEAResult then installs instant savings measures that are deemed appropriate.

### *Targeted Products*

The measures and services within this program may include, but are not limited to:

- LED Bulbs
- Kitchen Aerators
- Bathroom Aerators
- Low Flow Showerheads
- Smart Strips
- LED Nightlights

### *Measures Installed*

| Technology | 2020 Measures Installed |
|---|---|
| 5W Globe LED Bulb | 609 |
| 9 Watt LED Bulb | 5,277 |
| Bath Aerator | 104 |
| BR 30 Dimmable LED Bulb | 0 |
| Kitchen Aerator | 90 |
| LED Nightlight | 580 |
| Showerhead | 89 |
| SmartStrip | 555 |
| **TOTAL** | **7,304** |

### *Targeted Customers*

The program targets multi-family complexes of four or more units that are individually metered. Recruitment efforts target:

- Property management companies
- Multi-family property owners
- Condominium board members

The goal is to have a single point of contact to schedule multiple properties to be retrofitted whenever possible. Customers living in rental properties are typically underserved by energy efficiency programs, due to property owners' and management companies' reluctance to invest in energy efficiency measures. This program addresses this barrier by providing measures that benefit both the resident and the property owner or management company through lower electric bills and lower maintenance costs.

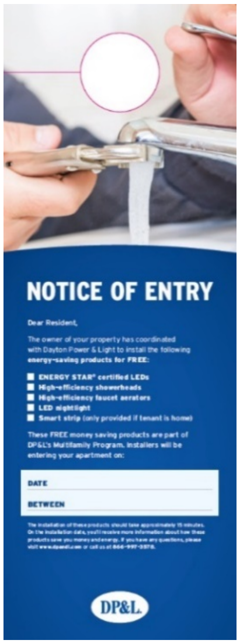
### *Staffing*

CLEAResult's local staff members manage the program and serves as DP&L's direct point-of-contact. The local field staff, consisting of a program manager, outreach manager, and two field installers, is responsible for implementing the Multi-Family Direct Install Program. The local staff is supported by the experienced managers and support team located in the CLEAResult main office.

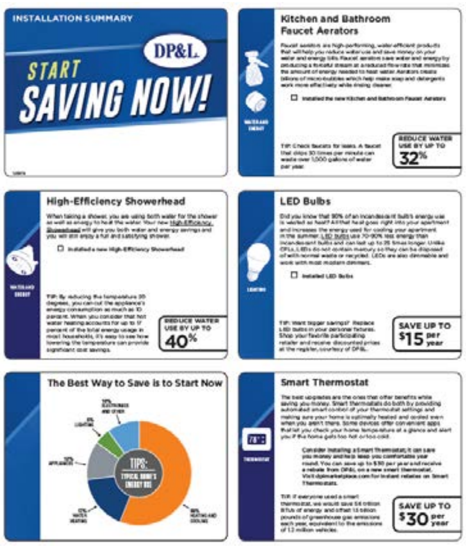
### *Marketing*

The program is marketed to apartment associations using face to face meetings with property management firms and owners. As needed, apartment associations are identified and targeted for presentations. Participants are accepted on a first come, first served basis to prevent oversubscription. Should the need arise to target additional property types, the program implementer, CLEAResult will work directly with property owners, associations, and management firms to identify qualified, interested customers.


*Outreach Flyer/ Leave-Behind*




*Door Hanger*




*Leave Behind*

***Customer Service***

In all programs, customer service is a critical element of program success. As such, DP&L designed a number of customer service elements into its program, some of which have been previously discussed.

For those who want to speak to a representative, DP&L set up a program hotline number staffed by local CLEAResult employees. The staff has been trained to answer detailed questions about the Multi-Family Direct Install Program.

DP&L maintains its own customer service center, accepting calls regarding all functions of DP&L.  DP&L management staff continues to update customer service center staff regarding program details as needed.

## SMART THERMOSTATS

### PROGRAM DESCRIPTION

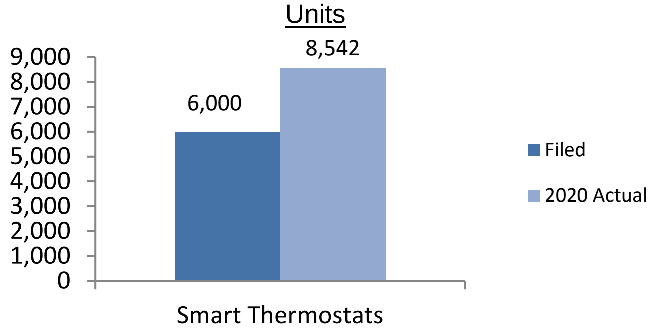
The Residential Smart Thermostats program offers rebates toward the purchase of a new Energy Star smart thermostat.  Customers can purchase a smart thermostat through a variety of distribution channels and receive a rebate.  For example, customers can purchase a thermostat through a retail outlet and receive a mail-in rebate or receive an instant rebate at select locations using a coupon code through Rebates as a Service (RaaS).  Customers can also receive an instant rebate through DP&L's online marketplace at the time of purchase.  In April of 2020, the rebate was increased from $50 to $75. The program increases consumer awareness and acceptance of smart thermostats and their benefits.

### PERFORMANCE SUMMARY

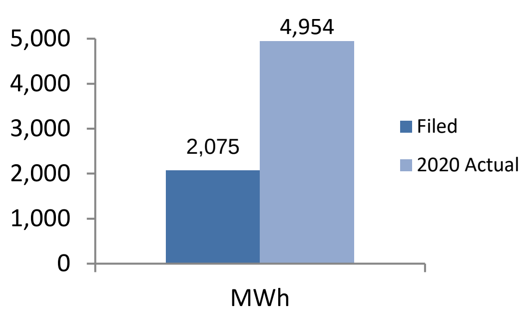
During 2020, a total of 8,542 smart thermostats were rebated throughout the DP&L service territory, resulting in gross annualized energy savings of 4,954 MWh and peak demand savings of 0.42 MW. In 2020, DP&L requested and was granted permission from the PUCO to transfer $175,000 from the Multi-Family Direct Install program to the Smart Thermostat program to provide additional incentives to meet high customer demand in the Smart Thermostat program. Transfer of these funds is reflected in the filed program budgets.

***2020 Performance***

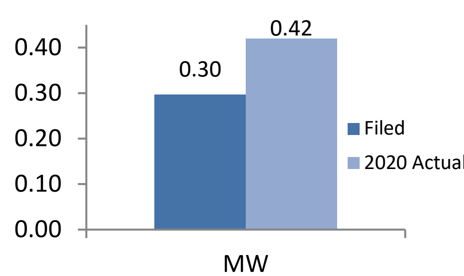
Units




Energy Savings




Demand Savings

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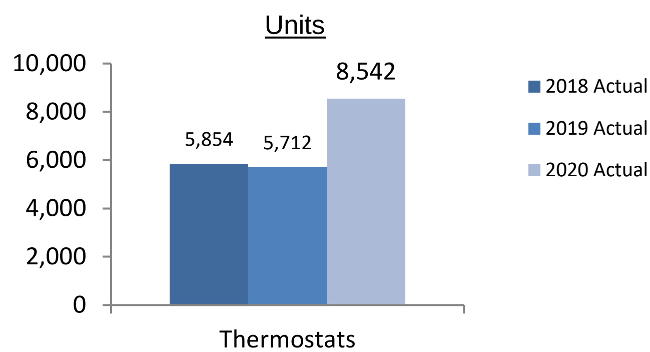
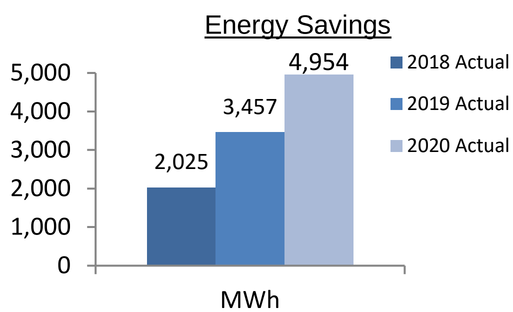
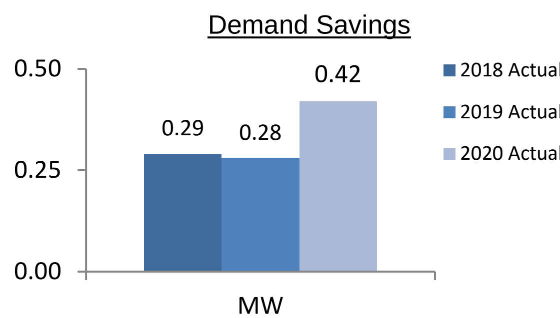
### *Three-Year Trend Analysis*




### *Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $625,000 | $552,142 |
| Marketing & Admin | $151,827 | $103,851 |
| Total Costs | $776,827 | $655,993 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

DP&L works with implementation partner(s) that oversee all details of the rebate process, including placement of in-store signage, auditing retail outlets to confirm appropriate program policies are being implemented, tracking the number of smart thermostats purchased, and processing incentives. Third party implementation vendors serve as an extension of the utility to help implement this program. CLEAResult and Uplight (formerly Simple Energy) were selected as implementation vendors. CLEAResult manages retail merchandising and processing of mail-in third party applications for thermostat incentives.  Uplight hosts the DP&L Marketplace and software engine behind RaaS.  Where appropriate DP&L has partnered with Vectren (the local gas utility) to combine utility rebates for customers of both utilities. Also, DP&L and Vectren have shared costs for rebates claimed from one utility only.

### *Units in Each Channel*

| Channel | Implementation Partner | Quantity |
|---|---|---|
| DP&L Online Marketplace/RaaS | Uplight | 7,909 |
| DP&L Retail Mail-In | CLEAResult | 242 |
| Third Party Markdown | CLEAResult | 0 |
| Vectren Transfer | Vectren | 391 |
| **Total** | | **8,542** |

### *Targeted Customers*

The Residential Smart Thermostats program is targeted to all DP&L residential customers. All customers taking delivery service from DP&L are eligible for this program regardless of their choice of generation supplier. Landlords may qualify to participate in this program.

### *Staffing*

For Mail-In rebates one CLEAResult program manager managed the program and served as DP&L's direct point-of-contact. This manager coordinated all staff members in processing several channels of smart thermostat rebates including mail-In, Nest.com, and Third Party markdowns.

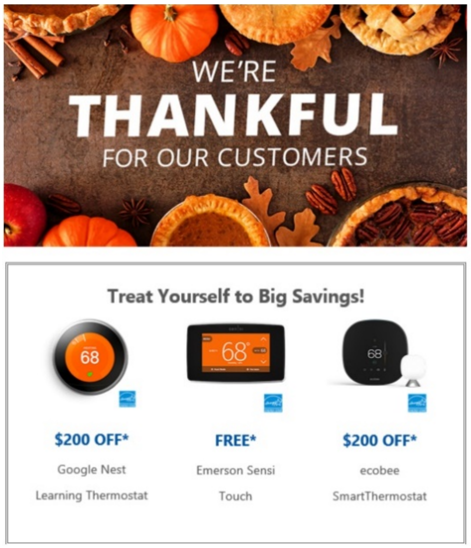
For the DP&L Marketplace, one Uplight program manager managed the program and served as DP&L's direct point-of-contact. This manager coordinated all staff members and tasks involved with implementing the DP&L Marketplace from sourcing products, designing and developing the marketplace, customer service, and order fulfillment.

### *Marketing*

Marketing materials communicate the availability of rebates for customers as well as the benefits of smart thermostats. Marketing tactics include email, in-store signage, bill stuffers, web pages, mass media advertising, and presence at community events, all with the goal of increasing program awareness and customer participation.


*Marketplace – Black Friday*

Bill Insert




*Marketplace - Black Friday*

Email


*Rebates as a Service*

In-Store Signage

***Customer Service***

In all programs, customer service is a critical element of program success. As such, DP&L designed a number of customer service elements into its programs, some of which have been previously discussed.

The program web pages allow DP&L to provide a breadth of information for all customers with internet access. The web pages not only educate about Smart Thermostats, but also help customers take advantage of different channels to rebates.

For those without internet access, or who want to speak to a representative, DP&L set up a program hotline number staffed by CLEAResult employees.  The staff has been trained to answer detailed questions about the smart thermostat program.

DP&L maintains its own customer service center, accepting calls regarding all functions of DP&L.  DP&L management staff continues to update customer service center staff regarding program details as needed.

The CLEAResult local field staff continues to be a large component of DP&L's customer service, ensuring the accuracy of prices and products in stores, which helps to meet customers' expectations.  In a retail environment, it is possible for POP materials to be inadvertently removed or placed next to products that may or may not be discounted as restocking occurs.

Uplight also staffs a customer service department to handle DP&L customer questions pertaining to the DP&L Marketplace and Rebates as a Service.  Customers can submit questions via email, live online chat, or phone.  The staff has been trained to answer detailed questions about the products sold on the marketplace, customer validation, rebate redemption, and order fulfillment.

# NON-RESIDENTIAL PROGRAMS

## NON-RESIDENTIAL PRESCRIPTIVE REBATES

### PROGRAM DESCRIPTION

The Non-Residential Prescriptive Rebate Program provides non-residential customers with incentives for new equipment purchases that reduce energy consumption and demand. Technologies covered in the program include energy efficient lighting, HVAC, motors, drives and compressed air.

The objective of the program is to help business and government customers overcome the upfront cost hurdle associated with energy efficient technologies.

The Prescriptive Rebate Program is comprised of several channels. Rapid Rebates® are designed for all DP&L business and government customers who purchase new energy efficient equipment through a manufacturer, distributor or contractor. All business and government customers taking delivery service from DP&L are eligible for this program regardless of their choice of generation supplier.

DP&L began accepting online Rapid Rebate® applications on April 1, 2009. In 2020, 66 unique measures were offered through the Rapid Rebates® Program. DP&L received 977 Rapid Rebate® applications and paid 1,160 Rapid Rebates® in 2020.

Customers may also participate in a Midstream buy-down of lighting and VFDs currently sold through 17electrical distributor locations. Additionally, customers participate in a Midstream buy-down of HVAC equipment sold through 7 distributor locations.

Additionally, the Appliance Recycling Programs is available to non-residential customers.

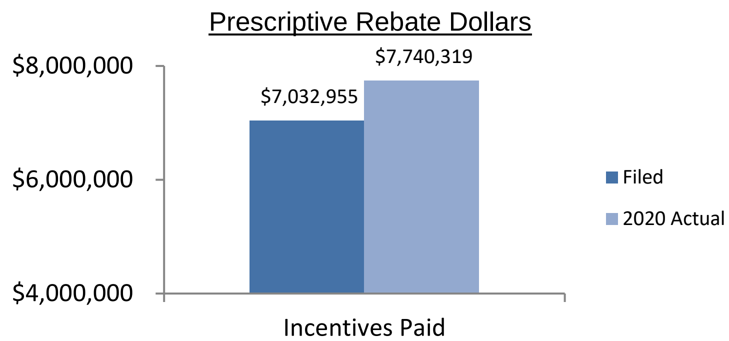
### PERFORMANCE SUMMARY

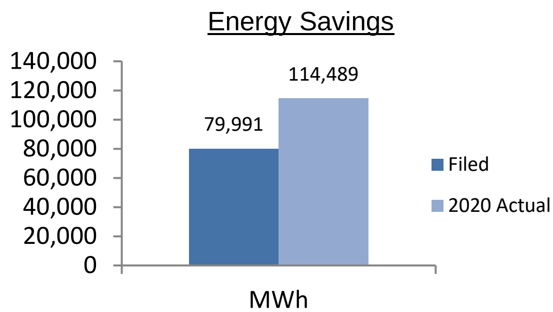
During 2020, DP&L paid $4,446,785 in Rapid Rebates® to business and government customers, resulting in gross annualized energy savings of 60,172 MWh and peak demand savings of 9.35 MW. Keys to the program's success include continued operation of a customer-friendly online application system, quality customer service and follow through, and strong relationships with Channel Partners.

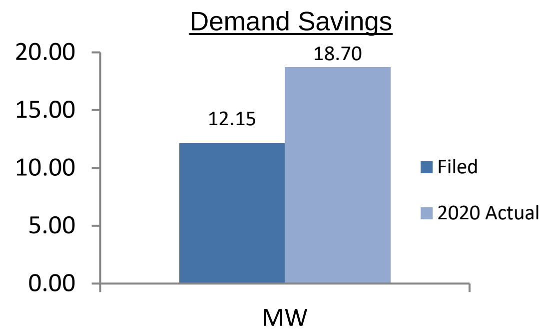
An additional 54,261 MWh and 9.34 MW in savings were realized through the Midstream channel which included $3,147,115 in incentives. Also in 2020, DP&L extended the Appliance Recycling Program to business customers. This resulted in 44 units collected from business customers which accounts for 55.9 MWh of energy savings, 0.01 MW of peak demand savings and $2,000 in incentives paid. Additionally, Channel Partners were paid rewards for driving business in the amount of $144,419. Additionally, DP&L received approval from the PUCO to transfer $375,000 from the Small Business Direct Install Program and $70,000 from the Mercantile Program into the Prescriptive Rebates Program. All metrics in this section include Midstream

Program costs and savings and Appliance Recycling costs and savings as well as the transfer of funds into the Prescriptive Programs.

***2020 Performance***

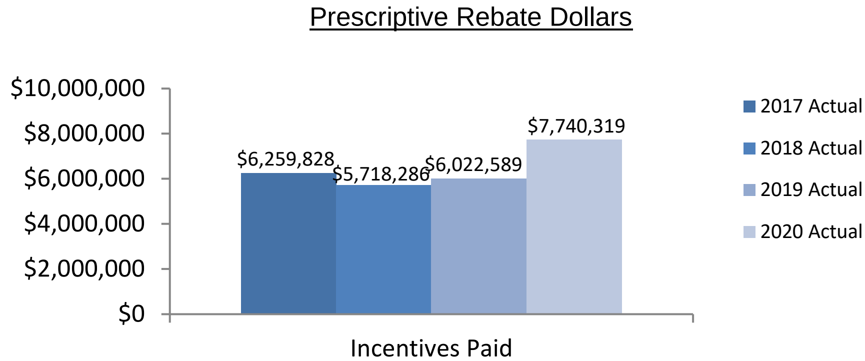


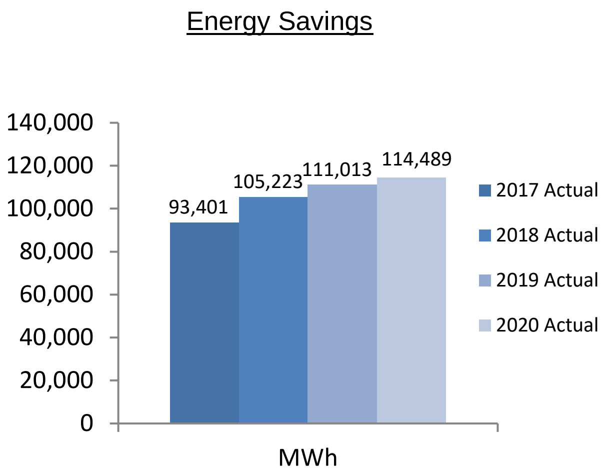



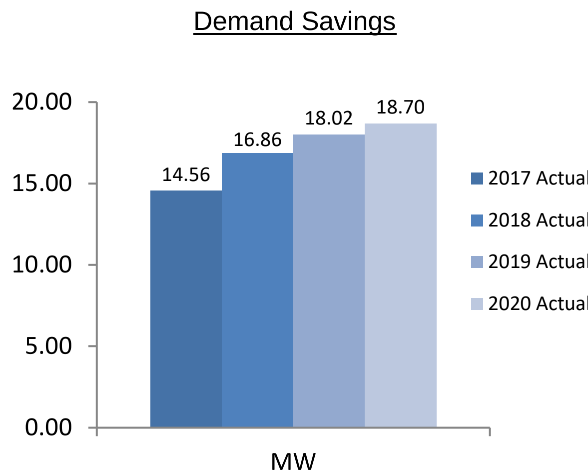




All “filed” numbers are taken from DP&L’s program portfolio filing; Case No. 17-1398-EL-POR.

### *Four-Year Trend Analysis*




### *Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $7,032,955 | $7,740,319 |
| Marketing & Admin | $1,474,629 | $1,881,567 |
| Total Costs | $8,507,584 | $9,621,886 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

Since 2009, DP&L has implemented and managed the Prescriptive Rebate Program internally. DP&L chose this course of action, as opposed to hiring an outside implementer, for several reasons. First, implementing the program in-house significantly strengthens DP&L employee knowledge of energy efficiency programs and technologies. Second, it provides DP&L with the opportunity to build relationships with contractor networks and customers, leading to quality customer service. And third, unlike the residential programs, we do not believe a third-party rebate provider adds significant value at this point in the program lifecycle. Potential rebate volume for business customers is lower than for residential customers, and DP&L continues to be able to process this lower volume of rebates internally.

DP&L offers a midstream, buy-down of lighting and HVAC equipment currently sold through 24 distributor locations. No coupon or rebate form is required; the customer receives the discount at the register at the time of purchase. The customer provides information to verify they are a non-residential customer. The goal of the midstream channel is to reach those customers who are not using the traditional prescriptive program. CLEAResult is the implementer of the midstream channel. In 2020, midstream sales accounted for approximately 47 percent of the Prescriptive Rebate Program energy savings.

***Targeted Products***

DP&L's Prescriptive Rebate Program was designed to provide business and government customers with an extensive choice of energy efficient, retrofit opportunities. In 2020, 66 unique measures were available for Rapid Rebates®. This extensive list broadens the number of customers who can potentially participate in programs. The list of measures was developed, and is continually updated, based on industry accepted standards for high efficiency equipment and the associated energy and demand savings. Rapid Rebate® incentives disbursed to customers ranged from $8 to $90,849 in 2020. Historically, DP&L has reallocated 5 percent of lighting savings sold through the Residential Efficient Products upstream program to the Prescriptive Rebate Rrogram. In 2020, DP&L chose not to reallocate 5 percent of lighting savings sold, but instead used those funds to maximize the number of customer rebates paid through the Rapid Rebates® program.

***Prescriptive Rebate Allocation***

| Product Type | Rebate Dollars Paid | Energy Saved (MWh) | Demand Saved (MW) |
|---|---:|---:|---:|
| Lighting | $3,818,818 | 50,645 | 7.70 |
| HVAC | $359,628 | 7,000 | 1.34 |
| Compressed Air | $216,025 | 1,891 | 0.14 |
| Motors | $52,314 | 636 | 0.17 |
| Midstream Channel | $3,147,115 | 54,261 | 9.34 |
| Appliance Recycling | $2,000 | 56 | 0.01 |
| Channel Partner Rewards | $144,419 | - | - |
| TOTAL | $7,740,319 | 114,489 | 18.7 |

DP&L does not endorse any equipment manufacturers or suppliers in the Prescriptive Rebate Program. Business and government customers may purchase any brand of equipment from any supplier they choose, as long as the equipment is new and meets the eligibility requirements detailed on the measure lists. Additionally, equipment must use electricity as the fuel source and be replacing existing equipment or be installed as part of a retrofit project.

### *Application Process*

DP&L's Prescriptive Rebate application process was designed to be customer friendly and comprehensive. The application is completely online which makes it convenient for customers and efficient for program control purposes. The application consists of three pages. The first page asks for basic customer information such as company name, address, installation address, DP&L account number, facility type and hours of operation, and contractor contact information. On the second page, customers choose from a drop-down list of measures, enter the manufacturer and model numbers, and input the appropriate quantities. The third page allows customers to upload supporting documentation to their application, such as specification sheets, engineering calculations and invoices. When the customer has entered all measures for which they are applying, they "submit rebate" and receive a confirmation number. When customers or contractors have questions, DP&L staff is available to guide them through the process.

The online Rapid Rebate® application is electronically submitted to DP&L for review. Applications must be complete and include the necessary contact information, equipment specification, and equipment costs. DP&L then reviews the application, verifies the information provided, and sends a confirmation email indicating the application has been approved. If the application has been approved, the funds will be reserved. Program guidelines request the customer or vendor provide DP&L with proof of purchase within 60 days of the approval notification. To be eligible for an incentive, the equipment for the customer's project must be purchased during the calendar year in which the customer's rebate application is submitted to DP&L. Proof of purchase may come in the form of an invoice, purchase order or other supporting document. If proof of purchase is not received, DP&L reserves the right to remove the fund reservations. Applicants can reapply for a rebate, but they will be placed in the back of the queue. The equipment should be installed and ready to operate within 120 days of application approval and DP&L must be notified of the installation. DP&L must be provided with a final invoice reflecting the true costs of purchasing and installing the energy savings measure (including all materials, labor, and equipment discounts) as well as equipment serial numbers. If the installation does not occur within 120 days, the customer may request an extension from DP&L using the Online Extension Request Form. Extension requests are handled on a case by case basis. DP&L releases the rebate funds to the customer within approximately 30 days of receiving the verification of installation.

DP&L reserves the right to inspect the installed measure(s) prior to releasing any funds to ensure compliance with the program terms and conditions. DP&L audits a random sampling of rebates less than $10,000 and the majority of rebates over $10,000. In 2020, 10 percent of all Rapid Rebates were audited. Third party engineers and contractors are utilized to perform pre- and post-installation verification audits for a sampling of projects rebated through the Prescriptive Rebate Program.

### *Staffing*

DP&L has three program managers to manage the business rebate programs, including the Prescriptive Rebate Program, and serve as DP&L's direct point-of-contact with customers. The internal staff is responsible for reviewing, approving and processing rebate applications. They track and report all incentive dollars as well as energy and demand savings. The staff is also responsible for promoting the program to customers through a variety of marketing tools and business and community events.

### *Marketing*

In order to promote the Prescriptive Rebate Program to business and government customers, DP&L employed a variety of marketing methods. These methods included publication of program information on the company web site, print literature, bill inserts, inserts in local business journals, mass media advertising, presentations at community- and vendor-sponsored events, one-on-one marketing by DP&L major account managers, and the continued utilization of a Channel Partner network.

Channel Partners are contractors, engineers and distributors with energy efficiency experience. They have participated in DP&L rebate workshops and are familiar with using DP&L rebate programs to help customers save money. Channel Partners are viewed as an invaluable third party "marketing extension" of DP&L's internal group of program managers. They have direct contact with customers on a daily basis and can influence the customer's purchasing decisions. Of the 60,172 MWh in Rapid Rebate® savings attained by customers in 2020, Channel Partners were involved in securing 36,809 MWh or 61 percent of those savings.

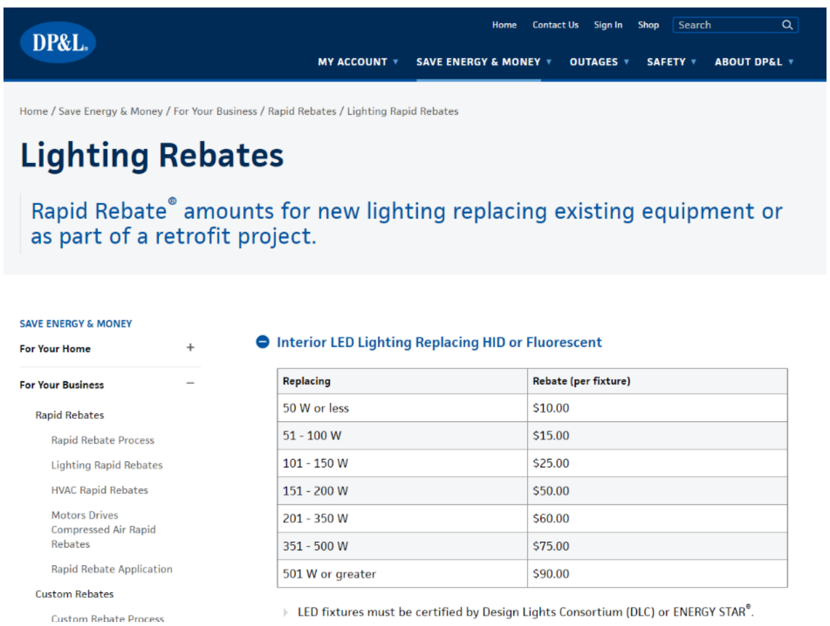
DP&L partnered with Dayton Regional Green, Vectren, IGS, and Energy Optimizers USA to sponsor another Bring Your Green Challenge. The Bring Your Green Challenge is the third iteration of a friendly year-long contest for government buildings, commercial property owners/managers and office tenants to reduce costs while reducing greenhouse gas emissions and resources used. The highly interactive program encourages participants to assess their practices and engage their employees to foster a culture of sustainability. Online tools, trainings, workshops, best practices, and technical assistance will be provided along the way. During the year-long contest, participants were also eligible for a 50 percent increase in standard rebate values. The initiative began in October of 2018 and ran through September of 2020.


Tuesday, February 11, 2020
Sinclair Community College
Charity Earley Auditorium
8 a.m. – 10 a.m.

Wednesday, February 12, 2020
Edison Community College
North Hall, Auditorium
8 a.m. – 10 a.m.

*Channel Partners*

Channel Partners participate in DP&L rebate workshops and are familiar with using DP&L rebate programs to help customers save money.




*Web Site*

The Business Rebates pages on the DP&L web site give a description of the Prescriptive Rebate Program and allow customers to navigate to other pages for more information or apply online for a rebate.


***September 30, 2020 is a critical date!***


***Apply for rebates through***
***DP&L Energy Efficiency Programs***
***while there is still time!***

## Rapid Rebates Promotion Deadline Approaching

Help your customers receive a **50% enhancement** of their rebate before time runs out! The promotion for Rapid Rebates* is still available **exclusively for Channel Partner projects**.

**The following must occur before September 30:**

1. The rebate **application is submitted** to DP&L.
2. The **customer purchases the equipment** for their project.
3. The customer's **proof of equipment purchase is uploaded** to the rebate application. *This must be an itemized invoice which specifies the unit cost and description for all types of equipment purchased.*

**The following must occur before November 30:**

4. The customer's **proof of installation documentation is uploaded** to the rebate application.

Click here to review all promotion criteria. Questions about whether a project would qualify for the promotion? Send us an email so you know for sure. **Applications will only be accepted through September 30!**

***DP&L will continue paying rebates for existing and new applications in a first-come, first-serve manner, based on the date all required documentation for an application is received and complete regardless of when the application was submitted, until December 31, 2020 or until program budgets are depleted, whichever comes first.*

## PUCO Deadlines

Per the Public Utilities Commission of Ohio (PUCO) Order issued this past February, **mandated energy efficiency programs in the State of Ohio will terminate by December 31, 2020.** Applications must be submitted by **September 30** in order for a project to be eligible for a rebate.

## Business Rebates Program Updates

The DP&L Business Rebates Team is continuing to monitor progress toward **meeting our 2020 savings goals**. We are also closely watching **rebate applications** for all programs. With the **September 30 deadline quickly approaching**, visit our website often for current information about each program.

**Rapid Rebates and Custom Rebates**
We are still accepting new applications for both Rapid Rebates and Custom Rebates. In order to be eligible for a rebate, the application must be submitted prior to **September 30**. In addition, final documentation must be submitted prior to November 30.

Rapid Rebates applications may also be eligible for the current promotion, receiving a 50% enhancement of the final rebate amount. Click here to review all promotion criteria.

**Midstream**
Qualifying purchases may be made at any participating distributor location until **September 30**.

**New Construction**
New construction projects, whether Lighting or Whole Building, will be reviewed on a case-by-case basis. Eligibility for a rebate will be dependent upon whether the building is scheduled to have its occupancy permit on or before November 30. Please contact our team before **September 30** to confirm whether your customer's project would qualify.

**Small Business Direct Install**
Appointment requests will be accepted for the Small Business Direct Install program through **September 30**.

**Other Programs**
We are no longer accepting applications for the following programs: Large Customer Self-Direct (Mercantile), Retro-commissioning, or Combined Heat and Power.

*Newsletter*

Channel Partners are kept up to date on program news and changes through a quarterly Channel Partner newsletter.

DP&L

BE A SAVINGS CHAMPION WITH RAPID REBATES

DP&L's Rapid Rebates* give you cash back on energy efficient products and upgrades.

**Control Your Energy Costs**

Controlling energy costs is becoming increasingly important. Not only does it positively affect your bottom line, it's also an important component of any company's green initiative. Thanks to new technologies, there are ample opportunities to decrease energy usage, increase efficiency and save money.

**Customers Can Get Cash Back With DP&L's Rapid Rebates***

To help customers save even more, DP&L is offering Rapid Rebates – cash back on energy-efficient lighting, HVAC systems, motors, drives and compressed air systems. All DP&L business and government customers in good standing are eligible to receive Rapid Rebates. There may also be opportunities to combine Rapid Rebates with federal and state incentives.

**Rapid Rebates* are Streamlined and Online**

It's easy to get your rebate and you can reserve your funds in advance. Our Rapid Rebate application, an up-to-date listing of available rebates, and eligibility requirements can be found at **dpandl.com/rapid**.

**Apply Online**

Our Rapid Rebates application and additional details on the Rapid Rebates program can be found at **dpandl.com/rapid**.

**Get Your Rapid Rebates for Energy Efficient:**

- Lighting
- Heating Ventilation and Air Conditioning (HVAC)
- Motors and Drives
- Compressed Air

DPANDL.COM/SAVE

*Print Literature*

DP&L used standard print materials for hand-outs at meetings with customers and at a variety of speaking events.

*Event Sponsorships*

DP&L Business Programs frequently sponsor and participate in community- and vendor-sponsored events.


*Print Ads*

The Midstream Program was advertised in the Dayton Business Journal.

*Collaborative Partners*

DP&L continues to work with its collaborative partners to promote programs.

***Customer Service***

In all programs, customer service is a critical element for success. As such, DP&L designed a number of customer service elements into the Rapid Rebate® Program, some of which have been previously discussed.

The Rapid Rebate® section of the DP&L web site acts as the main information portal for customers, contractors, distributors and other program participants. It contains a listing of all eligible measures and the rebate amounts, as well as access to the online application. The online application process is akin to online shopping. When the customer has entered all measures for which they are applying, they “submit rebate” and receive a confirmation number. The confirmation number allows the customer to access their application’s status and upload documents to their application.

In addition to being an effective means of marketing DP&L programs, Channel Partners are also a valuable resource for delivering the program to customers in a quality manner. Channel Partners are trained on both measures rebated through the program and on the application process. Many Channel Partners have used DP&L rebate programs to offer a “turn-key” experience for the customer, including approximate rebates in customer quotes and applying for rebates on behalf of customers. Through this process, customers can have confidence the proposed equipment will be eligible while allowing DP&L to work with the Channel Partner to clarify any issues that may arise. In short, the Channel Partners are an effective “middleman” for the program with proper upfront training and ongoing program communication.

To encourage Channel Partners to continue to provide excellent service to customers, the Channel Partner Rebate Rewards program was launched in 2011. A Channel Partner must be listed on the rebate application in order to be eligible for Rewards associated with an incentive. In addition, the Channel Partner must attain a minimum of $10,000 in DP&L incentives issued to customers in a program year. Once a Channel Partner meets all requirements for receiving Rewards, the Channel Partner begins to earn a cash bonus equal to 5 percent of the DP&L rebates paid to the customers for the Channel Partner’s projects. This incentivizes the Channel Partner to complete the rebate application for the customer. In 2020, DP&L paid $144,419 in prescriptive Channel Partner Rebate Rewards.

As a quality control measure, the auditing process ensures contractors and vendors are not misrepresenting the program. From a customer service perspective, customers appreciate and welcome the audit process, as it gives them unbiased energy savings data. They can use this data in submitting comprehensive post-analysis reports on their capital projects.

To make communication convenient for the customer, the Business Programs staff maintains an Energy Efficiency Inbox, energyefficiency@dplinc.com, a clearinghouse for general program questions business and government customers may have.

DP&L staffs its own business call center, the Business Solutions Center, catering to DP&L business customers and their billing and other general inquiries. DP&L Business Program management staff conducted training sessions for business solutions center staff regarding energy efficiency program details. This was to ensure DP&L phone representatives had a basic understanding of the program, could assist customers in navigating the web site or point them to the Energy Efficiency Inbox.

## NON-RESIDENTIAL CUSTOM REBATES

### PROGRAM DESCRIPTION

The Non-Residential Custom Rebate Program provides business and government customers with incentives for equipment purchases and industrial process improvements that reduce energy consumption and demand. Custom Rebates are for equipment that is not covered by DP&L's Prescriptive Rebate Program and are generally best suited for customized industry-specific or facility-specific applications.

The objective of the program is to help business and government customers overcome the upfront cost hurdle associated with energy efficient technologies and to promote innovative and emerging technologies.

The Custom Rebate Program is designed for all DP&L business and government customers who purchase new energy efficient equipment through a manufacturer, distributor or contractor. All business and government customers taking delivery service from DP&L are eligible for this program regardless of their choice of generation supplier.

In 2020, DP&L received 70 Custom Rebate applications. DP&L paid 109 Custom Rebates in 2020.

### PERFORMANCE SUMMARY

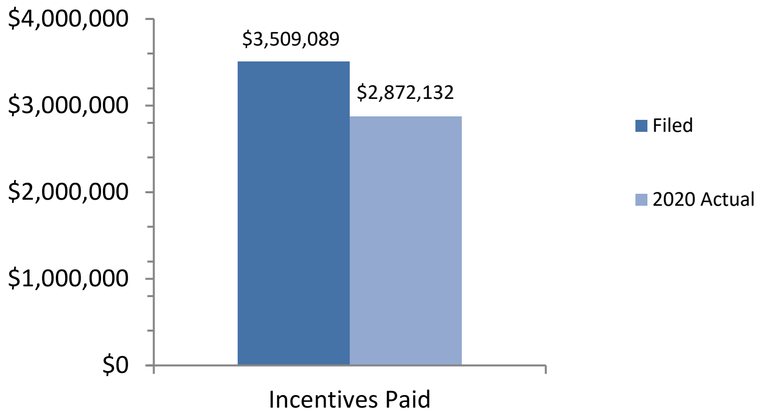
During 2020, DP&L paid $2,872,132 in Custom Rebates to business and government customers, resulting in gross annualized energy savings of 29,287 MWh and peak demand savings of 4.33 MW. Keys to the program's success include continued operation of a customer-friendly online application system, quality customer service and follow through, and strong relationships with Channel Partners.

New Construction Rebates are included in the Custom Rebate Program. The New Construction Rebates promote energy efficient design strategies by incenting reductions in the amount of energy a completed new construction project or major addition would use. In 2020, DP&L received 16 New Construction Rebate applications. 59 New Construction Rebates were paid in 2020, accounting for 8,645 MWh and 2.18 MW of annual savings, and $774,784 in rebates paid.

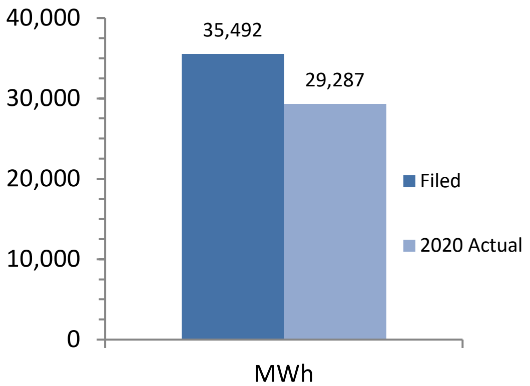
Retro-commissioning incentives are included in the Custom Rebate Program. Retro-commissioning is a process by which existing building control systems are optimized to perform as efficiently and effectively as possible. DP&L's retro-commissioning offering aims to help customers understand opportunities to save energy costs within their facility by co-funding a retro-commissioning study. Upon conclusion of the study, the customer is responsible for paying 20 percent of the study cost and facilitating implementation of recommended measures. Following successful implementation, the customer receives an incentive calculated based upon actual kilowatt hours saved. In 2020, DP&L received 17 new Retro-commissioning incentive applications. Eighteen projects were completed in 2020, accounting for 8,474 MWh and 0.59 MW of annual savings, and $922,269 in incentives paid.

***2020 Performance***

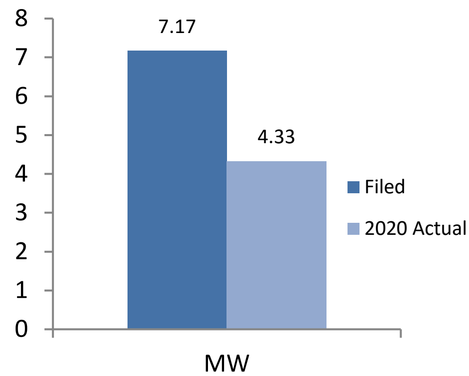
Custom Rebate Dollars




Energy Savings



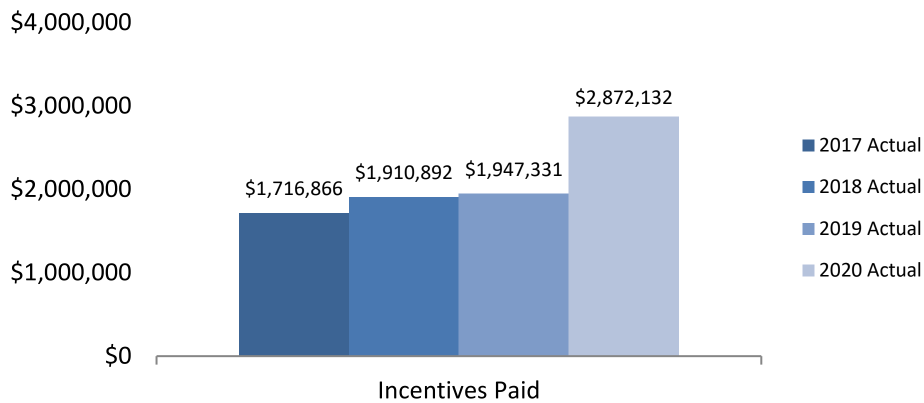

Demand Savings



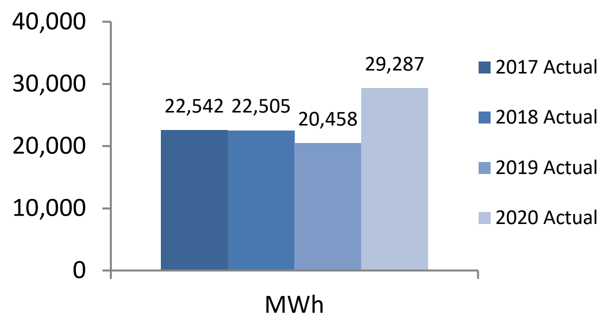

All "filed" numbers are taken from DP&L's program portfolio filing; Case No. 17-1398-EL-POR.

### *Four-Year Trend Analysis*

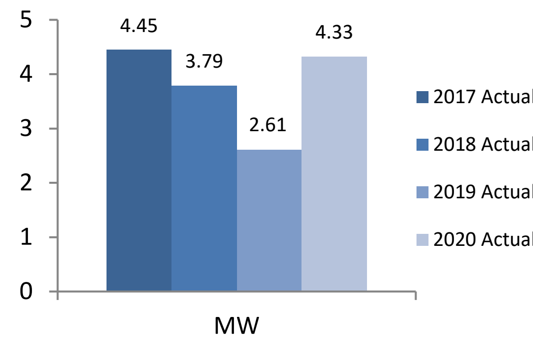
Custom Rebate Dollars




Energy Savings




Demand Savings




### *Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $3,509,089 | $2,872,132 |
| Marketing & Admin | $1,398,639 | $882,653 |
| Total Costs | $4,907,728 | $3,754,785 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

Since 2009, DP&L has implemented and managed the Custom Rebate Program internally. DP&L chose this course of action, as opposed to hiring an outside implementer, for several reasons. First, implementing the program in-house significantly strengthens DP&L employee knowledge of energy efficiency programs and technologies. Second, it provides DP&L with the opportunity to build relationships with contractor networks and customers, leading to quality customer service. And third, unlike with the residential programs, DP&L does not believe a third-party implementer adds significant value at this point in the program. DP&L continues to be able to process the volume of Custom Rebates internally.

### *Targeted Products*

DP&L's Custom Rebate Program was designed to provide business and government customers with an opportunity to receive rebates for implementing innovative energy efficient emerging technologies and process improvements. Rebate checks disbursed to customers in 2020 ranged from $55 to $188,250.

In 2015 a Combined Heat and Power (CHP) incentive structure was developed to fit into the Custom Rebate Program, with rebate levels calculated using "Other" as the project type. No CHP projects were applied for or completed in 2020.

### *Custom Rebate Allocation*

| Product Type | Rebate Dollars Paid | Energy Saved (MWh) | Demand Saved (MW) |
|---|---|---|---|
| Lighting | $25,534 | 443 | 0.06 |
| HVAC | $456,607 | 3,764 | 0.45 |
| Other, includes:<br>• Glass door retrofits on refrigerated cases<br>• Multi-compressor compressed air systems<br>• | $660,948 | 7,961 | 1.05 |
| New Construction | $774,784 | 8,645 | 2.18 |
| Retro-Commissioning | $922,269 | 8,474 | 0.59 |
| Channel Partner Rewards | $31,990 | - | - |
| Total | $2,872,132 | 29,287 | 4.33 |

In 2020, Custom Rebates were rebated per the following schedule:

| Project Type | Rebate Calculation |
|---|---|
| Lighting | $0.05/kWh + $50/KW |
| HVAC | $0.10/kWh + $100/KW |
| Other | $0.08/kWh + $100/KW |
| Retro-Commissioning | $0.04/kWh to $0.08/kWh + 80% study cost subsidy |

DP&L does not endorse any equipment manufacturers or suppliers in the Custom Rebate Program. Business and government customers may purchase any brand of equipment from any supplier they choose, as long as the equipment is new and meets the eligibility requirements. Equipment must use electricity as the fuel source and be replacing existing equipment or be installed as part of a retrofit project. Projects are required to have a payback of less than 7 years before rebates are applied. The 7 year maximum payback helps to promote cost effectiveness.

New Construction Rebates are calculated in one of two ways. The lighting power density (LPD) incentive encourages the inclusion or installation of lighting designs and equipment that provide quality lighting at lower installed wattages. The incentive is calculated on a per square foot basis for LPD performance exceeding ANSI/ASHRAE/IESNA Standard 90.1-2007, or for those applications received January 1, 2017 or after, Standard 90.1-2010.

$$\text{Incentive}_{\text{LPD}} = (\text{LPD}_{\text{baseline}} - \text{LPD}_{\text{actual}}) \text{ x area x \$0.30}$$

Alternately, customers can choose to have their new building evaluated using the Whole Building Energy Performance Baseline Improvement Method. This method incents customers who design their buildings to be more efficient than a baseline building constructed to ANSI/ASHRAE/IESNA Standard 90.1-2007, or for those applications received January 1, 2017 or after, Standard 90.1-2010. To be eligible for a whole building incentive, the customer must provide documentation of an energy model in accordance with ANSI/ASHRAE/IESNA Standard 90.1, Appendix G. Incentives are calculated using the following incentive rate guidelines. To receive an incentive, a project must achieve an annual electric energy and demand savings of 5 percent or better than baseline.

| Incentive Rate Guidelines | | |
|---|---|---|
| First Year Annual Electric Reduction | Energy Incentive Rate | Demand Incentive Rate |
| 5-10% over baseline | $0.05/kWh | $50/KW |
| >10% over baseline | $0.08/kWh | $75/KW |
| >20% over baseline | $0.10/kWh | $100/KW |

***Application Process***

DP&L’s Custom Rebate application process was designed to be customer friendly and comprehensive. The application is completely online which makes it convenient for customers and efficient for program control purposes. Customers must apply for a Custom Rebate prior to beginning their project. The pre-approval phase allows DP&L the opportunity to perform pre-installation auditing (in some cases, metering) of the affected systems. The application consists of three pages. The first page asks for basic customer information such as company name, address, installation address, DP&L account number, facility type and hours of operation, and contractor contact information. On the second page, customers enter a detailed project description, their baseline energy and demand usage, and their proposed energy and demand usage. The third page allows customers to upload supporting documentation to their application, such as specification sheets, engineering calculations and invoices. When the customer has input all their data, they “submit rebate” and receive a confirmation number. When customers or contractors have questions, DP&L staff is available to guide them through the process.

The customer or vendor completes the online Custom Rebate application and submits it electronically to DP&L for review. Applications must be complete and include the necessary contact information, equipment specifications, and equipment costs. Additionally, applicants must submit a full description of how the energy and demand savings were calculated. DP&L then reviews the application, verifies the information provided, and sends a confirmation email indicating the application has been approved. If the application has been approved, the funds will be reserved. Program guidelines suggest the customer or vendor provide DP&L with proof of purchase within 60 days of the approval notification. Proof of purchase may come in the form of an invoice, purchase order or other supporting document. If proof of purchase is not received, DP&L reserves the right to remove the fund reservation. Applicants can reapply for rebates but they will be placed in the back of the queue. The equipment should be installed and ready to operate within 120 days of application approval and DP&L must be notified of the installation. DP&L must be provided with a final invoice reflecting the true costs of purchasing and installing the energy savings measure (including all materials, labor, and equipment discounts) as well as equipment serial numbers. If the installation does not occur within 120 days, the customer may request an extension from DP&L using the Online Extension Request Form. Extension requests are handled on a case by case basis. DP&L releases the rebate funds to the customer within approximately 30 days of receiving the verification of installation.

DP&L reserves the right to inspect the installed measure(s) prior to releasing any funds to ensure compliance with the program Terms and Conditions. To ensure energy and demand savings are calculated correctly, many Custom Rebates are audited. This often requires equipment metering. In 2020, 80 percent of Custom Rebates were audited. In addition to the internal staff, third party engineers and contractors are utilized to perform pre- and post-installation verification audits for a sampling of projects rebated through the Custom Rebate Program.

### *Staffing*

DP&L has three program managers to manage the business rebate programs, including the Custom Rebate Program, and serve as DP&L's direct point-of-contact with customers. The internal staff is responsible for reviewing, approving and processing rebate applications. They track and report all incentive dollars as well as energy and demand savings. The staff is also responsible for promoting the program to customers through a variety of marketing tools and business and community events.

### *Marketing*

For efficiency and cost-effectiveness purposes, DP&L often promotes the Custom Rebate Program as it promotes its Rapid Rebates®. DP&L employs a variety of marketing methods, including publication of program information on the company web site, print literature, bill inserts, inserts in local business journals, mass media advertising, presentations at community- and vendor-sponsored events, one-on-one marketing through major account managers, and the Channel Partner network.

Channel Partners are contractors, engineers and distributors with energy efficiency experience. They have participated in DP&L rebate workshops and are familiar with using DP&L rebate programs to help customers save money. Channel Partners are viewed as an invaluable third party “marketing extension” of DP&L’s internal group of program managers. They have direct contact with customers on a daily basis and can influence the customer’s purchasing decisions. Of the 20,813 MWh in Custom Rebate Program savings attained by customers in 2020, Channel Partners were involved in securing 6,930 MWh or 33 percent of those savings.


*Channel Partners*

Channel Partners participate in DP&L rebate workshops and are familiar with using DP&L rebate programs to help customers save money.


***September 30, 2020 is a critical date!***

***Apply for rebates through***
***DP&L Energy Efficiency Programs***
***while there is still time!***


## Rapid Rebates Promotion Deadline Approaching

Help your customers receive a **50% enhancement** of their rebate before time runs out! The promotion for Rapid Rebates* is still available **exclusively for Channel Partner projects**.

**The following must occur before September 30:**

1. The rebate **application is submitted** to DP&L.
2. The **customer purchases the equipment** for their project.
3. The customer's **proof of equipment purchase is uploaded** to the rebate application. *This must be an itemized invoice which specifies the unit cost and description for all types of equipment purchased.*

**The following must occur before November 30:**

4. The customer's **proof of installation documentation is uploaded** to the rebate application.

Click here to review all promotion criteria. Questions about whether a project would qualify for the promotion? Send us an email so you know for sure. **Applications will only be accepted through September 30!**

**DP&L will continue paying rebates for existing and new applications in a first-come, first-serve manner, based on the date all required documentation for an application is received and complete regardless of when the application was submitted, until December 31, 2020 or until program budgets are depleted, whichever comes first.*

## PUCO Deadlines

Per the Public Utilities Commission of Ohio (PUCO) Order issued this past February, **mandated energy efficiency programs in the State of Ohio will terminate by December 31, 2020.** Applications must be submitted by **September 30** in order for a project to be eligible for a rebate.

## Business Rebates Program Updates

The DP&L Business Rebates Team is continuing to monitor progress toward **meeting our 2020 savings goals**. We are also closely watching **rebate applications** for all programs. With the **September 30 deadline quickly approaching**, visit our website often for current information about each program.

**Rapid Rebates and Custom Rebates**
We are still accepting new applications for both Rapid Rebates and Custom Rebates. In order to be eligible for a rebate, the application must be submitted prior to **September 30**. In addition, final documentation must be submitted prior to November 30.

Rapid Rebates applications may also be eligible for the current promotion, receiving a 50% enhancement of the final rebate amount. Click here to review all promotion criteria.

**Midstream**
Qualifying purchases may be made at any participating distributor location until **September 30**.

**New Construction**
New construction projects, whether Lighting or Whole Building, will be reviewed on a case-by-case basis. Eligibility for a rebate will be dependent upon whether the building is scheduled to have its occupancy permit on or before November 30. Please contact our team before **September 30** to confirm whether your customer's project would qualify.

**Small Business Direct Install**
Appointment requests will be accepted for the Small Business Direct Install program through **September 30**.

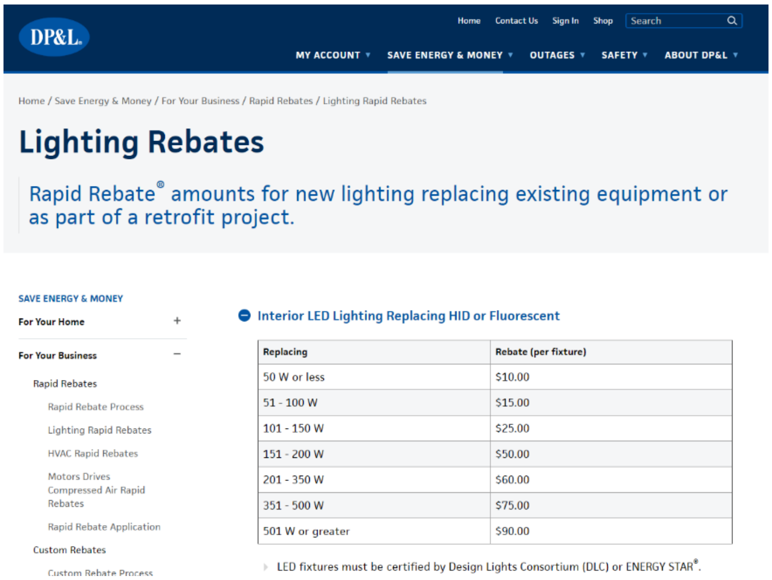
**Other Programs**
We are no longer accepting applications for the following programs: Large Customer Self-Direct (Mercantile), Retro-commissioning, or Combined Heat and Power.

*Newsletter*

Channel Partners are kept up-to-date on program news and changes through a quarterly Channel Partner newsletter

*Event Sponsorships*

DP&L Business Programs frequently sponsor and participate in community- and vendor-sponsored events.



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MY ACCOUNT SAVE ENERGY & MONEY OUTAGES SAFETY ABOUT DP&L

Home / Save Energy & Money / For Your Business / Rapid Rebates / Lighting Rapid Rebates

## Lighting Rebates

Rapid Rebate® amounts for new lighting replacing existing equipment or as part of a retrofit project.

SAVE ENERGY & MONEY
For Your Home
For Your Business
Rapid Rebates
Rapid Rebate Process
Lighting Rapid Rebates
HVAC Rapid Rebates
Motors Drives Compressed Air Rapid Rebates
Rapid Rebate Application
Custom Rebates
Custom Rebate Process

Interior LED Lighting Replacing HID or Fluorescent

| Replacing | Rebate (per fixture) |
|---|---|
| 50 W or less | $10.00 |
| 51 - 100 W | $15.00 |
| 101 - 150 W | $25.00 |
| 151 - 200 W | $50.00 |
| 201 - 350 W | $60.00 |
| 351 - 500 W | $75.00 |
| 501 W or greater | $90.00 |

LED fixtures must be certified by Design Lights Consortium (DLC) or ENERGY STAR®.

*Web Site*

The Business Rebates pages on the DP&L web site give a description of the Custom Rebate Program and allow customers to navigate to other pages for more information or apply online for a rebate.


*Print Literature*

DP&L used standard print materials for hand-outs at meetings with customers and at a variety of speaking events

*Collaborative Partners*

DP&L continues to work with its collaborative partners to promote programs

***Customer Service***

In all programs, customer service is a critical element to success. As such, DP&L designed a number of customer service elements into the Custom Rebate Program, some of which have been previously discussed.

The Custom Rebate section of the DP&L web site acts as the main information portal for customers, contractors, distributors and other program participants. The web site contains all Custom Rebate eligibility requirements, as well as access to the online application. Customers receive a confirmation number when they submit an online custom rebate application. The confirmation number allows the customer to access their application's status upload documents to their application.

In addition to being an effective means of marketing DP&L programs, Channel Partners are also a valuable resource for delivering the program to customers in a quality manner.  Channel Partners are trained on the custom rebate application process.  Many Channel Partners have used DP&L rebate programs to offer a “turn-key” experience for the customer, including approximate rebates in customer quotes and applying for rebates on behalf of customers.  Through this process, customers can have confidence the proposed project will be eligible for a rebate while allowing DP&L to work with the Channel Partner to clarify any issues that may arise.  In short, the Channel Partners are an effective “middleman” for the program with proper upfront training and ongoing program communication.

To encourage Channel Partners to continue to provide excellent service to customers, the Channel Partner Rebate Rewards program was launched in 2011.  A Channel Partner must be listed on the rebate application in order to be eligible for Rewards associated with an incentive.  In addition, the Channel Partner must attain a minimum of $10,000 in DP&L incentives issued to customers in a program year. Once a Channel Partner meets all requirements for receiving Rewards, the Channel Partner begins to earn a cash bonus equal to 5 percent of the DP&L rebates paid to the customers for the Channel Partner’s projects.  This incentivizes the Channel Partner to complete the rebate application for the customer.  In 2020, DP&L paid $31,990 in Custom Channel Partner Rebate Rewards.

As a quality control measure, the auditing process ensures contractors and vendors are not misrepresenting the program.  From a customer service perspective, customers appreciate and welcome the audit process, as it gives them unbiased energy savings data.  They can use this data in submitting positive post-analysis reports on their capital projects.

To make communication convenient for the customer, the Business Programs staff maintains an Energy Efficiency Inbox, energyefficiency@dplinc.com, a clearinghouse for general program questions business and government customers may have.

Lastly, DP&L maintains its own customer service center, accepting calls regarding all functions of DP&L.  DP&L Business Program management staff conducted training sessions for customer service center staff regarding program details.  This was to ensure DP&L phone representatives had a basic understanding of the energy efficiency programs and could assist customers in navigating the web site or point them to the Energy Efficiency Inbox.

## SMALL BUSINESS DIRECT INSTALL

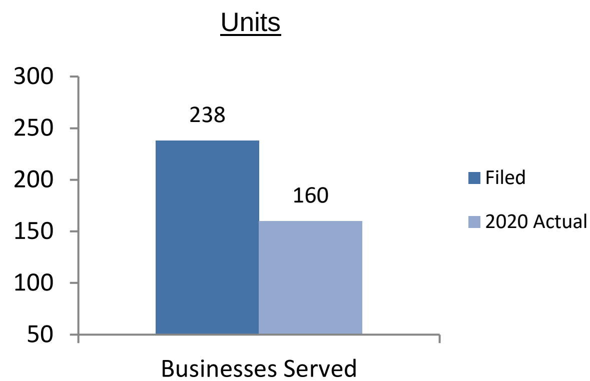
### PROGRAM DESCRIPTION

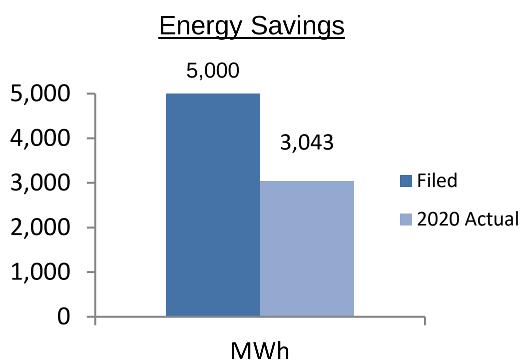
The Small Business Direct Install Program objective is to provide immediate energy saving opportunities and identify mid- and long-term cost-effective electric savings for small business customers (200kW and below). Savings are achieved by installing free instant savings measures, as well as educating customers on the energy and non-energy benefits associated with eligible and other prioritized project opportunities. The program also offers customers the opportunity to learn more about other DP&L program offerings available and applicable to their facility.

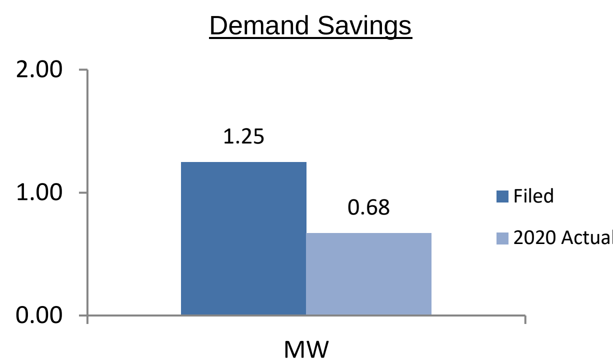
### PERFORMANCE SUMMARY

During 2020, a total of 160 small businesses were retrofitted throughout the DP&L service territory, resulting in gross annualized energy savings of 3,043 MWh and peak demand savings of 0.68 MW. In 2020, DP&L requested and was granted permission from the PUCO to transfer $375,000 from the Small Business Direct Install Program to the Prescriptive Rebate Program to provide additional incentives to meet high customer demand in the Prescriptive Rebate Program. Transfer of these funds is reflected in the filed program budgets.

***2020 Performance***



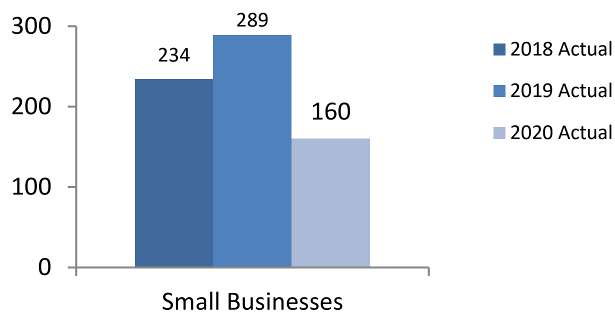



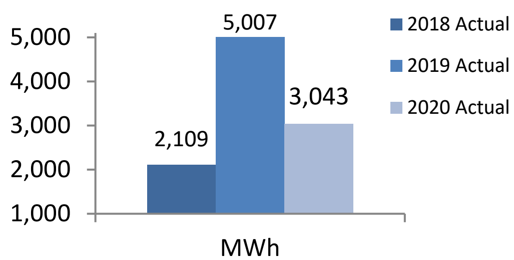

All “filed” numbers are taken from DP&L’s program portfolio filing; Case No. 17-1398-EL-POR.

### *Three-Year Trend Analysis*

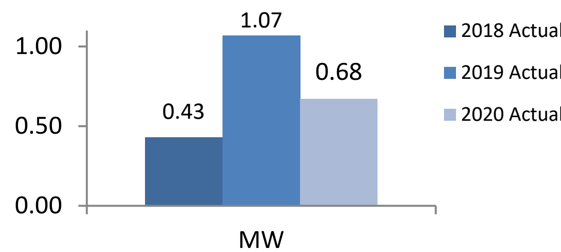
Units




Energy Savings




Demand Savings




### *Budget, Cost Summary*

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $535,000 | $388,355 |
| Marketing & Admin | $117,729 | $232,645 |
| Total Costs | $652,729 | $621,000 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

An implementation partner for Small Business Direct Install was selected through a 2017 RFP process. In December of 2017, the selected vendor withdrew from delivering the program. In the second quarter of 2018, DP&L selected CLEAResult to implement the Small Business Direct Install Program. CLEAResult was a clear choice to select because they could leverage all the local resources they have in place for the other programs they deliver for DP&L equipment installations.

CLEAResult is responsible for establishing partnerships with distributors, overseeing the implementation of cooperative advertising, and tracking the number of efficient equipment installations. CLEAResult performs a walk-through assessment with the customer, records pre-existing measures, and makes equipment replacement recommendations. Specific data points and savings calculations are collected and provided to customers. CLEAResult then installs instant savings measures.

***Targeted Products***

The measures and services within this program may include, but are not limited to:

- LED Bulbs
- LED Exit Signs
- Faucet Aerators
- Low Flow Showerheads
- Pre-Rinse Sprayers
- Salon Sprayers
- Pipe Insulation
- Smart Strips
- Occupancy Sensors

***Measures Installed***

| Technology | 2020 Measures Installed |
|---|---|
| Low Flow Showerhead | 4 |
| Faucet Aerator | 229 |
| Pre-rinse Sprayer | 6 |
| Salon Sprayer | 0 |
| Water Heater Pipe Insulation | 5 |
| LED A-line | 2,507 |
| LED PAR38 | 129 |
| LED PAR30 | 28 |
| LED BR30 | 972 |
| LED Tube - 2ft | 31 |
| LED Tube - 4ft | 35,171 |
| LED Exit Sign | 17 |
| Occupancy Sensor | 47 |
| **TOTAL** | **39,146** |

***Targeted Customers***

The Small Business Direct Install Program is designed for all DP&L business customers with monthly electrical peak demand under 200 kW. This program allows small customers to have energy-saving equipment installed at no cost them.

### *Staffing*

CLEAResult's local staff members manage the program and serve as DP&L's direct point-of-contact. The local field staff, consisting of a program manager, outreach manager, and two field installers, is responsible for implementing the Small Business Direct Install Program. The local staff is supported by the experienced managers and support team located in the CLEAResult main office.

### *Marketing*

Through the Small Business Direct Install Program, DP&L assists a traditionally underserved business segment by communicating the energy and cost-saving benefits of energy-efficient upgrades to small business customers. Marketing is done through a direct outreach approach. The program also informs manufacturers, engineers, distributors and retailers about customer demand and preferences for energy-efficient technologies.  These efforts, combined with the financial incentives provided by the rebates, help to increase demand for energy efficient products.


*Wrapped Installation Van*



*Leave Behind Flyer*

***Customer Service***

In all programs, customer service is a critical element of program success. As such, DP&L designed a number of customer service elements into its program, some of which have been previously discussed.

For those who want to speak to a representative, DP&L set up a program hotline number staffed by local CLEAResult employees. The staff has been trained to answer detailed questions about the Small Business Direct Install Program.

DP&L maintains its own customer service center, accepting calls regarding all functions of DP&L. DP&L management staff continues to update customer service center staff regarding program details as needed.

## MERCANTILE SELF-DIRECT PROGRAM

### PROGRAM DESCRIPTION

Pursuant to O.R.C §4928.66, mercantile customers may commit their peak demand reduction, demand response and energy efficiency projects for integration with an electric utility's programs. DP&L's Self-Direct Program consists of the company allowing mercantile customers to commit their resources for integration in DP&L's programs in exchange for a one-time payment, a commitment payment or exemption from the Energy Efficiency Rider (EER). This Self-Direct Program is available to customers who consume 700,000 kWh or more per year or are part of a regional or national account and who commit their demand and energy savings to be integrated into DP&L's energy efficiency programs.

In 2020, consistent with the Commission's program for mercantile customers to commit energy efficient/peak demand reduction adopted in Case No.10-834-EL-EEC, DP&L's Self-Direct Program allows mercantile customers who have successfully identified and documented savings from energy efficiency projects since January 1, 2017 to apply for a one-time incentive payment or an exemption from the EER. If a customer provides all the necessary project documentation, DP&L will file a joint application with the customer, requesting PUCO approval of an incentive payment or exemption from the EER for a period of time. Rules also permit a customer to file directly with the PUCO.

The one-time payments are reduced to 75 percent of the incentive amount the customer could have received for the same project under the 2020 Rapid Rebate® or Custom Rebate programs. EER exemption requests are based on the percentage of demand and energy saved versus the overall customer demand and energy consumed. The EER exemption is proposed to last as long as the percentage of savings achieved by the customer exceeds the legislated demand and/or energy targets on an individual basis. Customers may participate as an individual facility or have the option to aggregate all facilities into a single application. All applications are filed at the PUCO individually and reviewed on a case-by-case basis.

All mercantile applications must be approved by the PUCO prior to taking effect.

### PERFORMANCE SUMMARY

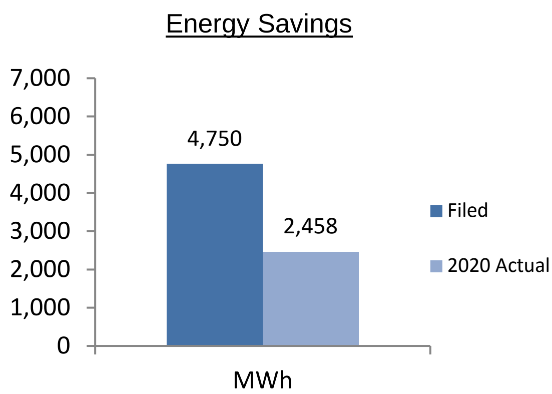
During 2020, DP&L paid six applications with customers requesting a one-time incentive payment for historical energy efficiency projects. These applications were filed using the PUCO-issued mercantile template format and resulted in energy savings of 2,458 MWh and demand savings of 0.36 MW.

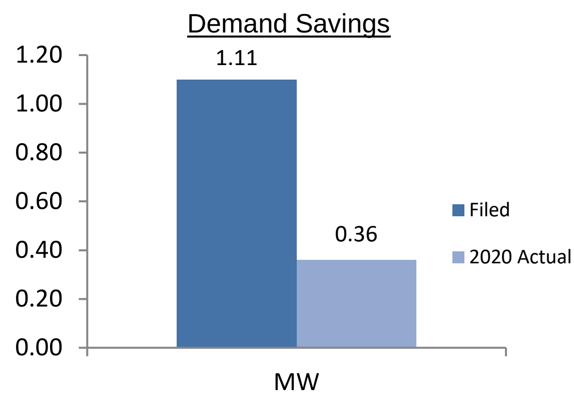
In 2020, DP&L requested and was granted permission from the PUCO to transfer $70,000 from the Mercantile Self-Direct Program to the Prescriptive Rebate Program to provide additional incentives to meet high customer demand in the Prescriptive Rebate Program. Transfer of these funds is reflected in the filed program budgets.

Savings continue to be claimed on a single energy efficiency rider exemption (10-2205-EL-EEC), which was filed in 2010 and approved by the Commission on December 7, 2011.

| 2020 Mercantile Program Summary | | Approved by PUCO | Energy Savings (kWh) | Demand Savings (kW) | Incentive Payment |
|---|---|---|---|---|---|
| One-Time Incentive Payments for Energy Efficiency | | | | | |
| City of Dayton (Phase 4) | 20-1174-EL-EEC | ✓ | 156,418 | 0 | $14,696.25 |
| Colepak | 20-0867-EL-EEC | ✓ | 31,384 | 0 | $1,987.50 |
| University of Dayton | 20-1483-EL-EEC | | 828,859 | 169.2 | $37,400.00 |
| SouthviewMedical Center | 20-1329-EL-EEC | ✓ | 832,717 | 113.7 | $16,597.50 |
| Greene Memorial Hospital | 20-1328-EL-EEC | ✓ | 105,695 | 4.2 | $3,090.00 |
| Children's Medical Center | 20-1484-EL-EEC | ✓ | 502,742 | 69.4 | $13,646.25 |
| TOTAL 2020 Mercantile Savings | | | 2,457,815 | 356.5 | $87,417.50 |

***2020 Performance***




All "filed" numbers are taken from DP&L's program portfolio filing; Case No. 17-1398-EL-POR.

***Budget, Cost Summary***

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $50,000 | $87,418 |
| Marketing & Admin | $64,256 | $14,698 |
| Total Costs | $114,256 | $102,116 |

## IMPLEMENTATION REVIEW

### *Implementation Strategy*

DP&L is implementing this program in-house, utilizing business program managers. This provides a dedicated point of contact at DP&L to assist the customer through the process. It is the program manager's responsibility to understand program details, communicate the program to customers, and help customers manage their way through the mercantile process.

### *Targeted Customers*

DP&L has determined approximately 1,200 customers qualify for the Self-Direct Program based on the law's minimum usage criteria of 700,000 kWh per year, set forth in O.A.C. §4901:1-39(P).

### *Staffing*

DP&L utilizes business program managers to manage the Self-Direct Program. These managers focus on managing all stages of the Self-Direct Program including program design, PUCO rule review, marketing and customer service.

### *Marketing*

To promote the Self-Direct Program, DP&L educates industry contractors and distributors about its availability. Their knowledge about local efficiency projects was used to establish leads for potential customers that may have implemented projects in the 2017 to 2019 timeframe.

### *Customer Service*

DP&L utilizes its business program managers to provide customers with a single point of contact to assist with the mercantile application process. DP&L's program managers are knowledgeable about program rules, requirements and procedures and can help customers with their initial analysis related to program savings and expected energy efficiency rider costs. Further, DP&L can provide the regulatory and legal support required to make initial filings and assist throughout the regulatory process.

# CROSS SECTOR PROGRAMS

## CUSTOMER EDUCATION AND MARKETING

In 2020, DP&L's customer education activities included a mass media campaign, in-person events and participation in various community events and conferences.

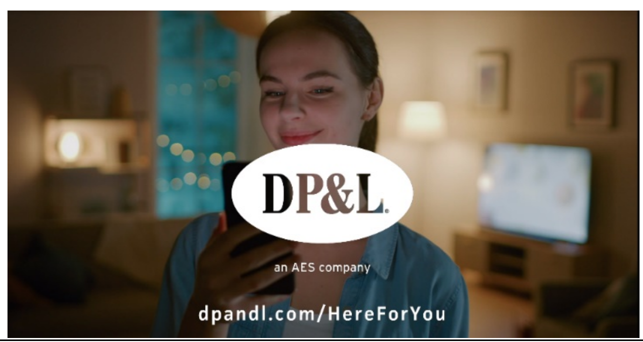
***Budget, Cost Summary***

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| General Education, Awareness Building | $1,628,420 | $652,731 |
| Total Costs | $1,628,420 | $652,731 |

### MASS MEDIA CAMPAIGN

During 2020, DP&L aired a multi-media educational and promotional campaign including television, radio online advertising and social media targeted to all of its customers. The goals of the campaign were to communicate the value of energy efficiency and increase the awareness of available energy efficiency programs. In addition, the campaign provided a general level of program marketing support, helping to promote the continued expansion of customer participation in energy efficiency programs.

*Television Script*

| | |
|---|---|
| Announcer Voice Over<br><br>Your connectivity to the world has been completely redefined.<br><br>Today – and every day – DP&L puts safety first… for our people, our customers and our communities.<br><br>As you plug in, log on, tune in and charge up… we are enhancing our energy efficiency programs to find new ways to help you save money.<br><br>From rebates on lighting and smart thermostats to heating and cooling rebates, they're all ready for you right now.<br><br>DP&L. In a world of change, our commitment is unwavering. | <br><br> |

*Radio Script Example*

DP&L is enhancing our energy efficiency programs finding new ways to help you save money while spending more time at home.

Right now, when you purchase a smart thermostat through DP&L's online Marketplace, you can save up to $150 with instant rebates. Shop the leading brands, all which allow you to easily control your home's heating and cooling right from your phone.

Visit dpandl.com/hereforyou to check out all our rebates and learn more ways to save.

DP&L. In a world of change, our commitment is unwavering.

*Online Ad Examples*



*Other Events and Activities*

In 2020, DP&L performed limited education and awareness activities as a result of the COVID-19 virus.  However, early in the year, DP&L participated in the Dayton Homeworld Show as well as an LED bulb trade-in event at the University of Dayton.

## PILOT PROGRAM

### PROGRAM DESCRIPTION

Pilot programs are intended to allow DP&L the flexibility to research or pilot programs to test their feasibility for cost-effective savings and potential inclusion in future portfolio plans. The objective of the Pilot Program is to develop and deploy new opportunities as they arise. Results of the pilot program may also inform mid-stream adjustments to the current plan programs as needed.

In accordance with the Stipulation and Recommendation adopted in DP&L's 2018-20 Portfolio Plan, Case No. 17-1398-EL-EEC, DP&L agrees to file an Application before the Commission seeking approval of any proposed Pilot programs.

### PERFORMANCE SUMMARY

On January 31, 2019, DP&L filed an application for approval of a Residential Demand Response Pilot Program in Case No. 19-0334-EL-UNC. The intent of the pilot was to control residential air conditioning loads through smart thermostats, and the pilot was intended to run through the summers of 2019 and 2020. The filed 2-year budget was $702,120. As of the date of this report filing, the Commission has not issued an order on the pilot. Therefore, DP&L did not implement or spend money associated with the Pilot Program in 2019 or 2020.

***Budget, Cost Summary***

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| Incentive Costs | $434,217 | $0 |
| Marketing & Admin | $186,092 | $0 |
| Total Costs | $620,309 | $0 |

## STAKEHOLDER INITIATIVES

### PROGRAM DESCRIPTION

DP&L partners with collaborative members when possible to extend programming to various customer groups.  The Stakeholder Initiatives program was originally intended to implement programming or coordinate funding with stakeholders for whom a commitment was established in in DP&L's Electric Security Plan ("ESP 3"), Case No. 16-0395-EL-SSO.  However, in December 2019, ESP 3 was withdrawn and a modified ESP 1 became effective, rendering the terms and conditions of ESP 3 no longer applicable.

### PERFORMANCE SUMMARY

DP&L did not implement the Stakeholder Initiatives program 2020.

***Budget, Cost Summary***

| Budget Category | Filed 2020 | Actual 2020 |
|---|---|---|
| City of Dayton | $200,000 | $0 |
| Honda | $45,000 | $0 |
| Ohio Hospital Association | $200,000 | $0 |
| People Working Cooperatively | $200,000 | $0 |
| Marketing & Admin | $0 | $0 |
| Total Costs | $645,000 | $0 |

## TRANSMISSION AND DISTRIBUTION INFRASTRUCTURE IMPROVEMENTS

### PROGRAM DESCRIPTION

Pursuant to O.R.C §4928.66(A)(2)(d), programs implemented by a utility to meet the statutory reduction requirements may include transmission and distribution infrastructure improvements that reduce line losses.

In December 2011, DP&L filed an application (11-6010-EL-POR) with the Public Utilities Commission of Ohio to include energy efficiency gains resulting from the upgrade of the company's distribution network from 4 kilovolt (kV) to 12 kilovolt distribution lines, for activities completed in the years 2010 and 2011. On August 7, 2013, the Commission approved the application, allowing DP&L to include those savings in the program portfolio plan covering 2009 through 2011.

In April 2013, DP&L filed an updated portfolio plan (13-0833-EL-POR) for energy efficiency programs for years 2013 through 2015. Part of this plan included DP&L's intention to count savings toward its statutory benchmarks associated with infrastructure improvements. Increasing the operating voltage on the distribution system, as was done in the 4 kV to 12 kV project, is one example of an infrastructure improvement project cited in the plan. The plan was approved by the Commission on December 4, 2013.

As stated in both 11-6010-EL-POR and 13-0833-EL-POR, DP&L did not seek to recover 4 kV to 12 kV costs through the Energy Efficiency Rider for savings reported in the 2013 Portfolio Status Report (14-0738-EL-POR).

In June 2017, DP&L filed an updated portfolio plan (17-1398-EL-POR) for energy efficiency programs for years 2018 through 2020. Again, this plan sought approval to count the savings from infrastructure improvements that reduce line losses toward its statutory benchmarks as part of its overall compliance efforts. The plan was approved by the Commission on December 20, 2017.

### PERFORMANCE SUMMARY

DP&L is not claiming savings from any additional transmission and distribution infrastructure projects in 2020.

## SMART GRID

### PROGRAM DESCRIPTION

Pursuant to O.R.C §4928.66(A)(2)(d)(i)(II), programs implemented by a utility to meet the statutory reduction requirements may include smart grid investment programs, provided that such programs are demonstrated to be cost beneficial.

### PERFORMANCE SUMMARY

DP&L did not utilize the Smart Grid program 2020.

# APPENDIX A – ANNUAL REPORT STANDARDIZED TEMPLATE

# Ohio Utility Energy Efficiency Savings Summary

## 1 Incremental Savings from Programs in Year 2020

| | Ex Ante Gross Savings | | | Realization Rate | | Actual Expenditures | | | Participation | | Weighted Program Measure Life | TRC Test Ratio | PAC Test Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G=F/A | H=F/C | I | J | K=C/A | L | M |
| | First Year Annual Energy Savings | First Year Peak Demand Savings | Lifetime Savings | Energy Savings (Ex Post Gross/Ex Ante Gross) | Demand Savings (Ex Post Gross/Ex Ante Gross) | Program Costs | Ex Ante First Year Cost Per First Year Annual Savings (F/A) | Ex Ante First Year Cost per Lifetime Savings (F/C) | Participation Number | Description (Units Description is provided in the PSR) | Years | By Program | By Program |
| | MWh | MW | MWh | % | % | $ | $/kWh | $/kWh | | | | | |
| **Residential Programs** | | | | | | | | | | | | | |
| Efficient Products | 49,773 | 5.95 | 995,451 | 100% | 100% | $3,106,142 | $0.06 | $0.00 | 1,561,545 | Bulbs | 20.0 | 13.07 | 11.88 |
| HVAC Equipment | 6,458 | 1.31 | 80,075 | 100% | 100% | $1,365,278 | $0.21 | $0.02 | 5,082 | Rebates | 12.4 | 0.52 | 2.74 |
| Appliance Recycling | 1,959 | 0.33 | 14,886 | 100% | 100% | $246,860 | $0.13 | $0.02 | 1,525 | Appliances | 7.6 | 3.25 | 3.21 |
| School Education | 3,430 | 0.21 | 25,036 | 100% | 100% | $256,658 | $0.07 | $0.01 | 8,845 | Kits | 7.3 | 4.32 | 4.04 |
| Multi-Family Direct Install | 288 | 0.03 | 4,120 | 100% | 100% | $77,848 | $0.27 | $0.02 | 580 | Apartment Units | 14.3 | 2.52 | 2.22 |
| Smart Thermostats | 4,954 | 0.42 | 49,544 | 100% | 100% | $655,993 | $0.13 | $0.01 | 8,542 | Thermostats | 10.0 | 1.62 | 3.75 |
| Behavior Change | 8,358 | 1.44 | 8,358 | 76% | 76% | $326,588 | $0.04 | $0.04 | 115,000 | Customers | 1.0 | 3.60 | 3.6 |
| Energy Savings Kits | 5,252 | 0.58 | 64,603 | 100% | 100% | $357,103 | $0.07 | $0.01 | 21,342 | Kits | 12.3 | 8.49 | 7.57 |
| Income Eligible Efficiency | 842 | 0.09 | 10,951 | 100% | 100% | $844,632 | $1.00 | $0.08 | 472 | Homes | 13.0 | 0.69 | 0.68 |
| **Total Residential** | **81,313** | **10.37** | **1,253,023** | **98%** | **97%** | **$7,237,102** | **$ 0.09** | **$ 0.01** | | | | **3.95** | **6.82** |
| **Business Programs** | | | | | | | | | | | | | |
| Rapid Rebates (Prescriptive) | 114,489 | 18.70 | 1,121,994 | 98% | 93% | $9,621,886 | $0.08 | $0.01 | 1,160 | Rebates | 9.8 | 1.67 | 5.35 |
| Custom Rebates | 29,287 | 4.33 | 363,158 | 100% | 97% | $3,754,785 | $0.13 | $0.01 | 91 | Rebates | 12.4 | 1.60 | 4.22 |
| Small Business Direct Install | 3,044 | 0.68 | 35,609 | 100% | 100% | $621,000 | $0.20 | $0.02 | 160 | Businesses | 11.7 | 2.75 | 2.75 |
| Mercantile Self-Direct | 2,458 | 0.36 | 24,578 | 100% | 100% | $102,116 | $0.04 | $0.00 | 6 | Applications | 10.0 | 1.71 | 12.99 |
| **Total Business** | **149,277** | **24.05** | **1,545,339** | **100%** | **95%** | **$14,099,787** | **$ 0.09** | **$ 0.01** | | | | **1.67** | **4.99** |
| **Other Programs** | | | | | | | | | | | | | |
| Pilot Program | 0 | 0.00 | N/A | N/A | N/A | $0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Stakeholder Initiatives | N/A | N/A | N/A | N/A | N/A | $0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Customer Education and Marketing | N/A | N/A | N/A | N/A | N/A | $652,731 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Behavior Change Program Uplift | -819 | -0.06 | -819 | 82% | 100% | N/A | N/A | N/A | N/A | N/A | 1.0 | N/A | N/A |
| Evaluations, Measurement & Verification | N/A | N/A | N/A | N/A | N/A | $853,937 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| **Total Other** | **-819** | **-0.07** | **N/A** | **82%** | **100%** | **$1,506,668** | | | | | | | |
| **Portfolio Total** | **229,772** | **34.36** | **2,798,363** | **98%** | **95%** | **$22,843,557** | **$ 0.10** | **$ 0.01** | | | | **2.17** | **5.24** |

## 2 Information Relative to Statutory Targets for Year 2020

| | |
|---|---|
| 3 year baseline retail normalized (mercantile, weather, opt-out, etc.) sales (MWh) | 12,665,340 |
| 2020 Annual Benchmark Target (%) | 1% |
| 2020 Savings (MWh) | 229,772 |
| 2020 Achievement (%) | 181% |

## 3 Banked Savings in Year 2020

| | |
|---|---|
| 2020 Excess Savings Banked Toward Future Compliance (MWh) | 103,118 |
| Total Banked Savings Remaining After 2020 (MWh) | 1,162,716 |

## 4 Opt Out - Three year baseline in 2020

| | |
|---|---|
| Total Opt Out load (MWh) | 954,002 |

# APPENDIX B – 2019 BENCHMARK REPORT

# THE DAYTON POWER & LIGHT COMPANY
# 2020 Benchmark Report

The Dayton Power and Light Company ("DP&L" or "the Company") herewith submits its updated Benchmark Report ("Benchmark Report") pursuant to Section 4901:1-39-05(C)(1)(a) of the Ohio Administrative Code ("O.A.C"). In this report, DP&L identifies the energy and demand baselines for kilowatt-hour sales and kilowatt demand for reporting year 2020 based on the preceding three calendar years (2017, 2018, and 2019) as specified in Section 4928.66(A)(2)(a) of the Ohio Revised Code ("O.R.C."), along with DP&L's energy saving and peak demand reduction statutory benchmarks. In this report, DP&L also makes adjustments pursuant to O.R.C. §4928.66(A)(2)(a)(i) and (ii), O.R.C. §4928.66(A)(2)(c) and O.A.C §4901:1-39-05(B) to adjust its sales and demand baselines to normalize for weather and changes to DP&L's customer base related to reasonable arrangements, statutory portfolio plan opt-outs, and mercantile opt-out applications. DP&L's benchmarks and adjustments are supported by the descriptions shown below, including the method of calculating the baselines, supporting data, assumptions, rationales, and calculations as required by O.A.C. §4901:1-39-05(B).

## DP&L 2020 Energy Efficiency Baseline Calculation

Consistent with the definition of "Energy baseline" pursuant to O.A.C. §4901:1-39-01(J), DP&L's Total Retail sales for the three preceding calendar years (2017, 2018, and 2019), which are shown below, were taken from DP&L's most recent long-term forecast report found on the Electric Utility Ohio Service Area Energy Consumption Forecast (PUCO Form FE-D1) and included as Workpaper A.

2017: 13,778,247 MWh
2018: 14,579,712 MWh
2019: 13,980,211 MWh

## DP&L 2020 Peak Demand Baseline Calculation

Consistent with the definition of "Peak-demand baseline" pursuant to O.A.C. §4901:1-39-01(S), DP&L's Peak Demands for the three preceding calendar years (2017, 2018, and 2019), which are shown below, were taken from DP&L's most recent long-term forecast report found on the Electric Utility Ohio Seasonal Peak Load Demand Forecast (PUCO Form FE-D3) and included as Workpaper B.

2017: 2,771 MW
2018: 2,859 MW
2019: 2,805 WM

## Normalizing Adjustments

**Adjustments for Reasonable Arrangement and Statutory Opt-Out Customers**

Pursuant to O.R.C §4928.66(A)(2)(a)(i) and (ii), an electric distribution utility must adjust its baseline to exclude the load and usage of both customers "for which a reasonable arrangement has been approved under section 4905.31 of the Revised Code" and "that has opted out of the utility's portfolio plan under section 4928.6611 of the Revised Code". DP&L has identified the customers that fall under these sections and both adjustments were included on Schedules 1 and 2.

**Adjustment for Mercantile Customers**

Pursuant to O.R.C §4928.66(A)(2)(c), an electric distribution utility must adjust its baseline to exclude the effects of all energy efficiency or peak demand reduction programs that may have existed during the period used to establish the baseline. Therefore, in addition to the adjustment for reasonable arrangement and statutory opt-out customers, DP&L also adjusted its baseline to account for the energy efficiency and peak demand reduction that was realized in connection with the approval of mercantile opt-out applications. With the exception of two applications, such mercantile applications, which included energy efficiency projects for the 2009-2016 timeframe, were approved by the Commission under the 60-day automatic approval in 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, and 2020 pursuant to the Commission's pilot program for Mercantile Customers as established in Case No. 10-834-EL-EEC. Two of the mercantile applications were approved by the Commission for exemption from DP&L's Energy Efficiency Rider as a result of implementation of energy efficiency projects. The adjustment for Mercantile Customers is shown in more detail in Workpaper C.

**Weather normalization**

Weather-normalization adjusts actual weather-sensitive retail sales by class (Residential, Commercial, and Public Authority) to account for the difference between actual and normal heating and cooling degree days based on historical use per customer per day per cooling degree day and heating degree day relationships for these classes.

Workpaper D, pages 1-3 calculate the weather normalized retail sales and peak demands for the period. The weather normalization factor is the ratio of weather normalized values to actual values (sales or peak demands) and is calculated on Workpaper E.

The annual MWh sales adjusted for mercantile opt out applications are multiplied by the Weather Normalization Factors to yield the Normalized Retail Energy Sales (MWh). The same process is applied to calculate Weather Normalized Peak Demands (MW).

**DP&L 2020 Normalized Energy Efficiency Baseline Calculation**

DP&L's 2020 Normalized Energy Efficiency baseline calculation is shown on Schedule 1. The methodology is consistent with O.A.C. §4901:1-39-01(J) and includes the adjustments described above. The normalized retail energy sales for 2017, 2018, and 2019 are averaged over the three years, to produce DP&L's 2020 Normalized Energy Efficiency Baseline of 12,665,340 MWh.

**DP&L 2020 Energy Efficiency Reduction Benchmark Calculation**

As described in O.R.C. §4928.66(A)(1)(a), beginning in 2009, an electric distribution utility shall:

> "Implement energy efficiency programs that achieve energy savings equivalent to at least three-tenths of one per cent of the total, annual average, and normalized kilowatt-hour sales of the electric distribution utility during the preceding three calendar years to customers in this state. The savings requirement, using such a three-year average, shall increase to an additional… one percent from 2014 to 2020."

DP&L's 2020 Normalized Energy Efficiency Baseline of 12,665,340 MWh is multiplied by the 2020 Energy Efficiency Reduction Benchmark percentage of 1.00% pursuant to O.R.C. §4928.66(A)(1)(a). The result is DP&L's 2020 Incremental Energy Efficiency Reduction Benchmark of 126,653 MWh. DP&L's 2020 cumulative Energy Efficiency Reduction Benchmark is 1,097,541 MWh. The calculations are shown on Schedule 1.

**DP&L 2020 Normalized Peak Demand Baseline Calculation**

DP&L's 2020 Normalized Peak Demand Reduction baseline calculation is shown on Schedule 2. The methodology is consistent with O.A.C. §4901:1-39-01(S) and includes the adjustments described above. DP&L's Normalized Peak Demands for 2017, 2018, and 2019 are averaged over the three years, to produce DP&L's 2020 Normalized Peak Demand Baseline of 2,575 MW.

**DP&L 2020 Peak Demand Reduction Benchmark Calculation**

As described in O.R.C. §4928.66 (A)(1)(b), beginning in 2009, an electric distribution utility shall:

> "Implement peak demand reduction programs designed to achieve a one per cent reduction in peak demand in 2009 and an additional seventy-five hundredths of one per cent reduction each year through 2020."

DP&L's 2020 Normalized Peak Demand Reduction Baseline of 2,575 MW is multiplied by the 2020 Peak Demand Reduction Benchmark percentage of 7.75% pursuant to O.R.C. §4928.66 (A)(1)(b). The result is DP&L's 2020 Peak Demand Reduction Benchmark of 199.6 MW. The calculation is shown on Schedule 2.

**THE DAYTON POWER & LIGHT COMPANY**

**2020 Benchmark Report**

Energy Efficiency Baseline and Benchmark Calculation

| | | 2017 | 2018 | 2019 | |
|---|---|---|---|---|---|
| 1 | **Baseline Calculation Components** | | | | |
| 2 | Retail MWh Sales [1] | 13,778,247 | 14,579,712 | 13,980,211 | |
| 3 | | | | | |
| 4 | **Normalizing Adjustments** | | | | |
| 5 | Reasonable Arrangement Adjustment [2] | 425,549 | 419,095 | 622,061 | |
| 6 | Opt-Out Customer Adjustment [3] | 902,524 | 890,865 | 1,068,617 | |
| 7 | Mercantile Customer Adjustment [4] | 70,052 | 72,382 | 74,420 | |
| 8 | Total Adjusted Retail Sales (2+7)-(5+6) | 12,520,226 | 13,342,134 | 12,363,953 | |
| 9 | Weather Normalization Factor [5] | 1.02467 | 0.97247 | 0.9861 | |
| 10 | Normalized Retail Energy Sales (8)*(9) | 12,829,100 | 12,974,825 | 12,192,094 | |
| 11 | | | | | |
| 12 | **2020 Normalized Energy Efficiency Baseline** | | | | |
| 13 | 3 Year Normalized Average (MWh) | | | | 12,665,340 |
| 14 | | | | | |
| 15 | **Calculation of 2020 Energy Efficiency Reduction Benchmark** | | | | |
| 16 | Normalized Preceding 3 Year Average Sales (13) | | | | 12,665,340 |
| 17 | 2020 Incremental Energy Efficiency Reduction Benchmark % [6] | | | | 1.00% |
| 18 | 2020 Incremental Energy Efficiency Reduction Benchmark (16)*(17) | | | | 126,653 |
| 19 | 2019 Energy Efficiency Reduction Benchmark [7] | | | | 970,888 |
| 20 | **2020 Cumulative Energy Efficiency Reduction Benchmark (18)+(19)** | | | | **1,097,541** |

[1] Retail sales for the period 2017-2019 are reported in PUCO Form FE-D1 (Case No. 20-0916-EL-POR). See Workpaper A, Column (6).

[2] Adjusted in compliance with O.R.C. §4928.66(A)(2)(a)(i).

[3] Adjusted in compliance with O.R.C. §4928.66(A)(2)(a)(ii).

[4] See Workpaper C for calculation of Mercantile Customer Adjustment.

[5] See Workpaper E for calculation of the weather normalization factor.

[6] Energy Efficiency benchmark as established in O.R.C. §4928.66(A)(1)(a).

[7] 2019 Cumulative Energy Efficiency Reduction Benchmark as established in Case No. 20-0916-EL-POR, Schedule 1, line 20.

# THE DAYTON POWER & LIGHT COMPANY
## 2020 Benchmark Report
Peak Demand Baseline and Benchmark Calculation

| | | 2017 | 2018 | 2019 | |
|---|---|---|---|---|---|
| 1 | **Baseline Calculation Components** | | | | |
| 2 | Peak MW Demand [1] | 2,771 | 2,859 | 2,805 | |
| 3 | | | | | |
| 4 | **Normalizing Adjustments** | | | | |
| 5 | Reasonable Arrangement Adjustment [2] | 66 | 76 | 102 | |
| 6 | Opt-Out Customer Adjustment [3] | 136 | 104 | 140 | |
| 7 | Mercantile Customer Adjustment [4] | 19 | 20 | 20 | |
| 8 | Total Adjusted Peak Demand (2+7)-(5+6) | 2,588 | 2,699 | 2,583 | |
| 9 | Weather Normalization Factor [5] | 1.04583 | 0.96817 | 0.93048 | |
| 10 | Normalized Peak Demand (8)*(9) | 2,707 | 2,613 | 2,404 | |
| 11 | | | | | |
| 12 | **2020 Normalized Peak Demand Reduction Baseline** | | | | |
| 13 | 3 Year Normalized Average (MW) | | | | 2,575 |
| 14 | | | | | |
| 15 | **Calculation of Normalized 2020 Peak Demand Reduction Benchmark** | | | | |
| 16 | Normalized Preceding 3 Year Average Peak Demand (13) | | | | 2,575 |
| 17 | 2020 Peak Demand Reduction Benchmark % [6] | | | | 7.75% |
| 18 | **2020 Peak Demand Reduction Benchmark (16)*(17)** | | | | **199.6** |

[1] Peak demand for the period 2017-2019 is reported in PUCO Form FE-D3.
See Workpaper B.

[2] Adjusted in compliance with O.R.C. §4928.66(A)(2)(a)(i).

[3] Adjusted in compliance with O.R.C. §4928.66(A)(2)(a)(ii).

[4] See Workpaper C for calculation of Mercantile Customer Adjustment.

[5] See Workpaper E for calculation of weather normalization factor.

[6] Peak Demand Reduction benchmark as established in O.R.C § 4928.66(A)(1)(b).

Workpaper A

# THE DAYTON POWER & LIGHT COMPANY
## 2020 Benchmark Report

### PUCO FORM FE-D1: ELECTRIC UTILITY OHIO SERVICE AREA ENERGY CONSUMPTION FORECAST
### (Megawatt-Hours Per Year)

| | | (1) | (2) | (3) | (4) | (5[a]) | (5[b]) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|---|---|
| | YEAR | RESIDENTIAL | COMMERCIAL | INDUSTRIAL | TRANSPORTATION[a] | OTHER[b] | ENERGY EFFICIENCY & DEMAND RESPONSE | TOTAL END USER CONSUMPTION (1)+(2)+(3)+(4)+(5a)-(5b) | LOSSES AND UNACCOUNTED FOR | NET ENERGY FOR LOAD (6)+(7) |
| -5 | 2015 | 5,187,751 | 3,742,101 | 3,684,745 | 3,885 | 1,302,505 | | 13,920,987 | 530,476 | 14,451,463 |
| -4 | 2016 | 5,253,286 | 3,788,252 | 3,852,079 | 3,647 | 1,344,361 | | 14,241,625 | 534,154 | 14,775,779 |
| -3 | 2017 | 4,993,562 | 3,673,103 | 3,831,994 | 3,052 | 1,276,536 | | 13,778,247 | 457,513 | 14,235,760 |
| -2 | 2018 | 5,614,038 | 3,793,106 | 3,871,102 | 2,271 | 1,299,195 | | 14,579,712 | 484,136 | 15,063,848 |
| -1 | 2019 | 5,212,842 | 3,670,311 | 3,833,966 | 2,355 | 1,260,738 | | 13,980,211 | 397,629 | 14,377,840 |
| 0 | 2020 | 5,306,581 | 3,724,308 | 3,933,317 | 2,595 | 1,267,097 | 213,104 | 14,020,795 | 526,105 | 14,546,900 |
| 1 | 2021 | 5,297,450 | 3,715,403 | 3,948,535 | 2,595 | 1,256,652 | 213,104 | 14,007,531 | 525,618 | 14,533,149 |
| 2 | 2022 | 5,316,001 | 3,728,989 | 3,963,244 | 2,595 | 1,246,210 | 213,104 | 14,043,934 | 526,954 | 14,570,888 |
| 3 | 2023 | 5,356,207 | 3,731,745 | 3,976,888 | 2,595 | 1,235,770 | 213,104 | 14,090,101 | 528,649 | 14,618,749 |
| 4 | 2024 | 5,412,138 | 3,735,603 | 3,984,764 | 2,595 | 1,225,333 | 213,104 | 14,147,329 | 530,749 | 14,678,078 |
| 5 | 2025 | 5,465,727 | 3,736,628 | 3,992,244 | 2,595 | 1,214,899 | 213,104 | 14,198,989 | 532,645 | 14,731,634 |
| 6 | 2026 | 5,527,896 | 3,724,595 | 4,000,736 | 2,595 | 1,204,468 | 213,104 | 14,247,186 | 534,414 | 14,781,600 |
| 7 | 2027 | 5,600,154 | 3,715,171 | 4,018,042 | 2,595 | 1,194,040 | 213,104 | 14,316,897 | 536,972 | 14,853,869 |
| 8 | 2028 | 5,684,957 | 3,710,272 | 4,028,730 | 2,595 | 1,183,614 | 213,104 | 14,397,064 | 539,914 | 14,936,978 |
| 9 | 2029 | 5,785,086 | 3,706,249 | 4,039,869 | 2,595 | 1,173,192 | 213,104 | 14,493,887 | 543,468 | 15,037,355 |
| 10 | 2030 | 5,808,226 | 3,721,074 | 4,056,029 | 2,606 | 1,177,885 | 213,104 | 14,552,715 | 545,627 | 15,098,342 |

(a) Transportation includes railroads & railways.

(b) Other includes Street & Highway Lighting, Public Authorities and Interdepartmental Sales.

Workpaper B

# THE DAYTON POWER & LIGHT COMPANY
## 2020 Benchmark Report

### PUCO FORM FE-D3: ELECTRIC UTILITY OHIO SEASONAL PEAK LOAD DEMAND FORECAST
(Megawatts)

| | | Native Load | | | | | Internal Load | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Year | Summer | Demand Response[b] | Net Summer | Winter[a] | | Summer | Demand Response[b] | Net Summer | Winter[a] |
| -5 | 2015 | 2845 | | | 2453 | | 2845 | | | 2453 |
| -4 | 2016 | 2883 | | | 2486 | | 2883 | | | 2486 |
| -3 | 2017 | 2771 | | | 2598 | | 2771 | | | 2598 |
| -2 | 2018 | 2859 | | | 2706 | | 2859 | | | 2706 |
| -1 | 2019 | 2805 | | | 2658 | | 2804 | | | 2658 |
| 0 | 2020 | 2953 | 26 | 2927 | 2589 | | 2953 | 26 | 2927 | 2589 |
| 1 | 2021 | 2964 | 26 | 2938 | 2575 | | 2964 | 26 | 2938 | 2575 |
| 2 | 2022 | 2985 | 26 | 2959 | 2580 | | 2985 | 26 | 2959 | 2580 |
| 3 | 2023 | 3006 | 26 | 2980 | 2587 | | 3006 | 26 | 2980 | 2587 |
| 4 | 2024 | 3027 | 26 | 3001 | 2598 | | 3027 | 26 | 3001 | 2598 |
| 5 | 2025 | 3046 | 26 | 3020 | 2595 | | 3046 | 26 | 3020 | 2595 |
| 6 | 2026 | 3064 | 26 | 3038 | 2597 | | 3064 | 26 | 3038 | 2597 |
| 7 | 2027 | 3087 | 26 | 3061 | 2603 | | 3087 | 26 | 3061 | 2603 |
| 8 | 2028 | 3118 | 26 | 3092 | 2618 | | 3118 | 26 | 3092 | 2618 |
| 9 | 2029 | 3145 | 26 | 3119 | 2624 | | 3145 | 26 | 3119 | 2624 |
| 10 | 2030 | 3168 | 26 | 3142 | 2624 | | 3168 | 26 | 3142 | 2624 |

(a) Winter load reference is to peak loads which follow the summer peak load.

(b) Includes both energy efficiency and demand response.

# THE DAYTON POWER AND LIGHT COMPANY
## 2020 Benchmark Report
### Adjustment for Mercantile Customers

| Ln | Customer | Demand Savings (kW) | | | Energy Savings (kWh) | | |
|---|---|---|---|---|---|---|---|
| | | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 1 | **2010 Mercantile Customer Adjustment *** | | | | | | |
| 2 | Customer A | 499.4 | 499.4 | 499.4 | 1,914,690 | 1,914,690 | 1,914,690 |
| 3 | Customer B | 13.2 | 13.2 | 13.2 | 202,161 | 202,161 | 202,161 |
| 4 | Customer C | 294.5 | 294.5 | 294.5 | 959,998 | 959,998 | 959,998 |
| 5 | Customer D | 91.5 | 91.5 | 91.5 | 91,554 | 91,554 | 91,554 |
| 6 | Customer E | 261.5 | 261.5 | 261.5 | 261,565 | 261,565 | 261,565 |
| 7 | Customer F | 237.0 | 237.0 | 237.0 | 1,000,430 | 1,000,430 | 1,000,430 |
| 8 | Customer G | 97.1 | 97.1 | 97.1 | 526,864 | 526,864 | 526,864 |
| 9 | **Total 2010 Adjustment** | **1,494.2** | **1,494.2** | **1,494.2** | **4,957,262** | **4,957,262** | **4,957,262** |
| 10 | | | | | | | |
| 11 | **2011 Mercantile Customer Adjustment *** | | | | | | |
| 12 | Customer H | 108.7 | 108.7 | 108.7 | 952,131 | 952,131 | 952,131 |
| 13 | Customer I | 120.5 | 120.5 | 120.5 | 620,513 | 620,513 | 620,513 |
| 14 | Customer J | 192.5 | 192.5 | 192.5 | 958,979 | 958,979 | 958,979 |
| 15 | Customer K | 8.1 | 8.1 | 8.1 | 40,600 | 40,600 | 40,600 |
| 16 | Customer L | 137.9 | 137.9 | 137.9 | 996,566 | 996,566 | 996,566 |
| 17 | Customer M | 275.2 | 275.2 | 275.2 | 233,127 | 233,127 | 233,127 |
| 18 | Customer N | 39.6 | 39.6 | 39.6 | 141,247 | 141,247 | 141,247 |
| 19 | EER Exemption Applications | 3,148.8 | 3,386.9 | 3624.60 | 17,416,672 | 18,934,588 | 20,515,180 |
| 20 | **Total 2011 Adjustment** | **4,031.3** | **4,269.4** | **4,507.1** | **21,359,835** | **22,877,751** | **24,458,343** |
| 21 | | | | | | | |
| 22 | **2012 Mercantile Customer Adjustment *** | | | | | | |
| 23 | Customer O | 57.1 | 57.1 | 57.1 | 499,656 | 499,656 | 499,656 |
| 24 | Customer P | 406.3 | 406.3 | 406.3 | 210,142 | 210,142 | 210,142 |
| 25 | Customer Q | 13.7 | 13.7 | 13.7 | 171,581 | 171,581 | 171,581 |
| 26 | Customer R | 2.3 | 2.3 | 2.3 | 44,855 | 44,855 | 44,855 |
| 27 | Customer S | 44.4 | 44.4 | 44.4 | 329,770 | 329,770 | 329,770 |
| 28 | Customer T | 158.0 | 158.0 | 158.0 | 785,861 | 785,861 | 785,861 |
| 29 | Customer U | 31.7 | 31.7 | 31.7 | 38,516 | 38,516 | 38,516 |
| 30 | Customer V | 1,719.8 | 1,719.8 | 1,719.8 | 1,120,905 | 1,120,905 | 1,120,905 |
| 31 | Customer W | 144.4 | 144.4 | 144.4 | 123,863 | 123,863 | 123,863 |
| 32 | Customer X | 517.3 | 517.3 | 517.3 | 2,269,477 | 2,269,477 | 2,269,477 |
| 33 | Customer Y | 162.1 | 162.1 | 162.1 | 209,352 | 209,352 | 209,352 |
| 34 | Customer Z | 312.8 | 312.8 | 312.8 | 201,505 | 201,505 | 201,505 |
| 35 | Customer AA | - | - | - | 43,804 | 43,804 | 43,804 |
| 36 | Customer AB | 365.0 | 365.0 | 365.0 | 300,316 | 300,316 | 300,316 |
| 37 | **Total 2012 Adjustment** | **3,934.9** | **3,934.9** | **3,934.9** | **6,349,603** | **6,349,603** | **6,349,603** |

* These Mercantile Applications (except the EER exemption applications) were approved by the Commission in 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018 respectively under the 60 day automatic approval, pursuant to the Commission's pilot program for Mercantile Customers as established in Case No. 10-834-EL-EEC. These adjustments are prorated and based on the timeframe that the energy efficiency was achieved. The EER exemption applications were approved by the Commission in 2011 for exemption from DP&L's Energy Efficiency Rider.

# THE DAYTON POWER AND LIGHT COMPANY
## 2020 Benchmark Report
### Adjustment for Mercantile Customers

| | | Demand Savings (kW) | | | Energy Savings (kWh) | | |
|---|---|---|---|---|---|---|---|
| Ln | Customer | 2016 | 2017 | 2018 | 2016 | 2017 | 2018 |
| 38 | **2013 Mercantile Customer Adjustment *** | | | | | | |
| 39 | Customer AC | 8.2 | 8.2 | 8.2 | 86,204 | 86,204 | 86,204 |
| 40 | Customer AD | 8.2 | 8.2 | 8.2 | 129,307 | 129,307 | 129,307 |
| 41 | Customer AE | 48.8 | 48.8 | 48.8 | 599,123 | 599,123 | 599,123 |
| 42 | Customer AF | 22.8 | 22.8 | 22.8 | 84,096 | 84,096 | 84,096 |
| 43 | Customer AG | 3.3 | 3.3 | 3.3 | 10,207 | 10,207 | 10,207 |
| 44 | Customer AH | 204.1 | 204.1 | 204.1 | 542,722 | 542,722 | 542,722 |
| 45 | Customer AI | 24.0 | 24.0 | 24.0 | 189,977 | 189,977 | 189,977 |
| 46 | Customer AJ | 405.9 | 405.9 | 405.9 | 2,126,547 | 2,126,547 | 2,126,547 |
| 47 | Customer AK | 33.0 | 33.0 | 33.0 | 154,080 | 154,080 | 154,080 |
| 48 | Customer AL | 218.3 | 218.3 | 218.3 | 216,992 | 216,992 | 216,992 |
| 49 | Customer AM | 200.8 | 200.8 | 200.8 | 540,896 | 540,896 | 540,896 |
| 50 | Customer AN | 123.6 | 123.6 | 123.6 | 54,750 | 54,750 | 54,750 |
| 51 | Customer AO | 171.2 | 171.2 | 171.2 | 423,159 | 423,159 | 423,159 |
| 52 | Customer AP | 41.0 | 41.0 | 41.0 | 104,383 | 104,383 | 104,383 |
| 53 | Customer AQ | 49.8 | 49.8 | 49.8 | 368,815 | 368,815 | 368,815 |
| 54 | Customer AR | 179.6 | 179.6 | 179.6 | 56,845 | 56,845 | 56,845 |
| 55 | Customer AS | 6.5 | 6.5 | 6.5 | 35,395 | 35,395 | 35,395 |
| 56 | Customer AT | 193.0 | 193.0 | 193.0 | 420,485 | 420,485 | 420,485 |
| 57 | Customer AU | 29.1 | 29.1 | 29.1 | 59,532 | 59,532 | 59,532 |
| 58 | Customer AV | 23.1 | 23.1 | 23.1 | 310,768 | 310,768 | 310,768 |
| 59 | Customer AW | 670.1 | 670.1 | 670.1 | 883,003 | 883,003 | 883,003 |
| 60 | Customer AX | 649.0 | 649.0 | 649.0 | 1,339,124 | 1,339,124 | 1,339,124 |
| 61 | **Total 2013 Adjustment** | **3,313.4** | **3,313.4** | **3,313.4** | **8,736,410** | **8,736,410** | **8,736,410** |
| 62 | | | | | | | |
| 63 | **2014 Mercantile Customer Adjustment *** | | | | | | |
| 64 | Customer AY | 1,165.8 | 1,165.8 | 1,165.8 | 227,155 | 227,155 | 227,155 |
| 65 | Customer AZ | 230.5 | 230.5 | 230.5 | 62,687 | 62,687 | 62,687 |
| 66 | Customer BA | 3.7 | 3.7 | 3.7 | 7,004 | 7,004 | 7,004 |
| 67 | Customer BB | 2.5 | 2.5 | 2.5 | 5,850 | 5,850 | 5,850 |
| 68 | Customer BC | 2.3 | 2.3 | 2.3 | 188,773 | 188,773 | 188,773 |
| 69 | Customer BD | 37.2 | 37.2 | 37.2 | 198,588 | 198,588 | 198,588 |
| 70 | Customer BE | 30.5 | 30.5 | 30.5 | 505,377 | 505,377 | 505,377 |
| 71 | Customer BF | 10.6 | 10.6 | 10.6 | 115,403 | 115,403 | 115,403 |
| 72 | Customer BG | 30.0 | 30.0 | 30.0 | 135,168 | 135,168 | 135,168 |
| 73 | Customer BH | 308.3 | 308.3 | 308.3 | 139,753 | 139,753 | 139,753 |
| 74 | Customer BI | 62.7 | 62.7 | 62.7 | 427,286 | 427,286 | 427,286 |
| 75 | Customer BJ | 41.8 | 41.8 | 41.8 | 173,925 | 173,925 | 173,925 |
| 76 | Customer BK | 40.0 | 40.0 | 40.0 | 253,584 | 253,584 | 253,584 |
| 77 | Customer BL | 7.1 | 7.1 | 7.1 | 44,055 | 44,055 | 44,055 |
| 78 | Customer BM | 30.7 | 30.7 | 30.7 | 138,154 | 138,154 | 138,154 |
| 79 | **Total 2014 Adjustment** | **2,003.7** | **2,003.7** | **2,003.7** | **2,622,762** | **2,622,762** | **2,622,762** |

* These Mercantile Applications (except the EER exemption applications) were approved by the Commission in 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018 respectively under the 60 day automatic approval, pursuant to the Commission's pilot program for Mercantile Customers as established in Case No. 10-834-EL-EEC. These adjustments are prorated and based on the timeframe that the energy efficiency was achieved. The EER exemption applications were approved by the Commission in 2011 for exemption from DP&L's Energy Efficiency Rider.

**THE DAYTON POWER AND LIGHT COMPANY**
**2020 Benchmark Report**
**Adjustment for Mercantile Customers**

| | | Demand Savings (kW) | | | Energy Savings (kWh) | | |
|---|---|---|---|---|---|---|---|
| Ln | Customer | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 80 | **2015 Mercantile Customer Adjustment *** | | | | | | |
| 81 | Customer BN | 22.9 | 22.9 | 22.9 | 132,704 | 132,704 | 132,704 |
| 82 | Customer BO | 173.2 | 173.2 | 173.2 | 194,532 | 194,532 | 194,532 |
| 83 | Customer BP | 96.0 | 96.0 | 96.0 | 104,887 | 104,887 | 104,887 |
| 84 | Customer BQ | 0.2 | 0.2 | 0.2 | 46,331 | 46,331 | 46,331 |
| 85 | Customer BR | 200.9 | 200.9 | 200.9 | 1,615,884 | 1,615,884 | 1,615,884 |
| 86 | Customer BS | - | - | - | 39,384 | 39,384 | 39,384 |
| 87 | Customer BT | 8.0 | 8.0 | 8.0 | 34,112 | 34,112 | 34,112 |
| 88 | Customer BU | - | - | - | 27,636 | 27,636 | 27,636 |
| 89 | Customer BV | - | - | - | 1,036,807 | 1,036,807 | 1,036,807 |
| 90 | Customer BW | 28.3 | 28.3 | 28.3 | 166,284 | 166,284 | 166,284 |
| 91 | Customer BX | 23.5 | 23.5 | 23.5 | 49,224 | 49,224 | 49,224 |
| 92 | Customer BY | 7.5 | 7.5 | 7.5 | 9,572 | 9,572 | 9,572 |
| 93 | Customer BZ | 18.0 | 18.0 | 18.0 | 248,372 | 248,372 | 248,372 |
| 94 | Customer CA | 295.7 | 295.7 | 295.7 | 462,249 | 462,249 | 462,249 |
| 95 | Customer CB | 8.1 | 8.1 | 8.1 | 33,276 | 33,276 | 33,276 |
| 96 | **Total 2015 Adjustment** | **882.3** | **882.3** | **882.3** | **4,201,254** | **4,201,254** | **4,201,254** |
| 97 | | | | | | | |
| 98 | **2016 Mercantile Customer Adjustment *** | | | | | | |
| 99 | Customer CC | 58.0 | 58.0 | 58.0 | 508,428.0 | 508,428.0 | 508,428.0 |
| 100 | Customer CD | 547.7 | 547.7 | 547.7 | 3,923,184.0 | 3,923,184.0 | 3,923,184.0 |
| 101 | Customer CE | 404.2 | 404.2 | 404.2 | 3,350,208.0 | 3,350,208.0 | 3,350,208.0 |
| 102 | Customer CF | - | - | - | 65,308.0 | 65,308.0 | 65,308.0 |
| 103 | Customer CG | 83.4 | 83.4 | 83.4 | 579,261.0 | 579,261.0 | 579,261.0 |
| 104 | Customer CH | 109.0 | 109.0 | 109.0 | 1,133,243.0 | 1,133,243.0 | 1,133,243.0 |
| 105 | Customer CI | 51.8 | 51.8 | 51.8 | 65,941.0 | 65,941.0 | 65,941.0 |
| 106 | Customer CJ | 48.6 | 48.6 | 48.6 | 267,522.0 | 267,522.0 | 267,522.0 |
| 107 | **Total 2016 Adjustment** | **1,302.7** | **1,302.7** | **1,302.7** | **9,893,095** | **9,893,095** | **9,893,095** |
| | | | | | | | |
| 108 | **2017 Mercantile Customer Adjustment *** | | | | | | |
| 109 | Customer CJ | 20.7 | 20.7 | 20.7 | 324,500 | 324,500 | 324,500 |
| 110 | Customer CK | 209.8 | 209.8 | 209.8 | 1,837,848 | 1,837,848 | 1,837,848 |
| 111 | Customer CL | 403 | 403 | 403 | 3,530,280 | 3,530,280 | 3,530,280 |
| 112 | Customer CM | 9.1 | 9.1 | 9.1 | 52,220 | 52,220 | 52,220 |
| 113 | Customer CN | 74.5 | 74.5 | 74.5 | 645,598 | 645,598 | 645,598 |
| 114 | Customer CO | 3.4 | 3.4 | 3.4 | 29,342 | 29,342 | 29,342 |
| 115 | Customer CP | 8.0 | 8.0 | 8.0 | 32,143 | 32,143 | 32,143 |
| 116 | Customer CQ | 9.1 | 9.1 | 9.1 | 99,615 | 99,615 | 99,615 |
| 117 | Customer CR | - | - | - | 133,356 | 133,356 | 133,356 |
| 118 | Customer CS | 126.2 | 126.2 | 126.2 | 684,682 | 684,682 | 684,682 |
| 119 | Customer CT | 17.2 | 17.2 | 17.2 | 222,234 | 222,234 | 222,234 |
| 120 | Customer CU | 261.9 | 261.9 | 261.9 | 520,802 | 522,264 | 522,264 |
| 121 | Customer CV | 14.2 | 14.2 | 14.2 | 18,132 | 18,132 | 18,132 |
| 122 | Customer CW | 149.9 | 149.9 | 149.9 | 584,748 | 584,748 | 584,748 |
| 123 | Customer CX | 2.5 | 2.5 | 2.5 | 27,624 | 27,624 | 27,624 |
| 124 | Customer CY | 112 | 112 | 112 | 198,789 | 198,789 | 198,789 |
| 125 | Customer CZ | 58.6 | 58.6 | 58.6 | 202,522 | 212,760 | 212,760 |
| 126 | Customer DA | 207.8 | 207.8 | 207.8 | 842,377 | 842,377 | 842,377 |
| 127 | Customer DB | 6.5 | 6.5 | 6.5 | 10,808 | 18,528 | 18,528 |
| 128 | **Total 2017 Adjustment** | **1,694.4** | **1,694.4** | **1,694.4** | **9,997,620** | **10,017,040** | **10,017,040** |
| | | | | | | | |
| 129 | **2018 Mercantile Customer Adjustment *** | | | | | | |
| 130 | Customer DC | 10.0 | 10.0 | 10.0 | 322,045 | 322,045 | 322,045 |
| 131 | Customer DD | 12.1 | 12.1 | 12.1 | 124,025 | 126,624 | 126,624 |
| 132 | Customer DE | - | 24.0 | 24.0 | - | 154,074 | 197,640 |
| 133 | Customer DF | - | 28.5 | 28.5 | - | 238,095 | 310,776 |
| 134 | Customer DG | - | 16.1 | 16.1 | - | 60,000 | 90,000 |
| 135 | **Total 2018 Adjustment** | **22.1** | **90.7** | **90.7** | **446,070** | **900,838** | **1,047,085** |
| | | | | | | | |
| 136 | **2019 Mercantile Customer Adjustment *** | | | | | | |
| 137 | Customer DH | - | - | 11.4 | - | 7,618.0 | 83,798.0 |
| 137 | Customer DI | - | - | 48.8 | - | 60,345.0 | 241,380.0 |
| 138 | Customer DJ | - | - | 7.9 | - | - | 54,120.0 |
| 138 | Customer DK | 557.0 | 557.0 | 557.0 | 947,676.0 | 947,676.0 | 947,676.0 |
| 139 | Customer DL | 110.5 | 110.5 | 110.5 | 540,272.0 | 810,408.0 | 810,408.0 |
| 140 | **Total 2019 Adjustment** | **667.5** | **667.5** | **735.6** | **1,487,948.0** | **1,826,047.0** | **2,137,382.0** |
| | | | | | | | |
| 136 | **Total Adjustment (All Years)** | **19,346.5** | **19,653.2** | **19,959.0** | **70,051,860** | **72,382,061** | **74,420,236** |

* These Mercantile Applications (except the EER exemption applications) were approved by the Commission in 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, and 2019 respectively under the 60 day automatic approval, pursuant to the Commission's pilot program for Mercantile Customers as established in Case No. 10-834-EL-EEC. These adjustments are prorated and based on the timeframe that the energy efficiency was achieved. The EER exemption applications were approved by the Commission in 2011 for exemption from DP&L's Energy Efficiency Rider.

**DAYTON POWER & LIGHT COMPANY**

**2020 Benchmark Report**

2017 Weather Normalization

**2017 Actual Calendar Retail Sales**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | YTD | Peak |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | 545,000 | 392,000 | 410,000 | 321,000 | 333,000 | 420,000 | 491,000 | 456,000 | 352,000 | 340,000 | 410,000 | 592,000 | 5,062,000 | MW |
| Commercial | 300,000 | 268,000 | 292,000 | 272,000 | 305,000 | 333,000 | 354,000 | 346,000 | 305,000 | 303,000 | 285,000 | 317,000 | 3,680,000 | August |
| Industrial | 301,000 | 290,000 | 326,000 | 300,000 | 324,000 | 341,000 | 333,000 | 346,000 | 323,000 | 340,000 | 311,000 | 306,000 | 3,841,000 | Actual |
| Other | 106,000 | 96,000 | 107,000 | 100,000 | 108,000 | 110,000 | 118,000 | 118,000 | 111,000 | 105,000 | 100,000 | 102,000 | 1,281,000 | **2771** |
| | | | | | | | | | | | | | | Load Factor[1] |
| **Total Retail** | **1,252,000** | **1,046,000** | **1,135,000** | **993,000** | **1,070,000** | **1,204,000** | **1,296,000** | **1,266,000** | **1,091,000** | **1,088,000** | **1,106,000** | **1,317,000** | **13,864,000** | 61.41% |

**2017 WN Calendar Retail Sales**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | YTD | WN Peak[2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | 638,000 | 512,000 | 425,000 | 356,000 | 331,000 | 420,000 | 513,000 | 502,000 | 330,000 | 350,000 | 415,000 | 565,000 | 5,357,000 | MW |
| Commercial | 321,000 | 285,000 | 293,000 | 272,000 | 305,000 | 333,000 | 358,000 | 357,000 | 304,000 | 303,000 | 286,000 | 311,000 | 3,728,000 | August |
| Industrial | 301,000 | 290,000 | 326,000 | 300,000 | 324,000 | 341,000 | 333,000 | 346,000 | 323,000 | 340,000 | 311,000 | 306,000 | 3,841,000 | WN |
| Other | 106,000 | 97,000 | 106,000 | 100,000 | 107,000 | 110,000 | 119,000 | 119,000 | 111,000 | 105,000 | 99,000 | 101,000 | 1,280,000 | **2898** |
| **Total WN Retail Sales** | **1,366,000** | **1,184,000** | **1,150,000** | **1,028,000** | **1,067,000** | **1,204,000** | **1,323,000** | **1,324,000** | **1,068,000** | **1,098,000** | **1,111,000** | **1,283,000** | **14,206,000** | |

**All sales in MWh**

[1]**Peak Load Factor is calculated by dividing peak month sales by the number of hours in the month then dividing the result by the peak demand [peak month sales/hours in month)/peak demand]**

[2]**Weather normalized peak is calculated by applying the peak load factor to the normalized peak month sales [(peak month sales/hours in month)/peak month load factor]**

[3]**Other Includes Public Authorities, Street Railway, and Street Lighting**

**DAYTON POWER & LIGHT COMPANY**
**2020 Benchmark Report**
2018 Weather Normalization

**2018 Actual Calendar Retail Sales**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | YTD | Peak |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | 598,378 | 436,363 | 464,379 | 382,262 | 389,202 | 462,151 | 505,894 | 515,343 | 421,250 | 403,364 | 442,255 | 509,000 | 5,529,841 | MW |
| Commercial | 325,515 | 271,680 | 291,608 | 274,713 | 326,799 | 337,609 | 354,905 | 356,853 | 326,924 | 333,887 | 276,298 | 287,164 | 3,763,957 | June |
| Industrial | 301,593 | 293,889 | 313,899 | 307,173 | 341,942 | 332,106 | 332,193 | 356,609 | 331,820 | 364,276 | 295,336 | 278,125 | 3,848,962 | Actual |
| Other | 112,196 | 94,039 | 104,111 | 98,050 | 116,366 | 108,554 | 117,419 | 122,453 | 117,087 | 116,660 | 92,266 | 96,831 | 1,296,032 | **2859** |
| | | | | | | | | | | | | | | Load Factor[1] |
| **Total Retail** | **1,337,683** | **1,095,971** | **1,173,997** | **1,062,199** | **1,174,309** | **1,240,420** | **1,310,412** | **1,351,258** | **1,197,081** | **1,218,186** | **1,106,156** | **1,171,120** | **14,438,791** | 60.26% |

**2018 WN Calendar Retail Sales**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | YTD | WN Peak[2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | 567,091 | 491,529 | 426,394 | 337,878 | 307,355 | 431,940 | 513,963 | 486,856 | 360,157 | 337,550 | 393,946 | 559,189 | 5,213,848 | MW |
| Commercial | 320,627 | 278,451 | 288,139 | 271,375 | 297,841 | 328,406 | 357,102 | 348,465 | 308,153 | 318,261 | 270,502 | 295,064 | 3,682,386 | June |
| Industrial | 301,593 | 293,889 | 313,899 | 307,173 | 341,942 | 332,106 | 332,193 | 356,609 | 331,820 | 364,276 | 295,336 | 278,125 | 3,848,962 | WN |
| Other | 112,196 | 94,039 | 104,111 | 98,050 | 116,366 | 108,554 | 117,419 | 122,453 | 117,087 | 116,660 | 92,266 | 96,831 | 1,296,032 | **2768** |
| **Total WN Retail Sales** | **1,301,507** | **1,157,908** | **1,132,543** | **1,014,477** | **1,063,504** | **1,201,006** | **1,320,677** | **1,314,383** | **1,117,217** | **1,136,747** | **1,052,050** | **1,229,209** | **14,041,227** | |

**All sales in MWh**

[1]**Peak Load Factor is calculated by dividing peak month sales by the number of hours in the month then dividing the result by the peak demand [peak month sales / hours in month) / peak demand]**

[2]**Weather normalized peak is calculated by applying the peak load factor to the normalized peak month sales [(peak month sales / hours in month) / peak month load factor]**

[3]**Other Includes Public Authorities, Street Railway, and Street Lighting**

**DAYTON POWER & LIGHT COMPANY**

**2020 Benchmark Report**

2019 Weather Normalization

**2019 Actual Calendar Retail Sales**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | YTD | Peak |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | 586,618 | 480,720 | 483,080 | 326,064 | 336,841 | 406,508 | 545,362 | 487,594 | 435,302 | 332,363 | 433,784 | 506,538 | 5,360,774 | MW |
| Commercial | 318,694 | 290,041 | 293,480 | 267,244 | 294,724 | 311,429 | 368,539 | 353,100 | 325,270 | 295,181 | 276,393 | 296,570 | 3,690,664 | July |
| Industrial | 312,557 | 285,852 | 309,265 | 301,040 | 320,342 | 330,432 | 317,937 | 346,332 | 328,998 | 311,269 | 302,509 | 267,139 | 3,733,671 | Actual |
| Other | 108,667 | 97,486 | 103,286 | 96,728 | 107,348 | 104,883 | 123,285 | 117,712 | 118,306 | 103,475 | 92,891 | 98,721 | 1,272,789 | **2805** |
| | | | | | | | | | | | | | | Load Factor[1] |
| **Total Retail** | **1,326,536** | **1,154,099** | **1,189,111** | **991,077** | **1,059,255** | **1,153,252** | **1,355,123** | **1,304,738** | **1,207,876** | **1,042,287** | **1,105,577** | **1,168,968** | **14,057,898** | 64.93% |

**2019 WN Calendar Retail Sales**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | YTD | WN Peak[2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | 588,043 | 522,139 | 459,372 | 358,918 | 307,916 | 406,711 | 485,607 | 468,502 | 323,393 | 343,987 | 391,400 | 613,664 | 5,269,652 | MW |
| Commercial | 319,102 | 296,424 | 291,250 | 272,096 | 284,183 | 311,245 | 351,254 | 347,392 | 289,809 | 291,870 | 271,958 | 311,912 | 3,638,495 | July |
| Industrial | 312,965 | 292,236 | 307,035 | 305,892 | 309,801 | 330,249 | 300,652 | 340,624 | 293,536 | 307,957 | 298,075 | 282,482 | 3,681,502 | WN |
| Other | 108,667 | 97,486 | 103,286 | 96,728 | 107,348 | 104,883 | 123,285 | 117,712 | 118,306 | 103,475 | 92,891 | 98,721 | 1,272,789 | **2610** |
| **Total WN Retail Sales** | **1,328,777** | **1,208,284** | **1,160,943** | **1,033,634** | **1,009,249** | **1,153,088** | **1,260,798** | **1,274,229** | **1,025,045** | **1,047,288** | **1,054,324** | **1,306,780** | **13,862,438** | |

**All sales in MWh**

[1]**Peak Load Factor is calculated by dividing peak month sales by the number of hours in the month then dividing the result by the peak demand [peak month sales / hours in month) / peak demand]**

[2]**Weather normalized peak is calculated by applying the peak load factor to the normalized peak month sales [(peak month sales / hours in month) / peak month load factor]**

[3]**Other Includes Public Authorities, Street Railway, and Street Lighting**

# THE DAYTON POWER & LIGHT COMPANY
## 2020 Benchmark Report
Weather Normalization Factors

| Year | Actual Calendar Retail Sales[1] | Weather Normalized Retail Sales[2] | Energy Weather Normalization Factor[3] |
|---|---|---|---|
| | (a) | (b) | (c) |
| 2017 | 13,864,000 | 14,206,000 | 1.02467 |
| 2018 | 14,438,791 | 14,041,227 | 0.97247 |
| 2019 | 14,057,898 | 13,862,438 | 0.98610 |

| | Actual System Peak Demands[1] | Weather Normalized Peak Demands[2] | Demand Weather Normalization Factor[3] |
|---|---|---|---|
| 2017 | 2,771 | 2,898 | 1.04583 |
| 2018 | 2,859 | 2,768 | 0.96817 |
| 2019 | 2,805 | 2,610 | 0.93048 |

[1] Workpaper D, Pages 1-3.

[2] Weather normalization sales and peaks are based on normal heating and cooling degree day adjustments (Workpaper D, Pages 1-3).

[3] Weather normalization factor (c)= (b)/(a).

# EXHIBIT 1 – CADMUS EVALUATION, MEASUREMENT & VERIFICATION REPORT

CADMUS

# 2020 Evaluation, Measurement, and Verification Report

January 29, 2021

**Prepared for:**

Dayton Power and Light

1900 Dryden Road

Dayton, Ohio 45439

## Table of Contents

# Tables

# Figures

# Acronyms and Abbreviations

| Acronym | Definition |
|---|---|
| AC | Air conditioner |
| ARP | Appliance Recycling program |
| Be E³ Smart | School Education program |
| C&I | Commercial and industrial |
| CAA | Community action agency |
| CADR | Clean Air Delivery Rate |
| CDD | Cooling degree day |
| CF | Coincidence Factor |
| COP | Coefficient of performance |
| CV | Constant variable volume |
| DHW | Domestic hot water |
| DOE | U.S. Department of Energy |
| DP&L | Dayton Power and Light |
| ECM | Electronically commuted motor |
| EER | Energy efficiency ratio |
| EFLH | Equivalent full-load hour |
| EISA | Energy Independence and Security Act of 2007 |
| EM&V | Evaluation, measurement, and verification |
| ESF | Energy savings factor |
| GPM | Gallons per minute |
| GSHP | Ground-source heat pump |
| HDD | Heating degree day |
| HEAP | Home Energy Assistance program |
| HER | Home energy report |
| HOMER | Home energy reports platform |
| HOU | Hours-of-use |
| HP | Heat pump |
| HWAP | Home Weatherization Assistance program |
| IECC | International Energy Conservation Code |
| IGS | Interstate Gas Supply, Inc. |
| IEER | Integrated energy efficiency ratio |
| Illinois TRM | *Illinois Technical Reference Manual* |
| IPLV | Integrated part load value |
| ISR | In-service rate |
| LEEN | Low Income Energy Efficiency Network |
| MFDI | Multi-Family Direct Install program |
| MS | Ductless mini-splits |
| LEEN | Low-Income Energy-Efficiency Network |
| LPD | Lighting power density |
| NC-LPD | New Construction Lighting Power Density |
| NPS | Net promoter score |
| OEP | Ohio Efficiency Project |
| Ohio TRM | *Ohio Energy Efficiency Technical Reference Manual* |
| OPAE | Ohio Partners for Affordable Energy |
| PCT | Participant Cost Test |
| PIPP | Percentage of Income Payment Plan |

| Acronym | Definition |
|---|---|
| PRISM | PRInceton Scorekeeping Method |
| PSC | Permanent spilt capacitor |
| PWC | People Working Cooperatively |
| QPL | Qualified Product List |
| RaaS | Rebates as a Service |
| RCT | Randomized control trial |
| RIM | Randomized Impact Measure |
| SBDI | Small Business Direct Install |
| SCT | Societal Cost Test |
| SEER | Seasonal Energy Efficiency Ration |
| TRC | Total Resource Cost |
| TRM | Technical reference manual |
| UCT | Utility Cost Test |
| UES | Unit energy savings |
| UMP | *Uniform Methods Project* |
| VAV | Variable air volume |
| VFD | Variable frequency drive |
| VRF | Variable refrigerant flow |
| VSD | Variable speed drive |
| WHF | Waste heat factor |

# Executive Summary

In 2017, Dayton Power and Light (DP&L) filed a three-year *Energy Efficiency and Peak Demand Reduction Program Portfolio Plan* (Case No. 17-1398-EL-POR) that covered the years 2018 through 2020, outlining a portfolio of residential and business programs in response to Senate Bill 221. DP&L selected Cadmus to evaluate its residential and commercial energy efficiency portfolio for the 2018-2020 program years. DP&L's portfolio includes four commercial and industrial (C&I) programs and nine residential programs.

Cadmus had several primary impact evaluation objectives:

- Assess the appropriateness of the programs' gross *ex ante* claimed savings
- Calculate gross *ex post* savings (verified gross and adjusted gross saving estimates)
- Determine program and portfolio cost-effectiveness

While Cadmus conducted activities to satisfy the above impact objectives for most programs in 2020, we conducted lighter evaluations for a subset of programs. For these programs, we applied past years' verified gross and adjusted gross energy and demand realization rates to 2020 program data to calculate 2020 verified gross and adjusted gross energy savings and demand reduction.

## *2020 Changes to Program Budgets and Operations*

House Bill 6 (HB 6), which became effective on October 22, 2019, terminated Ohio's annual energy efficiency savings requirements on December 31, 2020. On February 26, 2020, the Public Utilities Commission of Ohio ruled that the wind-down of the state's statutorily required energy efficiency programs shall commence on September 30, 2020 and that those programs shall terminate on December 31, 2020.[1] DP&L complied with this order and made additional changes to planned program budgets and operation dates as a result of the COVID-19 pandemic. Table 1 shows a summary of COVID-19 impacts on program operation dates and budgets, as well as the program end dates.

**Table 1. Impacts of COVID-19 Pandemic and House Bill 6 on Program Operation Dates and Budgets**

| Program | Time Period of Suspended Program Operations Due to COVID-19 | Budget Impact Due to COVID-19 | Program End Dates |
|---|---|---|---|
| Efficient Products | No Impact | No Impact | Upstream: 9/30/2020<br>Marketplace: 12/02/2020 |
| Appliance Recycling | All appliance pick-ups and recycling temporarily suspended; program resumed with outdoor pickups only | No Impact | 8/31/2020 |
| Income Eligible Efficiency | All in-home audits temporarily suspended | No Impact | 12/31/2020 |

[1] Dayton Power and Light. February 26, 2020. "Docketing Information System." Case No. 17-1398-EL-POR. http://dis.puc.state.oh.us

| Program | Time Period of Suspended Program Operations Due to COVID-19 | Budget Impact Due to COVID-19 | Program End Dates |
|---|---|---|---|
| Heating and Cooling Rebates | No Impact | $75k transferred from Multi-Family Direct Install to Heating and Cooling Rebates | 9/30/2020 |
| School Education | No Impact | No Impact | 6/30/2020 |
| Smart Thermostats | No Impact | $175k transferred from Multi-Family Direct Install to Smart Thermostats | Upstream: 9/30/2020<br>Marketplace: 12/02/2020 |
| Energy Savings Kits | No Impact | No Impact | 9/30/2020 |
| Behavior Change | No Impact | No Impact | 12/31/2020 |
| Multi-Family Direct Install | Program suspended | $175k transferred from Multi-Family Direct Install to Smart Thermostats and $75k transferred to Heating and Cooling Rebates | 2/28/2020 |
| Small Business Direct Install | All direct installations temporarily suspended | $375k transferred from Small Business Direct Install to Prescriptive Rebates | 9/30/2020 |
| Prescriptive Rebate | No Impact | $375k transferred from Small Business Direct Install and $70k transferred from Mercantile Self-Direct program | 9/30/2020 |
| Custom Rebate | No Impact | No Impact | 9/30/2020 |
| Mercantile Self-Direct | No Impact | $70k transferred from Mercantile Self-Direct program to Prescriptive Rebates | 9/30/2020 |

## *Portfolio Evaluation Results*

Cadmus presents three saving values throughout this report: *ex ante* claimed, verified gross, and adjusted gross:

- ***Ex Ante* Savings:** *Ex ante* estimates are generally the same values as used by DP&L in its filed and approved plans. These estimates establish savings goals for DP&L's portfolio. Comparing *ex ante* values to approved plan goals presents an appropriate metric for program and portfolio accomplishments.
- **Verified Gross Savings:** Adjustments to *ex ante* participation, based primarily on survey or on-site verification, result in verified gross savings. The unit energy savings (UES) estimation approach (used in the 2010 *Ohio Energy Efficiency Technical Reference Manual* [Ohio TRM] and for deemed savings) remains the same as that used in *ex ante* claimed savings. A verified gross savings realization rate represents how well a program or portfolio is performing; it assesses metrics that are reasonably within DP&L's control. Per Ohio Administrative Code rules,[2] the verification process is intended to confirm that measures were actually installed, that

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[2] December 10, 2009. Ohio Administrative Code. "Chapter 4901:1-39-05(C)(2)(b), Energy Efficiency Programs: Benchmark and Annual Status Reports." http://codes.ohio.gov/oac/4901:1-39-05

installation meets reasonable quality standards, that measures are operating correctly, and that measures are expected to generate predicted savings.

- **Adjusted Gross Savings:** Adjustments to *ex ante* participation (based on survey or on-site verification) and adjustments to UES and per-unit demand reduction estimates (based on engineering reviews of savings, statistical models, or other approaches) yield adjusted gross savings. Cadmus provides these estimates to present a more refined level of assessment, and they should be used for future program planning. Specifically, the Public Utilities Commission of Ohio should use adjusted gross savings results from evaluations conducted for the various Ohio investor-owned utilities when updating the Ohio TRM.

Table 2 provides saving results by program, as *ex ante* claimed, verified gross, and adjusted gross. C&I programs account for 64% of the portfolio *ex ante* energy savings and 69% of the portfolio *ex ante* demand reduction, with the Prescriptive program making up 78% of the *ex ante* energy savings and 79% of the *ex ante* demand reduction achieved by C&I programs. Residential Efficient Products makes up 62% of the *ex ante* energy savings and 58% of the *ex ante* demand reduction achieved by the residential programs.

The 2020 portfolio *ex ante* energy savings exceeded filed program goals by 6%; *ex ante* demand fell short of program goals by 7%. In comparison, the 2019 *ex ante* energy savings exceeded filed goals by 7%, and *ex ante* demand reduction fell short of program goals by 5%. The portfolio's overall strong performance for *ex ante* energy savings was driven by four programs: Efficient Products (105% of goal), Energy Savings Kits (135% of goal), Smart Thermostats (239% of goal), and Non-Residential Prescriptive (143% of goal). As in 2018 and 2019, the Efficient Products and Non-Residential Prescriptive programs respectively continued to make up the majority of residential and non-residential savings portfolio *ex ante* energy savings. The savings for Efficient Products and Non-Residential Prescriptive programs increased slightly from 2019 levels (2% and 3% respectively). DP&L's increased focus on the Smart Thermostats and Energy Savings Kits programs in response to the 2020 COVID-19 pandemic contributed to both those programs increasing their savings by 30% compared to 2019 levels. Although Efficient Products did not meet its demand reduction goal, the Energy Savings Kits, Smart Thermostats, and Nonresidential Prescriptive programs exceeded their demand reduction goals by more than 30% each.

Cadmus estimated Behavior Change program uplift (the effect of the program on customer participation in other DP&L efficiency programs) and the energy savings resulting from uplift in 2020. Therefore, the Behavior Change program savings that were counted in other programs were subtracted from DP&L's residential portfolio savings to avoid counting the savings twice. These savings are subtracted in the Behavior Change Program Uplift row in Table 2.

**Table 2. Portfolio Evaluation Results**

| Program | 2020 Program Goals | | *Ex Ante* Claimed Savings | | Verified Gross Savings | | Adjusted Gross Savings | |
|---|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | kWh | kW |
| **Residential** | | | | | | | | |
| Efficient Products | 47,467,000 | 7,900 | 49,772,572 | 5,954.0 | 49,758,704 | 5,950.6 | 55,067,217 | 6,729.0 |
| Appliance Recycling | 3,410,000 | 800 | 1,958,692 | 334.7 | 1,958,692 | 334.7 | 1,429,588 | 245.9 |
| Income Eligible Efficiency | 1,217,000 | 200 | 841,944 | 92.9 | 841,944 | 92.9 | 748,228 | 82.8 |
| Heating and Cooling Rebates | 7,754,000 | 1,400 | 6,457,671 | 1,309.1 | 6,457,351 | 1,309.0 | 5,840,354 | 1,189.8 |
| School Education | 3,846,000 | 300 | 3,429,553 | 210.5 | 3,429,553 | 210.5 | 3,534,826 | 207.9 |
| Smart Thermostats | 2,075,000 | 300 | 4,954,360 | 421.1 | 4,954,360 | 421.1 | 5,052,924 | 0.0 |
| Energy Savings Kits | 3,881,000 | 400 | 5,252,266 | 578.4 | 5,252,266 | 578.4 | 5,005,634 | 492.4 |
| Behavior Change | 18,700,000 | 3,200 | 8,358,004 | 1,441.8 | 6,351,578 | 1,095.6 | 6,351,578 | 1,095.6 |
| Multi-Family Direct Install | 3,451,000 | 700 | 288,111 | 30.4 | 288,111 | 30.4 | 294,967 | 31.4 |
| Behavior Change Program Uplift | **0** | **0** | **-818,754** | **-65.5** | **-667,320** | **-65.5** | **-667,320** | **-65.5** |
| **Nonresidential** | | | | | | | | |
| Small Business Direct Install | 5,000,000 | 1,300 | 3,043,536 | 676.2 | 3,043,536 | 676.2 | 2,858,379 | 636.3 |
| Prescriptive Rebate | 79,991,000 | 12,200 | 114,489,139 | 18,695.3 | 112,357,989 | 17,476.2 | 112,630,105 | 18,117.0 |
| Custom Rebate | 35,492,000 | 7,200 | 29,286,957 | 4,326.2 | 29,338,969 | 4,186.5 | 29,338,969 | 4,186.5 |
| Mercantile[a] | 4,750,000 | 1,100 | 2,457,815 | 356.5 | 2,457,815 | 356.5 | 2,457,815 | 356.5 |
| **Total (without Mercantile)** | **212,285,000** | **35,900** | **227,314,051** | **34,005.1** | **223,365,733** | **32,296.7** | **227,485,448** | **32,949.2** |
| **Total (with Mercantile)** | **217,035,000** | **37,000** | **229,771,866** | **34,361.6** | **225,823,548** | **32,653.2** | **229,943,263** | **33,305.7** |

Note: Total values in table are rounded for reporting purposes.

[a] Cadmus does not evaluate the Mercantile Self-Direct program. *Ex ante* savings were provided by DP&L and carried forward to verified and *ex post.*

Table 3 provides program and portfolio-level realization rates, comparing verified and adjusted gross savings and demand reduction against *ex ante* savings.

**Table 3. Portfolio Realization Rates**

| Program | Verified Gross Realization Rate | | Adjusted Gross Realization Rate | |
|---|---|---|---|---|
| | kWh | kW | kWh | kW |
| **Residential** | | | | |
| Efficient Products | 100% | 100% | 111% | 113% |
| Appliance Recycling | 100% | 100% | 73% | 73% |
| Income Eligible Efficiency (OPAE[b] and PWC[c]) | 100% | 100% | 89% | 89% |
| HVAC Equipment | 100% | 100% | 90% | 91% |
| School Education | 100% | 100% | 103% | 99% |
| Smart Thermostats | 100% | 100% | 102% | 0% |
| Energy Savings Kits | 100% | 100% | 95% | 85% |
| Behavior Change | 76% | 76% | 76% | 76% |
| Multi-Family Direct Install | 100% | 100% | 102% | 103% |
| **Non-Residential** | | | | |
| Small Business Direct Install | 100% | 100% | 94% | 94% |
| Prescriptive | 98% | 93% | 98% | 97% |
| Custom | 100% | 97% | 100% | 97% |
| **Total** | **98%** | **95%** | **100%** | **97%** |

Note: Total values in table are rounded for reporting purposes.

[a] As explained in the Residential Smart Thermostats chapter, Cadmus did not calculate demand reduction for smart thermostats

[b] Ohio Partners for Affordable Energy

[c] People Working Cooperatively

Cadmus found portfolio-level realization rates of 98% for energy savings and 95% for demand reduction, reflecting a comparison of verified gross savings to *ex ante* claimed savings. Differences result from Cadmus applying in-service rate (ISR) estimates collected through primary data collection or benchmarking, electric and natural gas water heater saturation rates, or estimates for the percentage of residential measures installed in nonresidential applications that differ from values used by DP&L.

Differences between *ex ante* claimed and adjusted gross saving resulted from differences in calculation methodologies, data sources available at the time, or both. These typically resulted from DP&L following the approved 2010 Ohio TRM while Cadmus referenced other sources or calculated savings based on measurement and verification. The Public Utilities Commission of Ohio has established the state's 2010 TRM and its saving estimates as a "safe harbor" for utilities to use when planning and reporting *ex ante* saving estimates, and DP&L has generally aligned itself with this practice.

In summary, Cadmus found DP&L's overall accounting of energy savings and demand reduction adhered to the principles established in Ohio and the resulting findings were as expected. Cadmus identified areas where incremental changes could improve program offerings and implementation, noted where appropriate throughout this evaluation report.

# Evaluation Objectives and Methodology

For the impact evaluations, Cadmus assessed and documented program savings, including gross savings relative to *ex ante* claimed saving values. For the process evaluations, Cadmus sought to document satisfaction and feedback from the perspectives of program and implementation staff and, for select programs, of participants.

## *Research Questions and Activities*

Table 4 provides the evaluation effort's general researchable questions and supporting activities. The program-specific sections present program-specific researchable questions.

**Table 4. Overall Researchable Questions and Supporting Activities**

| Researchable Question | Activity Used to Address Question |
|---|---|
| What changes to design and delivery would improve program performance? | • Program and implementation staff interviews<br>• Participant surveys<br>• Program database review |
| What barriers exist to increased customer participation, and how effectively do the programs address those barriers? | • Program and implementation staff interviews<br>• Participant surveys |
| What gross energy savings and demand reductions did the programs achieve? | • Program database review<br>• Data verification<br>• Site visits/metering<br>• Participant surveys and interviews<br>• Engineering analysis<br>• Billing analysis<br>• Uplift analysis |
| Were the programs cost-effective? Was the portfolio cost-effective? | • Cost-effectiveness tests |

## *Overall Evaluation Methodology*

Cadmus evaluated programs using nationally recognized evaluation methods. Primary evaluation activities included the following:

- Engineering calculations to verify program *ex ante* claimed savings and to determine adjusted program gross energy savings and demand reductions
- Remote verification of measure installations for C&I projects
- A detailed review of project documentation, calculations, audit reports, and assumptions
- A billing analysis for Behavior Change program participants

Cadmus performed a lighter evaluation in the 2020 program year for the following programs: Appliance Recycling (ARP), Income Eligible Efficiency, Heating and Cooling Rebates, Multi-Family Direct Install, School Education (Be E³ Smart), Energy Saving Kits, and Smart Thermostats (Table 5). For these programs, we did not gather new primary data for impact or process evaluations. Instead, we applied prior years verified gross and adjusted gross energy and demand realization rates to 2020 program data to calculate verified gross and adjusted gross energy savings and demand reduction. The programs selected for the lighter evaluation approaches have operated for several years without major changes to program design and delivery and have yielded consistent realization rates. In the interest of focusing evaluation resources on newer programs as DP&L's energy efficiency portfolio expands, DP&L and Cadmus agreed upon this approach for the 2020 evaluation period.

**Table 5. Level of Evaluation by Program**

| Program | Full Impact Evaluation | Light Impact Evaluation |
|---|---|---|
| Appliance Recycling | | ✓ |
| Efficient Products | ✓ | |
| HVAC Equipment | | ✓ |
| Multi-Family Direct Install | | ✓ |
| Energy Savings Kits | | ✓ |
| Behavior Change | ✓ | |
| Smart Thermostats | | ✓ |
| Income Eligible Efficiency | | ✓ |
| School Education | | ✓ |
| Small Business Direct Install | ✓ | |
| Prescriptive Rebate | ✓ | |
| Midstream Incentive Channel | ✓ | |
| Custom Rebate | ✓ | |

Table 6 shows the evaluation tasks Cadmus conducted for each program.

**Table 6. Evaluation Task by Program**

| Program | Program data review | Engineering Analysis | Billing Analysis | Implementation Staff Interviews | Remote EM&V | Uplift Analysis | Cost-effectiveness Analysis |
|---|---|---|---|---|---|---|---|
| Efficient Products | ✓ | ✓ | | | | | ✓ |
| Appliance Recycling | ✓ | | | | | | ✓ |
| Income Eligible Efficiency | ✓ | | | | | | ✓ |
| Heating and Cooling Rebates | ✓ | | | | | | ✓ |
| School Education | ✓ | | | | | | ✓ |
| Smart Thermostats | ✓ | | | | | | ✓ |
| Energy Savings Kits | ✓ | | | | | | ✓ |
| Behavior Change | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| Multi-Family Direct Install | ✓ | | | | | | ✓ |
| Small Business Direct Install | ✓ | ✓ | | | ✓ | | ✓ |
| Prescriptive Rebate | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| Midstream Incentive Channel | ✓ | ✓ | | | | | ✓ |
| Custom Rebate | ✓ | ✓ | | ✓ | ✓ | | ✓ |

The tables in the program chapters and appendices present several values:

- ***Ex ante* Claimed Gross Savings:** Savings based on *ex ante* participation and calculation assumptions. DP&L used multiple sources for claimed savings—primarily the Ohio TRM[3] and results from previous Cadmus evaluation work. Therefore, *ex ante* savings and adjusted gross savings may be similar when DP&L applies preliminary evaluation results. *Appendix G Ex Ante Measure-Level Savings Documentation* provides a detailed summary of the sources of *ex ante* claimed savings by measure.
- **Verified Gross Savings:** Savings resulting from adjustments to *ex ante* participation, based on survey or on-site verification. The UES estimation approach (using the Ohio TRM or deemed savings) remained the same as the *ex ante* claimed savings.
- **Adjusted Gross Savings:** Savings due to adjustments in *ex ante* participation based on survey or on-site verification and adjustments to UES and per-unit demand reduction estimates based on engineering reviews of savings, statistical models, or other approaches.[4] Adjusted gross savings represent the final evaluated *ex post* gross saving estimates. Each program-specific section provides a detailed explanation of adjustments made to calculate verified and adjusted gross savings.

## *Description of Programs Covered in Study*

In 2020, Cadmus evaluated thirteen DP&L programs (nine residential and three C&I). The evaluation did not include Mercantile customer participation or associated savings, but Cadmus did calculate cost-effectiveness for this program. Table 7 provides the reported participation per program.

[3] Vermont Energy Investment Corporation. Filed August 6, 2010. *State of Ohio Energy Efficiency Technical Reference Manual.* Prepared for the Public Utilities Commission of Ohio. Case No. 09-0512-GE-UNC.

[4] In several cases using Ohio TRM calculations or assumptions, Cadmus incorporated feedback from the Joint Objections and Comments to the August 6, 2010, *Technical Resource Manual* from Ohio Edison Company, the Cleveland Electric Illuminating Company, the Toledo Edison Company, Columbus Southern Power Company, Ohio Power Company, Duke Energy Ohio, Inc., DP&L, and Industrial Energy Users-Ohio, filed November 3, 2010, in Public Utilities Commission of Ohio Case No. 09-512-GE-UNC (*Ohio TRM Joint Objections and Comments*). Where appropriate, the text notes these locations.

**Table 7. Number of Program Participants**

| Program | Reported Quantity | Unit Type |
|---|---|---|
| **Residential** | | |
| Efficient Products | 1,561,545 | Energy saving measures |
| Appliance Recycling | 1,525 residential /44 nonresidential | Appliances recycled in residential/ nonresidential applications |
| Income Eligible Efficiency (OPAE Channel) | 416 | Unique sites |
| Income Eligible Efficiency (PWC Channel) | 56 | Unique sites |
| Heating and Cooling Rebates | 5,082 | Equipment rebated |
| Smart Thermostats | 8,542 | Smart thermostats rebated |
| School Education | 8,845 | Be $E^3$ kits distributed |
| Energy Savings Kits | 21,342 | Energy savings kits distributed |
| Behavior Change | 80,736 customers with electronic reports and 109,714 customers with paper reports (123,584 unique customers treated in total) | Unique customers treated |
| Multi-Family Direct Install | 7,304 | Equipment rebated |
| **Commercial and Industrial** | | |
| Small Business Direct Install | 39,146 | Equipment rebated |
| Prescriptive Rebate | 1,160 unique prescriptive projects, 324,028 midstream lamps, 287 midstream HVAC units | Prescriptive projects completed/ Midstream lamps and variable frequency drives sold |
| Custom Rebate | 109 unique projects | Projects completed |

The chapters that follow presents program overviews and evaluation methodologies and findings for each program in DP&L's portfolio evaluated by Cadmus in 2020.

# Residential Efficient Products Program

The Residential Efficient Products program consists of two program channels: upstream lighting rebates and the online DP&L Marketplace. This chapter describes Cadmus' evaluation approach, detailed findings, conclusions, and recommendations for the Residential Efficient Products program.

## *Program Description*

The upstream lighting rebates, implemented by CLEAResult and delivered at the retail level through manufacturer buy-downs of efficient lighting products, were the main source of program savings. The DP&L Marketplace, an online store added in 2018 and implemented by Uplight, provided instant rebates to residential customers for purchases of high-efficiency lighting, advanced power strips, water saving and air quality products, and smart thermostats. Savings from smart thermostats sold through the DP&L Marketplace were attributed to the Residential Smart Thermostats program and were not evaluated as part of the Residential Efficient Products program (see the *Residential Smart Thermostats* chapter). Customers browsed products through the online shop and account numbers were validated at the time of purchase to ensure eligibility.

Due to the COVID-19 pandemic, CLEAResult temporarily suspended field activities (shelf stocking and organization, in-store price verification, and placement of program signage) for the upstream lighting channel. Given the online platform, Uplight did not suspend DP&L Marketplace activities at any time in 2020 program year.

In-store discounts ended on September 30, 2020, and DP&L Marketplace discounts ended on December 2, 2020.

## *Evaluation Overview*

To evaluate the 2020 Residential Efficient Products program, Cadmus followed the evaluation activities and researchable questions outlined in Table 8.

**Table 8. Key Researchable Questions for Residential Efficient Products Program**

| Researchable Question | Activity Used to Address Question |
|---|---|
| What are the gross savings? | • Review of secondary sources, the Ohio TRM, and the program database<br>• Engineering analysis |
| Is the program cost-effective? | • Cost-effectiveness analysis |

## *Detailed Evaluation Findings*

The program exceeded its 47,467,119 kWh energy savings goal but fell short of the demand reduction goal of 7,865 kW, achieving 49,772,572 kWh and 5,954 kW in *ex ante* savings in 2020. A total of 1,561,545 measures were rebated through the program. Based on verified gross savings, the program achieved realization rates of 100% for *ex ante* energy savings and 100% for demand reduction. Table 9 provides program *ex ante*, verified gross, and adjusted gross savings and demand reductions. Key impact evaluation findings follow the table.

**Table 9. Residential Efficient Products Program Claimed and Achieved Energy Savings**

| Measure | *Ex Ante* Claimed Savings | | Verified Gross Savings | | Adjusted Gross Savings | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision[a] |
| **Upstream Products** | | | | | | | |
| Upstream LED | 46,242,447 | 5,531.0 | 46,255,139 | 5,531.2 | 51,566,053 | 6,325.0 | ± 16% |
| Air Purifier | 99,746 | 11.4 | 99,745 | 11.4 | 99,746 | 11.4 | ± 10% |
| Dehumidifier | 235,659 | 53.5 | 235,659 | 53.5 | 235,659 | 53.5 | ± 10% |
| Advanced Power Strip | 742,010 | 86.6 | 712,330 | 83.2 | 712,330 | 83.2 | ± 10% |
| Door Sweep | 104,667 | 0.0 | 104,791 | 0.0 | 104,791 | 0.0 | ± 14% |
| Pipe Wrap | 940,878 | 108.2 | 952,529 | 108.7 | 952,210 | 108.6 | ± 22% |
| **Online Marketplace** | | | | | | | |
| Marketplace LED | 1,099,319 | 131.5 | 1,095,911 | 131.0 | 1,103,204 | 116.7 | ± 19% |
| LED Night Light | 37,840 | 0.0 | 34,444 | 0.0 | 34,444 | 0.0 | ± 17% |
| Low-Flow Faucet Aerator | 420 | 0.1 | 420 | 0.1 | 420 | 0.1 | ± 26% |
| Low-Flow Showerhead | 1,668 | 0.1 | 1,668 | 0.1 | 1,667 | 0.1 | ± 29% |
| Low-Flow Showerhead w/ Shower Start | 85 | 0.0 | 85 | 0.0 | 85 | 0.0 | ± 29% |
| Dehumidifier | 1,105 | 0.3 | 1,105 | 0.3 | 1,105 | 0.3 | ± 10% |
| Heat Pump Water Heater | 18,158 | 2.5 | 18,158 | 2.5 | 18,158 | 2.5 | ± 10% |
| Advanced Power Strip | 248,570 | 29.0 | 246,720 | 28.8 | 237,345 | 27.7 | ± 20% |
| **Total** | **49,772,572** | **5,954.0** | **49,758,704** | **5,950.6** | **55,067,217** | **6,729.0** | **15%** |

Note: Total values in table are rounded for reporting purposes.

[a] Precision at 90% confidence.

Several notable items emerged regarding Cadmus' evaluation methodology and findings:

- **Upstream lighting baseline and efficient wattages.** For the 2020 evaluation, Cadmus calculated the baseline wattage for lighting based on the as-found wattage of an equivalent bulb. We established lumen bins for standard, globe, candelabra, and reflector style bulbs, along with a baseline wattage for each lumen bin. We then used the rebated bulb's lumen output to look up the corresponding baseline wattage used for *ex ante*, verified, and adjusted savings. Cadmus found the *ex ante* baseline calculations closely matched *ex post* baselines, though there were instances where the two differed. For some lamps, the official ENERGY STAR® wattage did not match the efficient wattage recorded in the tracking database. In these instances, Cadmus defaulted to the ENERGY STAR wattage.
- **Upstream lighting waste heat factors.** While most inputs aligned between *ex ante* and adjusted gross savings for upstream LEDs, Cadmus used lower waste heat factors than assumed in the *ex ante* methodology, which resulted in lower adjusted gross savings and demand reduction. The calculations for *ex ante* savings used a $WHF_e$ of 1.07 and a $WHF_d$ of 1.21, while Cadmus used a $WHF_e$ and $WHF_d$ of 1.06 for adjusted savings.
- **Upstream lighting residential–commercial split.** For adjusted and verified gross savings, Cadmus allocated 95.9% of the bulbs rebated through the upstream lighting channel to the program's savings and the remaining 4.1% of bulbs to the Nonresidential Prescriptive program. We assumed all of the DP&L Marketplace LEDs were installed in residential applications.

- **LED nightlights.** While most inputs aligned between *ex ante* and adjusted gross savings for LED nightlights, the *ex ante* calculation did not apply an ISR, which resulted in lower adjusted gross savings.

## *Evaluation Data Collection Methods*

To evaluate the Residential Efficient Products program, Cadmus conducted a program database review and an engineering analysis. Descriptions of each activity follow.

### Program Database Review

#### *Upstream Lighting Database*

The upstream lighting database included complete data and contained all necessary components. For upstream lighting products rebated by CLEAResult, Cadmus used the ENERGY STAR light bulb database to determine watts, lumens, and other defining characteristics for each bulb, based on its model number and measure description. We referenced other information provided by CLEAResult (such as the bulb type, bulb shape, and wattage) when we could not find an exact match.

#### *Online DP&L Marketplace Database*

Cadmus performed a similar database review of the DP&L Marketplace data, verifying model numbers and reported savings. For the DP&L Marketplace, a limited number of models were sold, and Cadmus matched all of these to the ENERGY STAR light bulb database. We used the same process described above for the data’s lighting portion; for non-lighting measures, we searched the SKU on retail websites to confirm flow rates, equipment types, and other details.

### Engineering Analysis

Cadmus performed an engineering desk review using equations from the Ohio TRM, Indiana TRM v2.2 and Illinois TRM v7.0, supplemented with additional primary and secondary sources, as needed. Using engineering calculations, we evaluated savings for measures delivered as part of the program.

## *Impact Evaluation Methodology and Findings*

To determine gross savings for the Residential Efficient Products program, Cadmus reviewed secondary sources, the Ohio TRM, and the program database, and conducted an engineering analysis.

### Lighting Inputs and Algorithms for Adjusted Gross Savings

Cadmus used the following algorithms to evaluate savings from LEDs provided through the 2020 Residential Efficient Products program:

$$\Delta kWh = \frac{\Delta Watts}{1{,}000} * ISR * HOU * 365 * WHF_e$$

$$\Delta kW = \frac{\Delta Watts}{1{,}000} * ISR * WHF_d * CF$$

Where:

| | | |
|---|---|---|
| ΔWatts | = | Delta watts (baseline wattage minus efficient wattage) |
| ISR | = | In-service rate |
| HOU | = | Hours of use per day |
| $WHF_e$ | = | Waste heat factor for energy |
| $WHF_d$ | = | Waste heat factor for demand |
| CF | = | Summer peak coincidence factor |

Table 10 shows the values Cadmus used to calculate energy savings and demand reductions for *ex ante*, verified and adjusted gross savings. The table includes commercial inputs to account for the portion of program bulbs allocated to the commercial sector for adjusted savings and for the bulbs installed in commercial applications instead of residential applications. Additional details for each variable follow the table.

**Table 10. Residential Efficient Products Program Energy Savings and Demand Reduction Calculation Inputs**

| Variable | *Ex Ante* | Verified | Adjusted Residential | Commercial |
|---|---|---|---|---|
| HOU/day | 2.85 | 2.85 | 2.85 | 9.66 |
| $WHF_e$ | 1.07 | 1.07 | 1.06 | 1.10 |
| $WHF_d$ | 1.21 | 1.21 | 1.06 | 1.20 |
| $ISR_{LED}$ | 0.91 | 0.91 | 0.91 | 0.91 |
| ΔWatts | Varies[a] | Varies[a] | Varies[a] | Varies[a] |
| CF | 0.11 | 0.11 | 0.11 | 0.76 |
| Allocation | 100% | 100% | 95.9% | *Ex ante* = 0%<br>Verified/Adjusted = 4.1% |

[a] 2020 *ex ante* and adjusted ΔWatts inputs were based on lumen equivalence and varied by bulb.

### *In-Service Rates*

In 2018, Cadmus calculated a lifetime ISR of 91% for LEDs, using an average based on 11 studies from 2016 and 2017. We used the average first-year ISR from these studies and calculated a lifetime ISR following the U.S. DOE's UMP for estimating future bulb installations from storage.[5]

In 2018, Cadmus also conducted a survey on installation of six-pack and 12-pack bulbs sold through the DP&L Marketplace. From the survey results, and based on values for first-year ISR shown in Table 10, we calculated separate lifetime ISRs of 96% for six-pack bulbs and 83% for 12-pack bulbs, which we used for verified and adjusted savings. Since the survey did not collect information for packs smaller than six bulbs, we applied the same ISR used for upstream bulbs (91%) to these packs.

[5] U.S. Department of Energy. February 2015. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. "Chapter 21: Residential Lighting Evaluation Protocol." https://energy.gov/sites/prod/files/2015/02/f19/UMPChapter21-residential-lighting-evaluation-protocol.pdf

### *Hours-of-Use*

Cadmus used the Ohio TRM HOU value of 2.85.

### *Waste Heat Factor*

Cadmus used a waste heat factor of 1.06 to calculate energy savings and demand reduction. In 2013, Cadmus updated this value with indoor/outdoor weighting to reflect the 2013 inventory study results. The study showed that the same percentage of bulbs were installed outside as those found during site visits conducted during 2009 (8%). The Ohio TRM's waste heat factor of 1.07 does not account for bulbs installed outdoors, so Cadmus applied an indoor/outdoor weighting from the 2013 inventory study to develop a weighted average waste heat factor of 1.06. Consistent with the previous evaluations, Cadmus updated the $WHF_d$ from its 1.21 *ex ante* value to 1.06, reflecting the Ohio TRM *Joint Objections and Comments.*

### *Coincidence Factor*

Consistent with previous evaluations, Cadmus used a residential summer peak coincidence factor of 0.11 to determine demand reduction. As the Ohio TRM *Joint Objections and Comments* suggested different coincidence factors (0.11 and 0.16, respectively), Cadmus performed a high-level review of coincidence factors from other comparable TRMs. The Ohio TRM's 0.11 coincidence factor aligned more closely with other TRM values and seemed more valid for this evaluation.

### *Wattage Baseline*

Cadmus used as-found baseline wattage values to calculate adjusted savings. These as-found savings proved representative of a typical bulb replaced by an LED. To calculate the as-found wattage, we mapped each bulb's lumen output to the appropriate lumen bin, which contained the typical wattage of a removed bulb for that bulb type and brightness. We created these bins based on regression modeling from field data in Wisconsin, which correlated the wattage to the lumen output of the bulb removed. Lumen bins were similar to Energy Independence and Security Act of 2007 (EISA) bins when possible, but were appropriate for every brightness level for all bulbs.

### *Nonresidential Allocation*

To be consistent with past evaluations, Cadmus used a nonresidential allocation value of 4.1% to determine the percentage of bulbs allocated toward small commercial applications. In 2015, Cadmus calculated the nonresidential allocation of program bulbs by estimating the total number of program bulbs reported as installed in small commercial applications and dividing this estimate by the total number of program bulbs sold. We used data from general population customer surveys and from DP&L's customer records to estimate the nonresidential allocation of program bulbs. The nonresidential allocation was only applied to lighting products sold through the upstream lighting channel. For the 2020 program year, DP&L did not allocate any residential *ex ante* savings to nonresidential program savings.

## Savings by Measure Type

The following sections outline Cadmus' calculated savings for each Residential Efficient Products program measure.

### *Bathroom and Kitchen Faucet Aerators*

The total reported *ex ante* energy and demand savings for bathroom and kitchen faucet aerators in 2020 were 420 kWh and 0.1 kW, which is identical to the adjusted gross savings Cadmus calculated. This resulted in realization rates of 100% for both energy savings and demand reduction.

The equations below, outlined in the Indiana TRM v2.2, were used to calculate *ex ante* and adjusted gross energy savings (ΔkWh) and demand reduction (ΔkW) for faucet aerators:

$$\Delta kWh = (GPM_{Base} - GPM_{Low}) * PH * MPD * \frac{days}{yr} * \frac{1}{FH} * 8.33 * (T_{FT} - T_{MAINS}) * \frac{1}{RE * 3{,}412} * \%electric * ISR$$

$$\Delta kW = \frac{\Delta kWh}{hours} * CF$$

Table 11 lists the inputs used to calculate *ex ante*, verified, and adjusted gross savings for bathroom faucet aerators. Table 12 lists the inputs used for kitchen faucets.

**Table 11. Bathroom Faucet Aerators Energy Savings and Demand Reduction Calculation Inputs**

| Variable | Description | *Ex Ante* | Verified | Adjusted |
|---|---|---|---|---|
| $gpm_{base}$ | Baseline gallons per minute | 2.20 | 2.20 | 2.20 |
| $gpm_{low}$ | Efficient gallons per minute | 1.00 | 1.00 | 1.00 |
| PH | People per household | 2.51 | 2.51 | 2.51 |
| MPD | Minutes of use per person daily | 1.65 | 1.65 | 1.65 |
| days/yr | Days of use per year | 365 | 365 | 365 |
| FH | Number of faucets per home | 1.91 | 1.91 | 1.91 |
| 8.33 | Product of the specific weight of water (8.33 pounds per gallon) and the heat capacity of water (1.0 Btu/lb-°F) | 8.33 | 8.33 | 8.33 |
| $T_{FT}$ | Average water temperature at point of use (°F) | 86 | 86 | 86 |
| $T_{MAINS}$ | Water main temperature upon entering house (°F) | 57.7 | 57.7 | 57.5 |
| RE | Electric water heater recovery efficiency | 0.98 | 0.98 | 0.98 |
| %electric | Electric water heater saturation | 30.2% | 30.2% | 30.2% |
| ISR | In-service rate | 48% | 48% | 48% |
| Hours | Hours of use per year per faucet | 13.19 | 13.19 | 13.19 |
| CF | Summer peak coincidence factor | 0.00262 | 0.00262 | 0.00262 |

**Table 12. Kitchen Faucet Aerators Energy Savings and Demand Reduction Calculation Inputs**

| Variable | Description | *Ex Ante* | Verified | Adjusted |
|---|---|---|---|---|
| $gpm_{base}$ | Baseline gallons per minute | 2.20 | 2.20 | 2.20 |
| $gpm_{low}$ | Efficient gallons per minute | 1.00 | 1.00 | 1.00 |
| PH | People per household | 2.51 | 2.51 | 2.51 |
| MPD | Minutes of use per person daily | 1.65 | 1.65 | 1.65 |
| days/yr | Days of use per year | 365 | 365 | 365 |
| FH | Number of faucets per home | 1 | 1 | 1 |
| 8.33 | Product of the specific weight of water (8.33 pounds per gallon) and the heat capacity of water (1.0 Btu/lb-°F) | 8.33 | 8.33 | 8.33 |
| $T_{FT}$ | Average water temperature at point of use (°F) | 86 | 86 | 86 |
| $T_{MAINS}$ | Water main temperature upon entering house (°F) | 57.7 | 57.7 | 57.5 |
| RE | Electric water heater recovery efficiency | 0.98 | 0.98 | 0.98 |
| %electric | Electric water heater saturation | 30.2% | 30.2% | 30.2% |
| ISR | In-service rate | 48% | 48% | 48% |
| Hours | Hours of use per year per faucet | 68.86 | 68.86 | 68.86 |
| CF | Summer peak coincidence factor | 0.00262 | 0.00262 | 0.00262 |

Cadmus estimated 235 kWh energy savings and 0.047 kW demand reduction for bathroom faucet aerators, with per-unit savings of 9.8 kWh and 0.002 kW, respectively. We estimated 185 kWh energy savings and 0.007 kW demand reduction for kitchen faucet aerators, with per-unit savings of 37.1 kWh and 0.001 kW, respectively. In total, the program distributed 24 bathroom and five kitchen faucet aerators.

### *Showerheads*

The total reported *ex ante* energy savings and demand reduction for showerheads in 2020 was 1,668 kWh and 0.1 kW, respectively, which is identical to the adjusted gross savings Cadmus calculated. This resulted in realization rates of 100% for both energy savings and demand reduction.

The equations below, outlined in the Indiana TRM (v2.2), were used to calculate *ex ante* and adjusted gross energy savings (ΔkWh) and demand reduction (ΔkW) for showerheads:

$$\Delta kWh = (GPM_{Base} - GPM_{Low}) * PH * MPD * SPD * \frac{days}{yr} * \frac{1}{SH} * 8.33 * (T_{FT} - T_{MAINS}) * \frac{1}{RE*3{,}412} * \%electric * ISR$$

$$\Delta kW = \frac{\Delta kWh}{hours} * CF$$

Table 13 lists the inputs used to calculate the *ex ante*, verified, and adjusted gross savings and demand reduction for showerheads.

**Table 13. Residential Efficient Products Program Showerhead Adjusted Gross Savings Algorithm Inputs**

| Input | Description | *Ex Ante* | Verified | Adjusted |
|---|---|---|---|---|
| $gpm_{Base}$ | Baseline gallons per minute | 2.5 | 2.5 | 2.5 |
| $gpm_{Low}$ | Efficient gallons per minute | 1.5 | 1.5 | 1.5 |
| PH | People per household | 2.51 | 2.51 | 2.51 |
| MPD | Minutes of shower use per person daily | 7.83 | 7.83 | 7.83 |
| SD | Showers per person daily | 0.61 | 0.61 | 0.61 |
| days/yr | Days of use per year | 365 | 365 | 365 |
| SH | Number of showerheads per home | 1.6 | 1.6 | 1.6 |
| 8.33 | Product of the specific weight of water (8.33 pounds per gallon) and the heat capacity of water (1.0 Btu/lb-°F) | 8.33 | 8.33 | 8.33 |
| $T_{FT}$ | Water temperature at point of use (°F) | 101 | 101 | 101 |
| $T_{MAINS}$ | Water main temperature upon entering house (°F) | 57.5 | 57.5 | 57.5 |
| RE | Electric water heater recovery efficiency | 0.98 | 0.98 | 0.98 |
| %electric | Electric water heater saturation | 30.2% | 30.2% | 30.2% |
| ISR | In-service rate | 81% | 81% | 81% |
| Hours | Hours of use per year per showerhead | 74.72 | 74.72 | 74.72 |
| CF | Summer peak coincidence factor | 0.00371 | 0.00371 | 0.00371 |

Cadmus estimated 72.5 kWh energy savings and 0.0036 kW demand reduction per-unit for showerheads. In total, the program distributed 15 showerheads.

### *Showerheads with Thermostatic Shutoff Valve*

The total reported *ex ante* energy savings and demand reduction for showerheads with thermostatic shutoff valves in 2020 was 84.9 kWh and demand savings of 0.009 kW, which is identical to the adjusted gross savings Cadmus calculated. This resulted in realization rates of 100% for energy savings and demand reduction.

The equations below, outlined in the Mid-Atlantic TRM, were used to calculate adjusted gross energy savings (ΔkWh) and demand reduction (ΔkW) for showerheads with thermostatic shutoff valves:

$$\Delta kWh = kWh_{Showerhead} + GPM_{Low} * PH * LengthSaved * SPD * \frac{days}{yr} * \frac{1}{SH} * 8.33 * (T_{FT} - T_{MAINS}) * \frac{1}{RE * 3{,}412} * electric * ISR$$

$$\Delta kW = \frac{\Delta kWh}{hours} * CF$$

Table 14 lists the inputs Cadmus used to calculate adjusted gross energy and demand reduction.

**Table 14. Residential Efficient Products Program Showerhead with ShowerStart Savings Inputs**

| Input | Description | Value |
|---|---|---|
| $kWh_{showerhead}$ | Savings of showerheads without thermostatic shutoff valve | 90.6 |
| LengthSaved | Number of minutes saved by the thermostatic device | 0.89 |
| $gpm_{Low}$ | Efficient gallons per minute | 1.5 |
| PH | People per household | 2.51 |
| SPD | Showers per person daily | 0.61 |
| days/yr | Days of use per year | 365 |
| SH | Number of showerheads per home | 1.6 |
| 8.33 | Product of the specific weight of water (8.33 pounds per gallon) and the heat capacity of water (1.0 Btu/lb-°F) | 8.33 |
| $T_{FT}$ | Water temperature at point of use (°F) | 101 |
| $T_{MAINS}$ | Water main temperature upon entering house (°F) | 57.5 |
| EF | Electric water heater recovery efficiency | 0.98 |
| %electric | Electric water heater saturation | 30.2% |
| ISR | In-service rate | 81% |
| Hours | Hours of use per year per showerhead | 8.49 |
| CF | Summer peak coincidence factor | 0.00371 |

Cadmus estimated 84.9 kWh energy savings and 0.009 kW demand reduction per-unit for showerheads with thermostatic shutoff valves. Only one showerhead with thermostatic shutoff valves was distributed in 2020.

### *Pipe Wrap*

The total reported *ex ante* energy savings and demand reduction for pipe wrap in 2020 was 940,878 kWh and 108.2 kW, respectively. Cadmus calculated adjusted gross energy savings of 952,529 kWh and demand savings of 108.7 kW. This resulted in realization rates of 101% for energy savings and 100% for demand reduction. The slight deviation from a 100% realization rate was due to quantity mismatches in the *ex ante* data; a small number of records achieved a 200% realization rate because *ex ante* savings only claims half of the quantity.

Cadmus used the savings methodology from the Illinois TRM v7.0 to evaluate the pipe wrap measure, while the *ex ante* savings calculation used the savings methodology from the Illinois TRM v6.0.

Cadmus used the following equations, as outlined in the Illinois TRM v7.0, to calculate adjusted gross energy savings (ΔkWh) and demand reduction (ΔkW) for pipe wrap:

$$\Delta kWh = \left(\frac{C_{exist}}{R_{exist}} - \frac{C_{new}}{R_{new}}\right) * L * \Delta T * 8{,}766 * \frac{1}{RE * 3{,}412} * \%electric$$

$$\Delta kW = \frac{\Delta kWh}{hours}$$

Table 15 lists the inputs Cadmus used to calculate adjusted gross energy and demand reduction.

**Table 15. Residential Efficient Products Program Pipe Wrap Savings Algorithm Inputs**

| Input | Description | Value |
|---|---|---|
| $R_{exist}$ | Pipe heat loss coefficient of uninsulated pipe | 1.0 |
| $R_{new}$ | Pipe heat loss coefficient of insulated pipe | 6.0 |
| L | Length of pipe from water heating source covered by pipe wrap | 6 |
| $C_{exist}$ | Circumference of pipe | 0.196 |
| $C_{new}$ | Circumference of pipe with insulation | 0.30 |
| ΔT | Average temperature difference between supplied water and outside air temperature | 60 |
| Hours | Hours per year | 8,766 |
| %electric | Electric DHW Saturation | 30.2% |

Cadmus estimated 41.75 kWh energy savings and of 0.0048 kW demand reduction per six feet of pipe wrap. In total, the program distributed 22,806 feet of pipe wrap in 2020.

### *LED Night Lights*

The total reported *ex ante* energy savings for LED night lights in 2020 was 37,840 kWh. DP&L did not claim demand reduction. Cadmus calculated adjusted gross energy savings of 34,444 kWh, which resulted in a realization rate of 91%. This lower realization rate was because *ex ante* savings did not apply the 91% ISR.

Cadmus used the following equation, as outlined in the Indiana TRM v2.2, to calculate adjusted gross energy savings (ΔkWh) for LED nightlights:

$$\Delta kWh = \frac{Watt_{base} - Watt_{LED}}{1{,}000} * ISR * Hours$$

Table 16 lists the inputs used to calculate *ex ante*, verified, and adjusted gross savings for this measure.

**Table 16. Residential Efficient Products Program LED Nightlights Savings Algorithm Inputs**

| Input | Description | *Ex Ante* | Verified | Adjusted |
|---|---|---|---|---|
| $Watt_{base}$ | Wattage of incandescent nightlight | 5.0 | 5.0 | 5.0 |
| $Watt_{LED}$ | Wattage of LED nightlight | 0.5 | 0.5 | 0.5 |
| ISR | In-service rate, or percentage of rebated units that get installed | 1.0 | 1.0 | 0.91 |
| Hours | Average hours of use per year | 2,920 | 2,920 | 2,920 |

Cadmus estimated that LED nightlights generated energy savings of 12.5 kWh per unit. In total, the program distributed 2,758 LED night lights in 2020.

### *Advanced Power Strips*

Cadmus used the prescriptive value outlined in the Ohio TRM to calculate adjusted gross energy savings and demand reduction for advanced power strips. The prescriptive energy savings for a seven-plug advanced power strip, as listed in the Ohio TRM, is 102.8 kWh energy savings and 0.012 kW demand reduction. Cadmus calculated an ISR of 96% from the 2018 survey results and applied it to the verified and adjusted savings. Since *ex ante* savings did not include the 96% ISR, the realization rate for this measure is 96%. There are also a small number of records categorized as smart strips attached to lighting SKUs reducing savings, but not enough to affect the realization rate. In total, the program distributed 9,623 advanced power strips in 2020 across the upstream and marketplace channels, which resulted in 990,580 kWh in energy savings and 115.6 kW in demand reduction.

### *Heat Pump Water Heaters*

Cadmus used the prescriptive value outlined in the Ohio TRM to calculate adjusted gross energy savings and demand reduction for heat pump water heaters. The prescriptive energy savings for a heat pump water heater, as listed in the Ohio TRM, is 1,297 kWh energy savings and 0.18 kW demand reduction. This measure achieved realization rates of 100% for energy savings and demand reduction. In total, the program distributed 14 heat pump water heaters in 2020, which resulted in 18,158 kWh energy savings and 2.52 kW demand reduction.

### *Air Purifiers*

Cadmus used the prescriptive value outlined in the Ohio TRM to calculate adjusted gross energy savings and demand reduction for air purifiers. The prescriptive energy savings for air purifiers, as listed in the Ohio TRM, is based on the Clean Air Delivery Rate (CADR) of the unit as seen in Table 17. In total, the program distributed 287 air purifiers in 2020, which resulted in 99,746 kWh energy savings and 11.4 kW demand reduction. This resulted in realization rates of 100% for energy savings and demand savings.

**Table 17. Residential Efficient Products Program Air Purifier Prescriptive Ohio TRM Savings**

| CADR Bin | kWh | kW |
|---|---|---|
| 51-100 | 124 | 0.014 |
| 101-150 | 275 | 0.031 |
| 151-200 | 443 | 0.051 |
| 201-250 | 573 | 0.065 |
| >250 | 814 | 0.093 |

### *Dehumidifiers*

Cadmus used the prescriptive value outlined in the Ohio TRM to calculate adjusted gross energy savings and demand reduction for dehumidifiers. The prescriptive energy savings for dehumidifiers, as listed in the Ohio TRM, is based on the capacity of the unit in pints as shown in Table 18. In total, the program distributed 2,243 dehumidifiers (2,217 upstream rebates and 26 DP&L Marketplace), which resulted in 236,764 kWh energy savings and 53.8 kW demand reduction. This resulted in realization rates of 100% for energy savings and demand savings.

**Table 18. Residential Efficient Products Program Dehumidifier Prescriptive Ohio TRM Savings**

| Pints Bin | kWh | kW |
|---|---|---|
| <25 | 94 | 0.021 |
| 25-50 | 89 | 0.020 |
| >50 | 131 | 0.030 |

### *Door Sweeps*

The reported *ex ante* energy savings for door sweeps in 2020 was 104,667 kWh. DP&L did not claim savings for demand reduction. Cadmus calculated adjusted gross energy savings of 104,791 kWh, which resulted in a realization rate of 100%.

Cadmus used the following savings approach outlined in the Illinois TRM v6.0 to calculate adjusted gross energy savings and demand reduction for door sweeps:

$$\Delta kWh = \left((kWh_{ER} * \%Saturation_{ER}) + (kWh_{HP} * \%Saturation_{HP})\right) * AirSealingAdjustment$$

Table 19 lists the inputs Cadmus used to calculate adjusted gross savings for this measure. In total, the program distributed 5,156 door sweeps in 2020, which yielded per-unit savings of 20.3 kWh per door sweep.

**Table 19. Residential Efficient Products Program Door Sweeps Savings Algorithm Inputs**

| Input | Description | Value |
|---|---|---|
| $kWh_{ER}$ | Annual door sweep energy savings for electrical resistance heater | 169.3 |
| $kWh_{HP}$ | Annual door sweep energy savings for heat pump | 84.7 |
| AirSealingAdjustment | Adjustment for air sealing savings to account for prescriptive estimates overclaiming savings | 80% |
| $\%Saturation_{ER}$ | Circumference of pipe | 5% |
| $\%Saturation_{HP}$ | Circumference of pipe with insulation | 20% |

## *Recommendations*

Cadmus recognizes that the Efficient Products program will not operate in 2021, but offers the following recommendations based on the 2020 evaluation findings to improve future programs. DP&L should review these recommendations prior to launching or relaunching a program to ensure they are still applicable:

- **Monitor as-found baseline wattages.** Update as-found baseline wattage values regularly. The typical wattage of bulbs in a home changes rapidly as more LEDs enter the market. Mapping wattages to lumen outputs requires updating values on a regular basis. Consider collecting primary data or using secondary data to update the average wattage every three years.
- **LED night light ISR.** *Ex ante* savings does not include an ISR. Consider applying a 91% ISR.
- **Advanced power strip ISR.** *Ex ante* savings does not include an ISR. Consider applying a 96% ISR.

# Residential Appliance Recycling Program

This chapter describes Cadmus' evaluation approach and detailed findings for the Residential Appliance Recycling program. For the 2020 program year, Cadmus did not conduct full impact or process evaluations of the Residential Appliance Recycling program due to the program's high stability and consistency of results in recent years. Instead, Cadmus applied impact evaluation results from prior program years (2015 through 2017) to calculate 2020 energy savings and demand reduction. The program stopped collecting appliances on August 22, 2020.

## *Program Description*

The Residential Appliance Recycling program offered customers rebates to collect and recycle functioning primary and secondary refrigerators and freezers. Customers who recycled a refrigerator or freezer could also recycle room air conditioners and dehumidifiers. Overall, the program reduced energy consumption by removing appliances from service. which ultimately reduced energy load on the grid. Recleim, the program implementer, removed appliances from customer residences and disposed of the material in an environmentally friendly manner—including recycling parts to the extent practical—at no cost to the customer. Recleim temporarily paused program activities in Spring 2020 due to the COVID-19 pandemic. Once program activities resumed, Recleim switched to a contactless pickup program design where participants needed to move their appliance to the driveway or street curb prior to Recleim's arrival.

DP&L offered two types of Residential Appliance Recycling program incentives and measures:

- A $50 incentive per refrigerator or freezer (up to two units per household, per calendar year); to qualify, the appliance must be in working condition, empty at the time of pick-up, and between 10 cubic feet and 30 cubic feet.
- A $20 incentive per room air conditioner or dehumidifier (up to two units per household, per calendar year), collected only from customers who recycle a refrigerator or freezer.

In addition, DP&L offered a free LED kit (one kit with two 9-watt LED bulbs) to participants who were present at the time of the appliance pick-up; customers could decline to receive the kit.

## *Program Savings Summary*

In 2020, the program fell short of its 3,410,000 kWh energy savings and 757 kW demand reduction goals, achieving 1,958,692 kWh and 334.7 kW in *ex ante* savings. The program recycled 1,525 appliances in residential applications and 44 in nonresidential applications. The program did not meet its 2020 targets because of the pause in program activities at the beginning of the COVID-19 pandemic and the program's early end-date. Based on verified gross savings, the program achieved realization rates of 100% for both *ex ante* energy savings and demand reduction. Table 20 shows *ex ante*, verified gross, and adjusted gross energy savings and demand reduction.

**Table 20. Residential Appliance Recycling Program Claimed and Achieved Energy Savings**

| Measure | *Ex Ante* Claimed Savings | | Verified Gross Savings | | Adjusted Gross Savings | |
|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW |
| Refrigerators | 1,513,600 | 242 | 1,513,600 | 242 | 1,099,993 | 174 |
| Freezers | 251,288 | 40 | 251,288 | 40 | 145,419 | 23 |
| Room Air Conditioners | 11,500 | 17 | 11,500 | 17 | 10,683 | 14 |
| Dehumidifiers[a] | 99,859 | 27 | 99,859 | 27 | 99,723 | 27 |
| Kits | 82,445 | 9 | 82,445 | 9 | 73,770 | 8 |
| **Total** | **1,958,692** | **334.7** | **1,958,692** | **334.7** | **1,429,588** | **245.9** |

Note: Total values in table are rounded for reporting purposes.

[a] *Ex ante* dehumidifier values were based on Cadmus' calculation for dehumidifiers sold after 2004.

Cadmus reviewed 2020 Residential Appliance Recycling program participant tracking data to confirm that there were no major inconsistencies. We confirmed measure counts and verified that recorded unit sizes and ages were reasonable. In 2020, consistent with Cadmus' methodology for evaluating savings for LEDs in the Efficient Products program, we used an as-found baseline and lifetime ISR for LEDs. DP&L also used an as-found baseline and lifetime ISR in *ex ante* savings calculations.

The approaches Cadmus used to evaluate previous program years can be found in the respective program year EM&V reports, contained in the annual DP&L status reports.[6]

Table 21 provides 2015 through 2017 historical realization rates for verified and adjusted gross energy savings and demand reduction, as well as the realization rates applied to 2020 program data (which are an average of 2015 through 2017, weighted by the number of units recycled in the respective year).

**Table 21. Residential Appliance Recycling Program Claimed and Achieved Energy Savings**

| Measure | Adjusted Gross Realization Rates | | | | | | | | 2020 Adjusted Gross Savings | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2015 | | 2016 | | 2017 | | 2020 | | | | |
| | kWh | kW | kWh | kW | kWh | kW | kWh | kW | kWh | kW | Precision |
| Refrigerators | 71% | 73% | 70% | 68% | 75% | 73% | 73% | 72% | 1,099,993 | 174 | ± 7% |
| Freezers | 59% | 60% | 59% | 60% | 57% | 55% | 58% | 58% | 145,419 | 23 | ± 15% |
| Room Air Conditioners | N/A[a] | N/A[a] | 76% | 76% | 100% | 100% | 93% | 81% | 10,683 | 14 | ± 10% |
| Dehumidifiers | N/A[a] | N/A[a] | 100% | 100% | 100% | 100% | 100% | 100% | 99,723 | 27 | ± 10% |
| Kits | N/A[c] | N/A[c] | 102% | 58% | 107% | 57% | 89% | 89% | 73,770 | 8 | ± 15 |
| **Total** | -- | -- | -- | -- | -- | -- | -- | -- | **1,429,588** | **245.9** | **± 6%** |

Note: Total values in table are rounded for reporting purposes.

6 Dayton Power and Light. May 13, 2016. *2015 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 16-0851-EL-POR. http://dis.puc.state.oh.us
Dayton Power and Light. May 15, 2017. *2016 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 17-1092-EL-POR. http://dis.puc.state.oh.us
Dayton Power and Light. May 15, 2018. *2017 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 18-0742-EL-POR. http://dis.puc.state.oh.us

The only instance where Cadmus did not apply a historical realization rate to the current *ex ante* savings was for room air conditioner demand savings. As Cadmus noted in its evaluation report for the 2019 program year, there was a calculation mistake for this measure in the 2010 Ohio TRM that led to overstated air conditioning demand savings.[7] For the 2020 evaluation, Cadmus used a weighted average of the 2015 and 2016 evaluated per-unit air conditioning demand savings using the correct equation (Table 22). DP&L updated *ex ante* demand savings based on the 2020 Ohio TRM, which assumed a capacity of 10,000 Btuh for room air conditioners. This led to a realization rate of 81% for room air conditioner demand savings.

**Table 22. Room AC Demand Calculation Inputs**

| Input | Year | |
|---|---|---|
| | 2016 | 2017 |
| Hours | 233 | 233 |
| Btuh | 6,441 | 8,500 |
| EERexist | 7.7 | 7.7 |
| %replaced | 76% | 76% |
| EERbase | 9.8 | 9.8 |
| CF | 0.3 | 0.3 |
| Units | 169 | 406 |
| **Evaluated kW Savings** | **0.1011** | **0.1334** |
| **Weighted kW Savings** | **0.1239** | |

## *Recommendations*

- Cadmus offers no recommendations for the Appliance Recycling program.

[7] Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report*. Case No. 20-0916-EL-POR. http://dis.puc.state.oh.us

# Residential Income Eligible Efficiency Program

This chapter describes Cadmus' evaluation approach and findings for the Residential Income Eligible Efficiency program. The program consists of two channels: one implemented by Ohio Partners for Affordable Energy (OPAE) and one implemented by People Working Cooperatively (PWC). Cadmus did not conduct full impact or process evaluations of the 2020 Residential Income Eligible Efficiency program due to the program's stability and consistency of results in recent years. Instead, Cadmus applied impact evaluation results from 2017 to the 2020 program data to calculate energy savings and demand reduction.

## *Program Description*

The Residential Income Eligible Efficiency program provided services to residential customers with household incomes up to 200% of the federal poverty level or to those who qualified for one of the following programs: the Ohio Home Weatherization Assistance program (HWAP), the Percentage of Income Payment Plan (PIPP), or the Home Energy Assistance program (HEAP). Eligible households included single-family homes and multifamily properties in which units were individually metered. To market the program, implementer staff targeted DP&L customers with high electric usage and incomes less than 80% of the median income, as well as those who received assistance through HWAP, HEAP, or PIPP.

### OPAE Program Design

OPAE coordinated with community action agencies (CAAs) that implemented the program in their respective service areas. There were six CAAs in DP&L's territory, each operating independently. OPAE worked with the CAAs to ensure consistent program delivery and capture of program data input through the Low Income Energy Efficiency Network (LEEN) database, which DP&L used to for program reporting. The CAAs completed audits of customer homes before installing program measures. Program participants could receive measures through HWAP and HEAP funding, as well as funding from natural gas utilities if they had natural gas heat. DP&L funding covered baseload measures (lighting, appliances, water saving, and other non-weather dependent measures) and shell measures for electrically heated homes. Table 24 shows the complete list of energy saving measures installed in 2020.

### PWC Program Design

The PWC channel targeted customers who received emergency home repairs through another program implemented by PWC, in addition to customers who received assistance through HEAP or PIPP in the DP&L service territory. PWC conducted audits of customer homes before installing program measures.

Measure eligibility was based on equipment condition, equipment electric use, whether customers had air conditioning units, and whether customers had electric heat or electric hot water. Based on the home's needs, customers received direct-install measures such as LEDs, weatherization improvements, and appliances like refrigerators and freezers.

Table 25 shows the complete list of energy saving measures installed in 2020.

## *Evaluation Data Collection Summary*

Cadmus reviewed the OPAE and PWC program participant tracking data for 2020 and confirmed there were no major inconsistencies. As a part of the review, Cadmus also confirmed measure counts and that all data necessary to calculate savings was collected.

## *Program Savings Summary*

The Income Eligible Efficiency program fell short of its 1,216,568 kWh energy savings goal and its 155 kW demand reduction goal, achieving 841,944 kWh and 92.9 kW in *ex ante* savings. A total of 472 unique sites received direct-install measures through the program. Based on verified gross energy savings, the program achieved realization rates of 100% of *ex ante* energy savings and demand reduction. This includes the OPAE and PWC program channels.

Table 23 shows *ex ante*, verified gross, and adjusted gross energy savings and demand reduction. The adjusted savings use a program-level realization rate and are presented at the program level. For the OPAE channel, Cadmus calculated adjusted savings using the 2017 billing analysis results. For the PWC channel, adjusted savings use the 2016 and 2017 realization rates, which were derived from engineering desk review. The 2017 evaluation approaches are detailed in the 2017 EM&V Report, contained in the 2017 DP&L Status Report.[8]

**Table 23. Residential Income Eligible Efficiency Program Claimed and Achieved Energy Savings**

| Program | *Ex Ante* Claimed Savings[a] | | Verified Gross Savings | | Adjusted Gross Savings | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision[b] |
| OPAE | 780,969 | 84.4 | 780,969 | 84.4 | 687,252 | 74.3 | ±6.9% |
| PWC | 60,976 | 8.5 | 60,976 | 8.5 | 60,976 | 8.5 | ±5.6% |
| **Total** | **841,944** | **92.9** | **841,944** | **92.9** | **748,228** | **82.8** | **±6.3%** |

Note: Total values in table are rounded for reporting purposes.

[a] Cadmus calculated the 2017 energy savings and demand reduction to include ISRs and other adjustments. DP&L used these adjusted gross estimates for *ex ante* savings.

[b] Precision is at 90% confidence.

## *Impact Evaluation Findings*

Cadmus reviewed the LEEN database and summarized the OPAE channel's *ex ante* savings for each measure, shown in Table 24. Refrigerators were the largest source of *ex ante* energy savings for OPAE in 2020, at 35%. This was followed closely by air source heat pumps at 31% and by LEDs at 18%.

[8] Dayton Power and Light. May 15, 2018. *2017 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 18-0742-EL-POR. http://dis.puc.state.oh.us.

**Table 24. OPAE Channel *Ex Ante* Savings by Measure**

| Measure | *Ex Ante* Savings | | Percentage of Total Savings | |
|---|---|---|---|---|
| | kWh | kW | kWh | kW |
| Aerator | 1,100 | 0.15 | 0.14% | 0.18% |
| Air Source Heat pump | 244,056 | 12.55 | 31.25% | 14.87% |
| Attic Insulation | 12,027 | 0.14 | 1.54% | 0.17% |
| Central AC | 470 | 0.31 | 0.06% | 0.36% |
| Foundation wall insulation | 1,308 | 0.01 | 0.17% | 0.02% |
| Freezer | 45,951 | 6.96 | 5.88% | 8.24% |
| Heat Pump Water Heater | 1,673 | 0.17 | 0.21% | 0.20% |
| LED | 141,836 | 15.54 | 18.16% | 18.41% |
| Pipe Wrap | 56,540 | 6.43 | 7.24% | 7.61% |
| Refrigerator | 272,718 | 41.94 | 34.92% | 49.67% |
| Showerhead | 2,992 | 0.20 | 0.38% | 0.24% |
| Smart Strip | 47 | 0.01 | 0.01% | 0.01% |
| Water Heater Insulation | 251 | 0.03 | 0.03% | 0.03% |
| **Total** | **780,969** | **84.4** | **100%** | **100%** |

Note: Total values in table are rounded for reporting purposes.

Cadmus reviewed the LEEN database and summarized the PWC channel's *ex ante* savings. We did not find any errors or missing data. Table 25 lists the total *ex ante* savings for each energy saving measure. Refrigerators were the largest source (47%) of *ex ante* energy savings for PWC in 2020, , followed by LEDs (29%). The other measures contributed significantly less to *ex ante* savings.

**Table 25. PWC Channel *Ex Ante* Savings by Measure**

| Measure | *Ex Ante* Savings | | Percentage of Total Savings | |
|---|---|---|---|---|
| | kWh | kW | kWh | kW |
| Air Source Heat pump | 639 | 0.16 | 1.05% | 1.87% |
| Attic Insulation | 3,762 | 0.04 | 6.17% | 0.52% |
| Central AC | 1,645 | 1.08 | 2.70% | 12.64% |
| Freezer | 3,468 | 0.53 | 5.69% | 6.17% |
| LED | 17,759 | 1.98 | 29.13% | 23.25% |
| Pipe Wrap | 1,980 | 0.23 | 3.25% | 2.64% |
| Refrigerator | 28,773 | 4.43 | 47.19% | 52.02% |
| Wall insulation | 2,866 | 0.07 | 4.70% | 0.78% |
| Water Heater Insulation | 84 | 0.01 | 0.14% | 0.11% |
| **Total** | **60,976** | **8.5** | **100%** | **100%** |

Note: Total values in table are rounded for reporting purposes.

## *Recommendations*

- Cadmus has no recommendations for the Residential Income Eligible Efficiency program.

# Residential Heating and Cooling Rebates Program

This chapter describes Cadmus' evaluation approach and detailed findings for the Residential Heating and Cooling Rebates program. For the 2020 program year, Cadmus did not conduct a full impact or process evaluations of the Residential Heating and Cooling Rebates program due to the program's stability and the consistency of results in recent years. Instead, Cadmus applied 2019 impact evaluation results to calculate 2020 energy savings and demand reduction. Cadmus also reviewed program participant program data to confirm that there were no major inconsistencies. The program stopped accepting rebate applications after September 30, 2020.

For smart and programmable thermostat measures delivered as part of the Residential Heating and Cooling Rebates program, we used adjusted gross savings in accordance with findings from the 2020 Smart Thermostats program. The *Residential Smart Thermostats Program* chapter describes Cadmus' methodology to calculate savings for these measures.

## *Program Description*

The Residential Heating and Cooling Rebates program offered rebates for the installation of high-efficiency heating and cooling equipment. The program's primary objectives were to increase consumer awareness of energy-efficient products and their benefits and to motivate customers to purchase efficient HVAC equipment above the current minimum standard for efficiency. Only customers who worked with a program participating contractor (known as an HVAC Partner) were eligible for rebates. The program HVAC Partners handled the rebate paperwork on behalf of customers, and customers received their rebate check in the mail. CLEAResult implemented the program and did not suspend any program activity as a result of the COVID-19 pandemic since HVAC contractors are considered essential workers.

Several measures were available through the 2020 program:

- Central air conditioners
- Air-source heat pumps
- Ground-source heat pumps
- Ductless mini-splits
- Thermostats
- Heat pump hot water heaters

## *Program Savings Summary*

The program fell short of its energy savings goal of 7,754,503 kWh, achieving 6,457,671 kWh in *ex ante* savings through 5,082 rebated measures. The 2020 program also fell short of its 1,400 kW demand reduction goal, achieving 1,309.1 kW in *ex ante* demand reduction. Verified gross savings were 6,457,351 kWh and 1,309.1 kW. Based on verified gross savings, the program achieved realization rates of 100% for both *ex ante* energy savings and demand reduction.

Table 26 shows program *ex ante*, verified gross, and adjusted gross savings and demand reduction. Bolded values indicate a difference exists between the *ex ante* and verified gross savings.

**Table 26. Residential Heating and Cooling Rebates Program Claimed and Achieved Energy Savings**

| Measure[a] | *Ex Ante* Claimed | | Verified Gross | | Adjusted Gross | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision |
| ER AC 14/15 SEER | 721,966 | 293 | 721,966 | 293.4 | 628,111 | 255.3 | ±9.9% |
| ER AC 16+ SEER | 1,407,502 | 572 | 1,407,502 | 572.2 | 1,224,527 | 555.1 | ±7.7% |
| NC AC 14/15 SEER | 6,422 | 3 | 6,422 | 3.4 | 8,478 | 3.6 | ±10% |
| NC AC 16+ SEER | 23,816 | 10 | 23,816 | 9.7 | 22,625 | 9.4 | ±10% |
| **RP AC 14/15 SEER** | **34,905** | **22** | **35,101** | **22.6** | **30,538** | **17.4** | **±39.8%** |
| **RP AC 16+ SEER** | **82,506** | **34** | **81,990** | **34.0** | **71,332** | **32.6** | **±31.3%** |
| ER HP 14/15 SEER | 290,772 | 38 | 290,772 | 37.7 | 270,418 | 33.6 | ±12.5% |
| ER HP 16+ SEER | 1,445,857 | 195 | 1,445,857 | 194.7 | 1,344,647 | 204.5 | ±10.8% |
| NC HP 14/15 SEER | 7,119 | 1 | 7,119 | 1.0 | 3,560 | 0.5 | ±10% |
| NC HP 16+ SEER | 55,637 | 7 | 55,637 | 7.2 | 37,277 | 5.9 | ±10% |
| RP HP 14/15 SEER | 24,088 | 4 | 24,088 | 3.6 | 22,402 | 1.7 | ±27.8% |
| RP HP 16+ SEER | 103,233 | 12 | 103,233 | 12.5 | 96,007 | 12.6 | ±27.4% |
| ER GSHP 16/18 EER | 78,008 | 4 | 78,008 | 3.9 | 50,706 | 2.2 | ±10% |
| ER GSHP 19+ EER | 304,763 | 20 | 304,763 | 20.4 | 198,096 | 16.3 | ±10% |
| NC GSHP 16/18 EER | 43,783 | 2 | 43,783 | 2.3 | 28,459 | 1.3 | ±10% |
| NC GSHP 19+ EER | 120,693 | 9 | 120,693 | 9.2 | 96,555 | 6.2 | ±10% |
| RP GSHP 16/18 EER | 20,950 | 1 | 20,950 | 1.1 | 20,950 | 1.1 | ±10% |
| RP GSHP 19+ EER | 120,834 | 9 | 120,834 | 9.2 | 96,667 | 8.0 | ±10% |
| NC MS AC 16+ SEER | 810 | 1 | 810 | 0.8 | 607 | 0.6 | ±10% |
| NC MS HP 16+ SEER | 344,518 | 19 | 344,518 | 18.7 | 361,744 | 15.0 | ±39.9% |
| RP MS HP 16+ SEER | 2,517 | 0 | 2,517 | 0.3 | 3,247 | 0.1 | ±39.9% |
| Programmable Wi-Fi Thermostat w/ AC | 290,580 | 0 | 290,580 | 0 | 293,396 | 0 | ±19% |
| Programmable Wi-Fi Thermostat w/ HP | 140,360 | 0 | 140,360 | 0 | 141,114 | 0 | ±19% |
| Programmable Wi-Fi Thermostat w/ GSHP | 14,500 | 0 | 14,500 | 0 | 13,303 | 0 | ±19% |
| Smart Thermostat with AC | 383,380 | 33 | 383,380 | 32.6 | 386,101 | 0.0 | ±19% |
| Smart Thermostat with HP or GSHP | 137,460 | 12 | 137,460 | 11.7 | 138,801 | 0 | ±19% |
| Heat Pump Water Heater - Nat Gas Home | 8,304 | 1 | 8,304 | 1.1 | 8,304 | 1.1 | ±10% |
| Heat Pump Water Heater - Electric Home | 10,376 | 1 | 10,376 | 1.4 | 10,376 | 1.4 | ±10% |
| Air Sealing | 75,869 | 1 | 75,869 | 0.9 | 75,869 | 0.9 | ±10% |
| Wall Insulation | 46,232 | 1 | 46,232 | 1.0 | 46,232 | 1.0 | ±10% |
| Attic Insulation | 109,910 | 2 | 109,910 | 2.4 | 109,910 | 2.4 | ±10% |
| **Total** | **6,457,671** | **1,309** | **6,457,351** | **1,309.0** | **5,840,354** | **1,189.8** | **±4.5%** |

Note: Total values in table are rounded for reporting purposes.

[a] ER = early replacement, AC = air conditioner, NC = new construction, RP = replacement, HP = heat pump, MS = mini-split, ECM = electronically commuted motor, GSHP = ground-source heat pump

[b] Adjusted gross savings for qualifying AC and HP units accounted for ECM savings with new AC and HP units.

Cadmus analyzed customer rebates to verify if the installed equipment met the program requirements for each measure. We verified all but one of the measures were correct. One 15.5 SEER central air conditioner was incorrectly rebated as a greater than 16 SEER system. This adjustment resulted in a slight decrease in verified gross savings of less than 0.1%.

After verifying program rebates, Cadmus applied 2019 adjusted gross realization rates to tracking data for the 2020 program year for all measures except thermostats.[9] Adjusted gross realization rates impact the per-measure energy savings based on previous evaluation results. The detailed approaches Cadmus used to evaluate previous program years can be found in the respective program year EM&V reports, contained in the annual DP&L status reports. Table 27 provides 2020 adjusted gross realization rates (adjusted gross energy savings and demand reduction divided by verified energy savings and demand reduction) for all measures.

**Table 27. Residential Heating and Cooling Rebates Program Claimed and Achieved Energy Savings**

| Measure[a] | 2020 Verified Quantity | 2020 Adjusted Gross Realization Rates | |
|---|---|---|---|
| | | kWh | kW |
| ER AC 14/15 SEER | 663 | 87% | 87% |
| ER AC 16+ SEER | 1130 | 87% | 97% |
| NC AC 14/15 SEER | 40 | 132% | 105% |
| NC AC 16+ SEER | 53 | 95% | 97% |
| RP AC 14/15 SEER | 179 | 87% | 77% |
| RP AC 16+ SEER | 159 | 87% | 96% |
| ER HP 14/15 SEER | 94 | 93% | 89% |
| ER HP 16+ SEER | 438 | 93% | 105% |
| NC HP 14/15 SEER | 8 | 50% | 53% |
| NC HP 16+ SEER | 39 | 67% | 82% |
| RP HP 14/15 SEER | 25 | 93% | 48% |
| RP HP 16+ SEER | 71 | 93% | 101% |
| ER GSHP 16/18 EER | 11 | 65% | 57% |
| ER GSHP 19+ EER | 45 | 65% | 80% |
| NC GSHP 16/18 EER | 7 | 65% | 59% |
| NC GSHP 19+ EER | 19 | 80% | 68% |
| RP GSHP 16/18 EER | 3 | 100% | 100% |
| RP GSHP 19+ EER | 18 | 80% | 86% |
| NC MS AC 16+ SEER | 9 | 75% | 75% |
| NC MS HP 16+ SEER | 155 | 105% | 80% |
| RP MS HP 16+ SEER | 1 | 129% | 37% |
| Programmable Wi-Fi Thermostat with AC | 501 | 101% | -- |
| Programmable Wi-Fi Thermostat with HP | 242 | 101% | -- |
| Programmable Wi-Fi Thermostat with GSHP | 25 | 92% | -- |
| Smart Thermostat with AC | 661 | 101% | -- |
| Smart Thermostat with HP or GSHP | 237 | 101% | -- |
| Heat Pump Water Heater - Nat Gas Home | 4 | 100% | 100% |
| Heat Pump Water Heater - Electric Home | 8 | 100% | 100% |

[9] Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report*. Case No. 20-0916-EL-POR. http://dis.puc.state.oh.us

| Measure[a] | 2020 Verified Quantity | 2020 Adjusted Gross Realization Rates | |
|---|---|---|---|
| | | kWh | kW |
| Air Sealing | 113 | 100% | 100% |
| Wall Insulation | 18 | 100% | 100% |
| Attic Insulation | 106 | 100% | 100% |

[a] ER = early replacement, AC = air conditioner, NC = new construction, RP = replacement, HP = heat pump, MS = mini-split, ECM = electronically commuted motor, GSHP = ground-source heat pump

[b] Adjusted gross savings for qualifying AC and HP units accounted for ECM savings with new AC and HP units.

Refer to the *Residential Smart Thermostats Program* chapter for verified and adjusted gross savings, as well as realization rates, for thermostats. Cadmus calculated 2020 thermostat saving based on the analysis presented in the Smart Thermostat chapter. Saving were assessed based the number of thermostats installed and the evaluated savings, per thermostat from the 2019 evaluation.

With the updates to smart thermostat measure energy savings, the overall realization rate for Residential Heating and Cooling Rebates program is 90%, the same realization rate as 2019. Table 28 shows overall program realization rates for non-thermostat and thermostat measures.

**Table 28. 2020 Savings and Realization Rates for Heating and Cooling Rebates Program**

| Measure | Verified Gross | | Adjusted Gross | | Adjusted Gross Realization Rate | |
|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW |
| Non-thermostat measures | 5,491,071 | 1,264.7 | 4,867,641 | 1,189.8 | 89% | 94% |
| Thermostat measures | 966,280 | 44.3 | 972,713 | 0 | 101% | -- |
| **Total** | **6,457,351** | **1,309.0** | **5,840,354** | **1,189.8** | **90%** | **91%** |

Note: Total values in table are rounded for reporting purposes.

## *Recommendations*

- Cadmus offers no recommendations for the Heating and Cooling Rebates program.

# Residential School Education (Be E³ Smart) Program

This chapter describes the approaches Cadmus used to evaluate the Residential School Education program (known to customers as Be E³ Smart). We did not conduct full impact and process evaluations of the 2020 program (which spans the 2019-2020 school year) due to the program's high stability levels and the consistency of results across recent years. Instead, as in 2019, Cadmus applied the 2018 impact evaluation results to calculate 2020 energy savings and demand reduction.[10]

## *Program Description*

Through the Residential School Education program, DP&L provided participating teachers with free energy efficiency kits for students to install in their homes. Fourth through twelfth grade teachers were eligible to participate. The nonprofit, Ohio Energy Project (OEP) implemented the program, developed the program curriculum, distributed the kits, and collected kit installation data via student family surveys.

In exchange for providing energy efficiency lessons and energy efficiency kits to their students, participating teachers received a free science curriculum (which aligns with Ohio's learning standards), lab equipment, a stipend ($100 the first year and $200 for repeat years), continuing education credits, and optional graduate school credits. Before receiving the curriculum and energy efficiency kits in the mail, teachers had to attend a program training.

As in previous years, the energy efficiency kits contained five measures:

- Two LEDs (9 watts)
- One LED night light (0.5 watts)
- Two bathroom faucet aerators (1.0 gpm)
- One kitchen faucet aerator (1.5 gpm)
- One low-flow showerhead (1.25 gpm)

## *Program Savings Summary*

With 8,845 kits sent to teachers, DP&L fell just short of its participation goal of distributing 9,000 kits. The program achieved 3,429,553 kWh and 210.5 kW in *ex ante* energy savings and demand reduction, respectively, falling short of its 3,846,125 kWh energy savings and 263.0 kW demand reduction goals. Adjusted gross savings represent realization rates of 103% and 99% against *ex ante* energy savings and demand reduction, respectively. Table 29 lists *ex ante*, verified gross, and adjusted gross energy savings (kWh) and demand reduction (kW).

[10] Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 19-0775-EL-POR. http://dis.puc.state.oh.us

**Table 29. Residential School Education Program Claimed and Achieved Energy Savings**

| Measure | *Ex Ante* Claimed Savings[a] | | Verified Gross Savings | | Adjusted Gross Savings | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision[b] |
| LEDs (2) | N/A | N/A | N/A | N/A | 551,624 | 58.3 | ±17.5% |
| LED night light | N/A | N/A | N/A | N/A | 33,799 | 0.0 | ±12.2% |
| Bathroom faucet aerators (2) | N/A | N/A | N/A | N/A | 354,523 | 50.7 | ±47.9% |
| Kitchen faucet aerator | N/A | N/A | N/A | N/A | 1,077,820 | 23.2 | ±22.7% |
| Low-flow showerhead | N/A | N/A | N/A | N/A | 1,517,060 | 75.7 | ±28.9% |
| **Total** | **3,429,553** | **210.5** | **3,429,553** | **210.5** | **3,534,826** | **207.9** | **±15.2%** |

Note: Total values in table are rounded for reporting purposes.

[a] *Ex ante* savings are presented at the kit, not measure, level.

[b] Precision at 90% confidence.

Cadmus reviewed the Residential School Education program's participant tracking data and confirmed there were no major inconsistencies. ISRs for kit measures ranged from 29% for LED night lights to 97% for LEDs. Cadmus adjusted the ISR for LED night lights to account for the percentage that replaced incandescent night lights. Using results from family surveys completed by students and their parents or guardians upon receipt of the kit, Cadmus also updated the saturation of electric water heaters (from 52.0% in 2019 to 50.2% in 2020). This had a very small downward effect on savings and realization rates.

For water-saving measures, Cadmus used program inputs to calculate adjusted gross energy savings and demand reduction. While DP&L's *ex ante* energy saving calculations use program-specific inputs, the demand reduction calculation still uses the Ohio TRM values. This discrepancy, rather than program performance, was responsible for lower demand reduction realization rates. This approach is consistent with the approach Cadmus took in the 2019 evaluation.

Affected variables are denoted with bold text below:

$$\Delta kW = \Delta kWh \div \boldsymbol{hours} * CF$$

$$hours = \boldsymbol{min/day} * days * \#people \div F/home \div min/hour$$

Table 30 shows the assumptions used in the updated gross demand reduction algorithm.

**Table 30. Updated Assumptions for Verified and Adjusted Gross Demand Reduction**

| Variable Name | Variable Description | Faucet Aerators | | Showerhead |
|---|---|---|---|---|
| | | Bathroom | Kitchen | |
| min/day [a] | Minutes per day | 1.65 | 4.51 | 4.78 [b] |
| days | Days per year | | | 365.25 |
| #people [c] | Average number of people per home | | | 4.44 |
| F/home [c] | Average number of faucets per home | 2.43 | 1.00 | 1.74 |
| min/hour | Minutes per hour | | | 60 |
| CF | Coincidence factor | 0.00262 | 0.00262 | 0.00371 |

[a] Cadmus Water Metering Study (2013).

[b] For showerheads, min/day = minutes per day * showers per day = 7.83 * 0.61 = 4.78.

[c] 2018 participant survey.

Cadmus' approaches to evaluating previous program years can be found in the respective program year EM&V reports contained in DP&L's 2019 program evaluation.[11]

## *Recommendations*

- Cadmus offers no recommendations for the Be E$^3$ Smart program, as the program effectively met its kit distribution goals.

[11] Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 19-0775-EL-POR. http://dis.puc.state.oh.us

# Residential Smart Thermostats Program

This chapter describes Cadmus' evaluation approach, detailed findings, conclusions, and recommendations for the Residential Smart Thermostats program. We did not conduct a full impact or process evaluation of the 2020 program year. Instead, Cadmus applied 2019 impact evaluation results to calculate 2020 energy savings and demand reduction.[12]

## *Program Description*

The Residential Smart Thermostats program offers customers rebates toward the purchase of smart thermostats through a variety of distribution channels. In 2020, DP&L delivered the program through five channels:

- The upstream Rebates for Retail channel and the downstream Heating and Cooling program implemented by CLEAResult.
- The online DP&L Marketplace (see the *Residential Efficient Products Program* chapter for a description) and the Rebates as a Service platform implemented by Uplight.
- Savings purchased from Vectren Energy Delivery of Ohio.

The Rebates for Retail, Heating and Cooling program, Rebates as a Service, and Vectren channels ended September 30, and the Marketplace channel ended December 2.

Table 31 shows the number of thermostats that were distributed through each channel, as well as historical thermostat counts per channel (including the Third-Party Supplier, University of Dayton Housing, Nest Online Store, and DP&L Online Store channels from past years). Most thermostats were purchased through the marketplace, accounting for 91% of purchased thermostats in 2020.

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[12] Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 20-0916-EL-POR. http://dis.puc.state.oh.us

**Table 31. Delivered Thermostats by Channel**

| Channel | 2018 Verified Count | 2019 Verified Count | 2020 Verified Count | Percentage of Total Program |
|---|---|---|---|---|
| Mail-In or In-Store Rebates (Rebates for Retail) | 1,041 | 649 | 242 | 3% |
| DP&L Marketplace | 1,809 | 4,077 | 7,749 | 91% |
| Rebates as a Service | - | 323 | 160 | 2% |
| Vectren | 571 | - | 391 | 5% |
| Third-Party Supplier[a] | 137 | 73 | - | |
| University of Dayton Housing[a] | - | 481 | - | |
| Nest Online Store[a] | 2,122 | 98 | - | |
| DP&L Online Store[a] | 149 | - | - | |
| **Total Thermostats Delivered** | **5,829** | **5,701** | **8,542** | |
| Heating and Cooling Rebates | 1,882 | 2,141 | 1,666 | |
| **Total Thermostats Delivered, including Heating and Cooling Rebates** | **7,711** | **7,842** | **10,208** | |

Note: Total values in table are rounded for reporting purposes.

[a] These channels were not offered in 2020.

## *Program Savings Summary*

In 2020, the Residential Smart Thermostats program achieved 4,954,360 kWh and 421.1 kW in *ex ante* savings, exceeding its 2,075,431 kWh energy savings goal and meeting its 296 kW demand reduction goal. Verified counts aligned 100% with *ex ante* counts, leading to a gross verified realization rates of 100%. Cadmus, however, did not calculate demand reduction for smart thermostats. While sites that received smart thermostats likely realized a small amount of demand reduction on average, we did not measure such average demand reduction as it is difficult to quantify.

The Heating and Cooling Rebates program rebated 768 Wi-Fi and 898 smart thermostat measures[13] (1,666 total) and achieved 966,280 kWh and 44 kW in verified gross savings.[14] The chapter on the Heating and Cooling Rebates program accounts for these savings, which count as part of that program's total savings. This chapter discusses the derivation of Wi-Fi and smart thermostat adjusted gross savings.

Table 32 shows program *ex ante* claimed, verified gross, and adjusted gross energy savings and demand reduction by channel for the Residential Smart Thermostats program. Key evaluation findings follow the table.

13 Cadmus defines smart thermostats as having connectivity features in addition to geocaching or learning features, and defines Wi-Fi thermostats as solely offering connectivity features. Data on measured results are not available to demonstrate a savings difference between these two categories.

14 Smart thermostat units had 0.04932 kW claimed demand reduction, while Wi-Fi thermostats had zero.

**Table 32. Residential Smart Thermostats Program Claimed and Achieved Energy Savings**

| Channel | *Ex Ante* Claimed | | Verified Gross | | Adjusted Gross | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision |
| Mail-In or In-Store Rebates (Rebates for Retail) | 140,360 | 11.9 | 140,360 | 11.9 | 143,013 | 0 | 11% |
| DP&L Marketplace Rebates as a Service | 4,587,220 | 389.9 | 4,587,220 | 389.9 | 4,678,142 | 0 | 19% |
| Vectren | 226,780 | 19.3 | 226,780 | 19.3 | 231,769 | 0 | - |
| **Residential Smart Thermostats Program Total** | **4,954,360** | **421.1** | **4,954,360** | **421.1** | **5,052,924** | **0** | **19.1%%** |

Note: Total values in table are rounded for reporting purposes.

Cadmus reviewed the thermostat tracking data for each delivery channel to confirm reported quantities. Beginning in the 2020 program year, DP&L no longer allowed customers to receive more than one rebated thermostat. The implementation of this change was largely successful. Cadmus only found 24 customers (0.3%) who received multiple rebates in 2020, compared to 3% in 2019, with many of these occurring early in the program year. Of the 24 secondary thermostats, nine were delivered through the Rebates as a Service channel, and all were rebated in March 2020. This indicates there were likely issues with implementing the change to only allow one rebate per household early on. After March 2020, we did not find any customers who received multiple thermostats rebated through the Rebates as a Service channel. The remaining 15 cases where customer purchased thermostats through separate delivery channels.

Cadmus applied 2019 per thermostat savings to tracking data for the 2020 program year. We applied savings of 593 kWh for the first thermostat rebated and 158 kWh for the second thermostat rebated. Cadmus' approach to calculate per-unit savings and evaluate previous program years is detailed in the respective annual DP&L status reports.

Table 33 shows the adjusted gross kilowatt-hour savings and realization rates by delivery channel. Realization rates varied from 101% to 102%. The primary reason realization rates exceeded 100% was because there were fewer instances of multiple thermostats being rebated in 2020 than in 2019. The *ex ante* savings assumed a per-unit value of 580 kWh per thermostat, the average evaluated savings per thermostat in 2019. This value is a weighted average of the 593 kWh and 158 kWh per-unit savings for the first and second thermostats, respectively. Because there were far fewer secondary thermostats rebated in 2020 compared to 2019, the average savings per thermostat in 2020 was 591 kWh compared to 580 kWh in 2019.

**Table 33. Adjusted Gross Savings by Delivery Channel**

| Channel | *Ex Ante* Thermostats | Verified Thermostats | First Thermostats | Secondary Thermostats | Adjusted Gross kWh Savings | Average Savings per Thermostat | RR |
|---|---|---|---|---|---|---|---|
| Mail-In or In-Store Rebates (Rebates for Retail) | 242 | 242 | 241 | 1 | 143,013 | 591 | 102% |
| DP&L Marketplace Rebates as a Service | 7,909 | 7,909 | 7,886 | 23 | 4,678,142 | 591 | 102% |
| Vectren | 391 | 391 | 391 | 0 | 231,769 | 593 | 102% |
| **Total / Average** | **8,542** | **8,542** | **8,518** | **24** | **5,052,924** | **592** | **102%** |
| Heating and Cooling Rebates | **1,666** | **1,666** | **1,631** | **35** | **972,713** | **584** | **101%** |

Note: Total values in table are rounded for reporting purposes.

## *Recommendations*

Drawn from the preceding findings, Cadmus offers the following recommendation for a future Residential Smart Thermostats program:

- **Update the reported savings value to 593 kWh per thermostat.** Because customers are no longer allowed to receive multiple rebates for thermostats, reported savings can be adjusted to reflect the 2019 evaluated savings (593 kWh) for homes that installed one thermostat. Updating savings in the future to 593 kWh would be appropriate, as long as it remains true that customers cannot receive multiple rebates, or if these instances are rare like in 2020.

# Residential Energy Savings Kits Program

This chapter describes Cadmus' evaluation approach, detailed findings, and recommendations for the Residential Energy Savings Kit program. For the 2020 program year, Cadmus did not conduct a full impact or process evaluation of the Residential Energy Savings Kits program due to the program's high stability and consistency. Instead, as for the 2019 evaluation, Cadmus applied the evaluation results from the 2017 and 2018 program years to calculate 2020 energy savings and demand reduction.[15] DP&L stopped accepting customer requests for kits after July 23, 2020 when the supply was depleted.

## *Program Description*

The Residential Energy Savings Kit program provided free energy savings kits to customers who sign up through the DP&L website or the program hotline. Enrolled customers received a kit in the mail that includes instructions to install the kit measures themselves. Customers could only receive one kit per home for the life of the program. However, landlords could receive multiple energy savings kits. Alternatively, landlords with properties that contain five or more units were eligible to participate in the Multi-Family Direct Install program. As in 2018 and 2019, AM Conservation (formerly Resource Action Programs) implemented the program in 2020. Due to the temporary suspension of program activities for some other DP&L programs, caused by the COVID-19 pandemic, DP&L increased marketing for the Energy Savings Kits program. DP&L sent emails to 125,000 customers and marketing postcards to 25,000 customers, cross-promoted the program through the Behavior Change program and included bill inserts about the kits in February and May.

Each kit contains:

- Four LED light bulbs (9 watts)
- One bathroom faucet aerator (1.0 gpm)
- One kitchen faucet aerator (1.5 gpm)
- One low-flow showerhead (1.5 gpm)
- Teflon tape to use when installing products
- Illustrated installation instructions
- QuickStart Guide with useful tips

## *Program Savings Summary*

With 21,342 kits mailed to customers, the Residential Energy Savings Kits exceeded its goal of 15,000 kits. The program achieved 5,252,266 kWh and 578.4 kW in *ex ante* savings and demand reduction,

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[15] Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report*. Case No. 20-0916-EL-POR. http://dis.puc.state.oh.us
Dayton Power and Light. May 15, 2019. *2018 Energy Efficiency and Demand Reduction/Response Portfolio Status Report*. Case No. 19-0775-EL-POR. http://dis.puc.state.oh.us
Dayton Power and Light. May 15, 2018. *2017 Energy Efficiency and Demand Reduction/Response Portfolio Status Report*. Case No. 18-0742-EL-POR. http://dis.puc.state.oh.us

respectively, exceeding its 3,881,531 kWh energy savings and 426.0 kW demand reduction goals. The program realized 95% of *ex ante* energy savings and 85% of *ex ante* demand reduction. Table 34 summarizes *ex ante*, verified gross, and adjusted gross energy savings (kWh) and demand reduction (kW).

**Table 34. Residential Energy Savings Kits Program Claimed and Achieved Energy Savings**

| Measure | *Ex Ante* Claimed Savings[a] | | Verified Gross Savings | | Adjusted Gross Savings | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision[b] |
| LEDs (4) | N/A | N/A | N/A | N/A | 2,565,354 | 271.3 | ±17.4% |
| Bathroom faucet aerator | N/A | N/A | N/A | N/A | 244,897 | 65.6 | ±34.2% |
| Kitchen faucet aerator | N/A | N/A | N/A | N/A | 1,084,573 | 46.0 | ±16.0% |
| Low-flow showerhead | N/A | N/A | N/A | N/A | 1,110,811 | 109.5 | ±19.2% |
| **Total** | **5,252,266** | **578.4** | **5,252,266** | **578.4** | **5,005,634** | **492.4** | **±10.6%** |

Note: Total values in table are rounded for reporting purposes.

[a] *Ex ante* savings are presented at the kit, not measure, level.

[b] Precision at 90% confidence.

Cadmus reviewed the Residential Energy Savings Kits program's participant tracking data and confirmed that the number of kits AM Conservation invoiced DP&L matched the number of kits delivered (21,342 kits).

Consistent with the methodology used for evaluating LEDs savings in the Efficient Products program, Cadmus used an as-found baseline and lifetime in-service rate for LEDs.

For water-saving measures, Cadmus used program inputs to calculate adjusted gross energy savings and demand reduction. While DP&L's *ex ante* saving calculations use program-specific inputs, the inputs used are slightly different than those used by Cadmus. This discrepancy, rather than program performance, was responsible for lower demand reduction realization rates. This approach is consistent with the approach Cadmus took in the 2019 evaluation.

Affected variables are denoted with bold text below:

$$\Delta kW = \Delta kWh \div \boldsymbol{hours} * CF$$

$$hours = \boldsymbol{min/day} * days * \#people \div F/home \div min/hour$$

Table 35 shows the assumptions used in the adjusted gross demand reduction algorithm.

**Table 35. Updated Assumptions for Verified and Adjusted Gross Demand Reduction**

| Variable Name | Variable Description | Faucet Aerators | | Showerhead |
|---|---|---|---|---|
| | | Bathroom | Kitchen | |
| min/day [a] | Minutes per day | 1.65 | 4.51 | 4.78 [b] |
| days | Days per year | | | 365.25 |
| #people [c] | Average number of people per home | | | 2.25 |
| F/home [c] | Average number of faucets per home | 2.31 | 1.00 | 1.74 |
| min/hour | Minutes per hour | | | 60 |
| CF | Coincidence factor | 0.00262 | 0.00262 | 0.00371 |

[a] Cadmus Water Metering Study (2013).

[b] For showerheads, min/day = minutes per day * showers per day = 7.83 * 0.61 = 4.78.

[c] 2018 participant survey.

Cadmus' approaches to evaluating previous program years can be found in the respective program year EM&V reports contained in DP&L's annual Status Reports.[16]

## Recommendations

- Cadmus offers no recommendations for the Residential Energy Savings Kits program, as the program effectively met its kit distribution goals.

[16] Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/*Response *Portfolio Status Report.* Case No. 20-0916-EL-POR. http://dis.puc.state.oh.us

# Residential Behavior Change Program

This chapter describes Cadmus' evaluation approach and methodology, detailed findings, and recommendations for the Residential Behavior Change program. Due to the program ending, customers received their last reports in December 2020 or January 2021.

## *Program Description*

The Residential Behavior Change program encouraged customers to save energy through energy use feedback, a social normative comparison, and educational tips aimed at motivating customers to save energy. Uplight, the program implementer, sent Energy Insights Reports to customers describing their energy usage, comparing their usage to other homes, and sharing steps they could take to reduce energy. Customers could also access the Energy Insights Portal, which offers further information on energy usage and opportunities for energy savings. In response to the COVID-19 pandemic, the reports included energy-savings tips related to staying and working at home.

The Residential Behavior Change program had two separate experimental groups: Experiment 1 included all customers with an email address attached to their DP&L billing accounts, and Experiment 2 included customers who did not have an email address on record. Customers in Experiment 1 were randomized into either a control group or one of four treatment groups (referred to as waves). Customers in Experiment 2 were randomized into either a control group or a treatment groups. All waves began receiving treatment by August 2018.

To increase to increase customer engagement with the Energy Insights Reports and thereby increase savings attributable to the program, Uplight made several program design and delivery changes in 2020:

- Uplight increased treatment to the waves that did not see statistically significant savings in 2019: the Email + Marketplace wave and the Marketplace wave (see Table 36 for a description of these waves). Beginning in 2020, customers in the Email + Marketplace wave began receiving paper reports in addition to their emailed reports, and the customers in the Marketplace-only wave began receiving emailed reports.
- Uplight migrated the Behavior Change program from the legacy Tendril platform to the Home Energy Reports (HOMERs) platform, which shortened the timeframe between when customers received their bill and when they received their paper report from two weeks to approximately one week. This change was designed to increase customer interest in their energy usage.
- Uplight created a sweepstakes drawing for customers who logged into the Energy Insights portal.
- For customers who received paper reports, Uplight mailed a thermostat setpoint reminder sticker in July.
- Uplight ensured that no-cost tips were included in each report. These no-cost savings were designed to increase stand-alone saving attributable to the Behavior Change program rather than DP&L's rebate programs.

- Uplight changed its paper report schedule so that customers received the paper reports immediately prior to the heating season. These reports contained energy savings tips about how customers could prepare their homes for the heating season.

Table 36 lists the treatments customers received in each experiment group and wave.

**Table 36. Description of Residential Behavior Change Treatment Structure**

| Experiment Group | Treatment Wave | Description of Treatment |
|---|---|---|
| **Experiment 1:** customers with email addresses tied to their billing accounts | Email + Paper | Customers received email and paper Energy Insights Reports |
| | Email + Paper + Marketplace | Customers received email, paper Energy Insights Reports, and Marketplace promotional emails |
| | Email + Marketplace | Customers received email, paper Energy Insights Reports, and Marketplace promotional emails |
| | Marketplace | Customers received Marketplace promotional emails and emailed reports. |
| **Experiment 2:** customers without email addresses tied to their billing accounts | Paper | Customers received paper Energy Insights Reports |

## *Evaluation Overview*

To evaluate the 2020 Residential Behavior Change program, Cadmus conducted the evaluation activities and answered the researchable questions outlined in Table 37.

**Table 37. Key Researchable Questions for Residential Behavior Change Program**

| Researchable Question | Activity Used to Address Question |
|---|---|
| What are the program's estimated gross savings and demand reduction? | • Database review<br>• Billing analysis<br>• Uplift analysis |
| Is the program cost-effective? | • Cost-effectiveness analysis |

## *Detailed Evaluation Findings*

Cadmus evaluated the energy savings and demand reduction achieved during the 2020 Residential Behavior Change program year. DP&L, through its home energy report (HER) vendor Uplight, sent paper or electronic Energy Insights Reports or Marketplace promotional emails to 123,584 customers in the treatment groups. Customers in Experiment 1 received between 12 and 24 electronic HERs, emailed either biweekly or once per month during the 2020 program year; some treatment groups in Experiment 1  also received paper reports. Customers in Experiment 2 received six paper reports. Dual-fuel customers also received two additional reports sent through a partnership with Vectren—DP&L electric service territory overlaps heavily with Vectren Ohio's gas service territory.

Cadmus estimated *ex ante* and *ex post* savings in 2020 using billing data covering the pre-treatment period and January through September 2020. Because of the timing of the billing analysis, Cadmus did not collect billing data covering October through December of 2020. Instead, we forecasted savings for the last quarter of 2020 to estimate *ex ante* savings using the annual savings distribution observed in 2019 for each wave. We only used savings estimated for the first nine months of 2020 for *ex post* savings, in keeping with the formal definition of *ex post*, which resulted in a realization rate less than 100%.

Across all five waves of treatment, the program achieved 8,358,004 kWh and 1,441.8 kW in *ex ante* energy and demand savings, respectively. For 2020 planning purposes, the program had a goal of 18,700,000 kWh and 3,170 kW. Cadmus was unable to detect statistically significant energy savings for two of the waves: Email + Marketplace and Marketplace only waves. Prior to 2020, treatment customers in both waves had only received electronic treatment through emailed HERs or Marketplace promotional emails. Partway through 2020, customers in the Email + Marketplace wave also began receiving paper HERs in attempts to increase their savings. However, consistent with previous evaluations, confidence intervals around the savings estimates in both the Email + Marketplace and Marketplace only waves included 0 kWh (indicated in the table by relative precisions larger than 100%). Adjusted gross energy savings at the program level are statistically significant, though, with a relative precision of ±42%[17] with 90% confidence. Table 38 shows *ex ante*, verified, adjusted gross energy savings, and demand reduction for the 2020 Residential Behavior Change program.

**Table 38.Residential Behavior Change Program Claimed and Achieved Energy Savings**

| Experiment Group | Treatment Wave | Treated Homes | *Ex Ante* Reported[a] | | Verified Gross[b] | | Adjusted Gross[b] | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | kWh | kW | kWh | kW | kWh | kW | RP[c] |
| Experiment 1 | Email+Paper | 11,916 | 1,596,564 | 275.4 | 1,175,842 | 203 | 1,175,842 | 202.8 | ±52% |
| | Email+Paper+ Marketplace | 23,863 | 1,951,649 | 336.7 | 1,487,304 | 257 | 1,487,304 | 256.6 | ±71% |
| | Email+ Marketplace | 45,512 | 1,191,282 | 205.5 | 812,745 | 140 | 812,745 | 140.2 | ±227% |
| | Marketplace | 11,903 | -147,036 | -25.4 | -185,335 | -32 | -185,335 | -32 | ±338% |
| Experiment 2 | Paper | 30,390 | 3,765,545 | 649.6 | 3,061,022 | 528 | 3,061,022 | 528.0 | ±44% |
| **Total** | | **123,584** | **8,358,004** | **1,441.8** | **6,351,578** | **1,095.6** | **6,351,578** | **1,095.6** | **±42%** |

Note: Total values in table are rounded for reporting purposes.
[a] *Ex Ante* reported savings include verified savings from January - September and projected savings from October – December
[b] Verified and adjusted gross savings only include verified savings from January – September (9 months).
[c] RP = relative precision

Participants in all five waves received treatment consistently for three years by the end of the 2020 program year. We typically see a ramp-up in savings over the first six to 18 months in similar programs. However, customers with low average daily consumption pre-treatment, such as customers in Experiment 1, can take longer to reach expected levels of savings.

[17] Precision around estimates are high in large part because the program has not matured. Precision would likely decrease if customers received more treatment and savings increased.

There are several notable findings from the evaluation:

- Experiment 1 treatment group customers who received paper HERs achieved statistically significant savings in the 2020 program year, consistent with the 2019 evaluation.
- Experiment 1 customers who had not received paper treatment prior to 2020 continued to generate lower savings than other waves in 2020. Cadmus did not detect statistically significant savings at the 90% confidence level for the Email + Marketplace or Marketplace-only waves, consistent with the 2018 and 2019 evaluations, despite the fact that Uplight added paper reports to the Email + Marketplace wave in June and emailed reports to the Marketplace only wave in May 2020.

## *Evaluation Methods*

To evaluate the 2020 program, Cadmus conducted a program database review, billing analysis, and uplift analysis for the 2020 program year through September, forecasted savings from October through December of 2020, and performed a cost-effectiveness review. Our methods for each task are discussed below.

### Program Database Review

Cadmus requested program tracking data directly from Uplight and performed a database review. For each treatment and control customer, the program tracking data included DP&L account numbers, contact information, wave, treatment status, account inactive dates, dates customers received their first reports (separate for email, paper, and Marketplace treatment), and opt-out dates for email, paper, and Marketplace treatment. Cadmus used the program tracking data to confirm treatment status for each customer, determine the number of days in 2020 that each customer was treated, and calculate opt-out rates.

### Billing Analysis

Cadmus estimated savings for the 2020 Residential Behavior Change program through September 2020 by analyzing customer billing data before and after treatment began. Prior to the program launch in 2018, Cadmus randomized customers eligible for the program (for Experiment 1 if they had email addresses attached to their DP&L billing account and otherwise for Experiment 2) into either treatment or control groups. The randomized control trial (RCT) design allowed Cadmus to control for unobservable effects of time related to customers' consumption and determine the change in consumption due to participation in the program. We collected billing data for customers beginning a year prior to the start of treatment (June 2017) through the end of 2019 and supplemented these data with customer bills from the 2020 program year through September 2020. Cadmus normalized billing data to the calendar months and fixed estimated reads[18] prior to modeling customer consumption. For

[18] DP&L designates a bill as estimated when it cannot directly read a customer's meter and bills the customer for an estimate consumption amount. The next true meter reading and corresponding bill corrects any error in the previous estimated bills. Cadmus accounted for estimated reads by aggregating savings from a consecutive set of estimated reads with the next actual read.

each experiment, the regression model controlled for differences in temperature and time effects between treatment and control customers. The estimated per-home savings rolled up to an overall program savings estimate. The billing analysis conformed to the *International Performance Measurement and Verification Protocol* Option C, whole facility,[19] and the approach described in the *Uniform Methods Project*.[20]

To estimate demand savings, Cadmus applied a peak adjustment factor to the average observed energy savings achieved during peak summer months (June, July, and August), which we calculated using the peak adjustment factor (1.5) and summer load shapes[21] provided in the 2019 Illinois TRM v7.0.[22]

### Uplift Analysis

Residential Behavior Change program participants could participate in other DP&L residential energy efficiency programs, and savings from cross-participation were claimed by both respective programs. Cadmus captured cross-participation savings in the Residential Behavior Change program billing analysis. To avoid double-counting savings, we analyzed differences in savings and participation rates counted in other energy efficiency programs between treatment and control customers. If cross-participation rates or savings were higher on average for treatment customers than for control customers, we deduced that the program influenced this behavior and we captured these savings (uplift savings) in the analysis. To perform the uplift analysis, we gathered adjusted gross savings for each customer and measure in DP&L's residential energy efficiency programs.

### Savings Forecast

The accelerated timing of the 2020 program evaluation, due to the required early wind-down of programs in Ohio, hindered Cadmus' ability to collect tracking, billing, and cross-participation savings

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19 Efficiency Valuation Organization. January 2012. *International Performance Measurement and Verification Protocol, Concepts and Options for Determining Energy and Water Savings, Volume 1.* p.25. (EVO 10000 – 1:2012). http://www.evo-world.org/

20 National Renewable Energy Laboratory. April 2013. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* "Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol." NREL/SR-7A30-53827.
http://www1.eere.energy.gov/office_eere/de_ump_protocols.html
National Renewable Energy Laboratory. August 2014. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* "Chapter 17: Residential Behavior Protocol." Written by J. Stewart and A. Todd. NREL/SR-7A40-62497.
http://www1.eere.energy.gov/office_eere/de_ump_protocols.html

21 Percentage of annual load occurring between May through September (42%) times the proportion of summer months that fall June, July, and August (3/5) divided by the number of hours in June, July, and August (8,760/4).

22 Illinois Energy Efficiency Stakeholder Advisory Group. September 28, 2018. *2019 Illinois Technical Reference Manual for Energy Efficiency Version 7.0.* http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_7/Final_9-28-18/IL-TRM_Effective_010119_v7.0_Vol_1-4_Compiled_092818_Final.pdf

data later than September 2020. We used these data to estimate *ex post* program and uplift savings attributable to the Energy Insights Reports from January 2020 through September 2020 and extrapolated these results to the last quarter of 2020 to estimate annual *ex ante* program savings.

Cadmus forecasted program savings in October through December of 2020 by assuming the 2020 annual program savings followed the annual savings distribution observed in the 2019 program year. Cadmus allowed the savings distribution to vary by wave of treatment.

Unlike the billing data used to calculate per-household Behavior Change program savings in 2020, Cadmus collected cross-program savings data for all 2020 months, and therefore directly calculated uplift savings across all 12 months of the year.

## *Impact Evaluation Findings*

The following sections discuss the results of the program database review, gross *ex post* energy and demand savings evaluation, and uplift participation and savings analysis.

### Program Database Review

Cadmus reviewed the program tracking data to confirm the population of customers reported by Uplight. Table 39 shows the customers who Cadmus confirmed were treated in the 2020 program year, as well as those who opted out of receiving reports (email or paper) and Marketplace promotional emails. Uplight sent email treatment to over 80,000 treatment customers, paper treatment to approximately 109,000 treatment customers, and Marketplace promotional emails to about 81,000 treatment customers. Nearly 100% of treatment customers active in 2020 received the correct methods of treatment for their experiment group. In 2020, about 2% to 3% of customers treated with email HERs opted out from receiving email HERs—compared to negligible amount of optouts for paper HER treatment and the Marketplace promotional emails.

**Table 39. Database Review of Treated and Opt-Out Customers**

| Treatment Wave | Active in 2020 | Treated in 2020 | | | 2020 Opt-Outs | | |
|---|---|---|---|---|---|---|---|
| | | Email | Paper | Market-place | Email | Paper | Marketplace |
| Email + Paper | 11,916 | 11,889 | 11,916 | 0 | 2% | 0% | N/A |
| Email + Paper + Marketplace | 23,863 | 23,685 | 23,863 | 23,862 | 3% | 0% | 0% |
| Email + Marketplace | 45,512 | 45,162 | 43,545 | 45,512 | 3% | 0% | 0% |
| Marketplace | 11,903 | 0 | 0 | 11,903 | N/A | N/A | 0% |
| Paper | 30,390 | 0 | 30,390 | 0 | N/A | 0% | N/A |
| **Total** | **123,584** | **80,736** | **109,714** | **81,277** | **1%** | **0%** | **0%** |

Note: Total values in table are rounded for reporting purposes.

### Evaluated Savings

Cadmus calculated *ex post* gross savings for each wave of treatment and for the program overall. We calculated a realization rate by comparing *ex post* to *ex ante* savings.

### *Ex Ante and Ex Post Gross Savings*

Cadmus estimated gross program *ex ante* savings of 8,358 MWh for the 2020 program year, including 2,006 MWh forecasted for October through December of 2020. We estimated gross program *ex post* savings of 6,352 MWh, which only includes the savings we observed in the billing analysis for January through September of 2020. Program gross savings were statistically significant for all waves of treatment that received paper reports—Cadmus could not detect significant savings for the two waves that had only received electronic HERs or Marketplace promotional emails prior to 2020, as indicated by their confidence intervals including 0 MWh. Program total gross *ex post* savings, which incorporated the uncertainty around savings from all waves, were still significantly different from 0 MWh with a 90% confidence interval of 3,680 MWh to 9,023 MWh (Table 40).

**Table 40. 2020 Behavior Change Savings**

| Experiment Group | Treatment Wave | Annual Gross Electricity Savings (MWh/yr) | | 90% Confidence Interval (MWh/yr) | | Realization Rate |
|---|---|---|---|---|---|---|
| | | *Ex Ante* | *Ex Post* Gross | Lower Bound | Upper Bound | |
| Experiment 1 | Email + Paper | 1,597 | 1,176 | 560 | 1,791 | 74% |
| | Email + Paper + Marketplace | 1,952 | 1,487 | 430 | 2,545 | 76% |
| | Email + Marketplace | 1,191 | 813 | -1,033 | 2,659 | 68% |
| | Marketplace | -147 | -185 | -811 | 440 | 126% |
| Experiment 2 | Paper | 3,766 | 3,061 | 1,704 | 4,418 | 81% |
| **Total** | | **8,358** | **6,352** | **3,680[a]** | **9,023[a]** | **76%** |

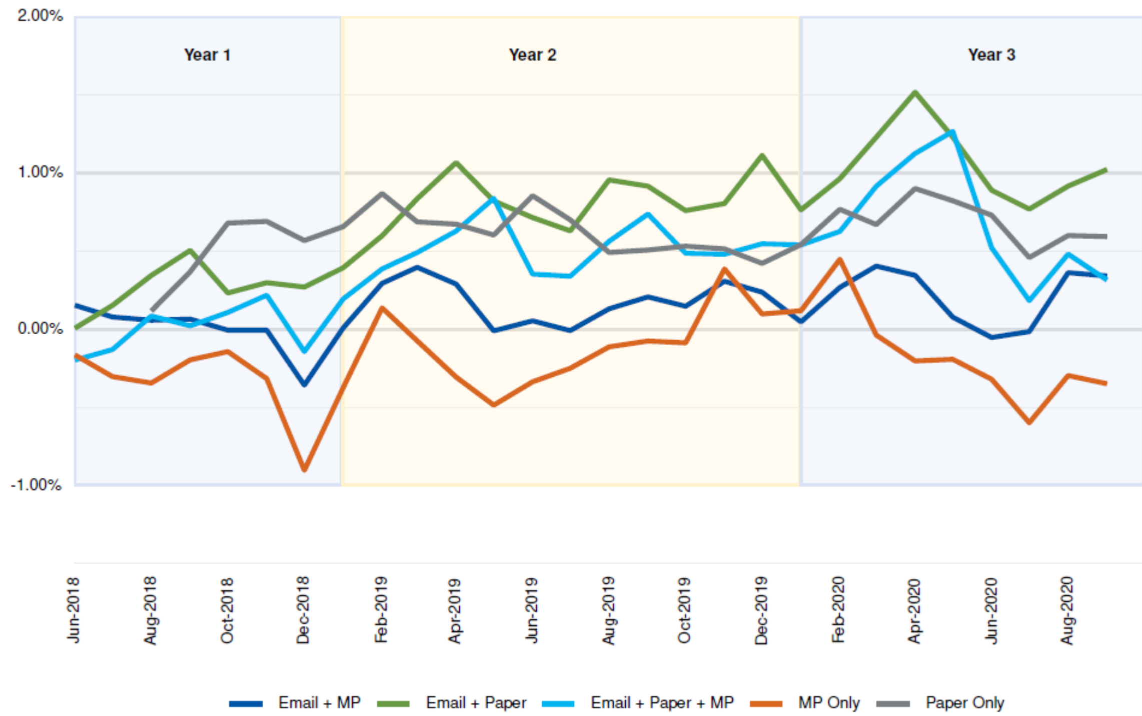
Note: Total values in table are rounded for reporting purposes.

[a] Confidence interval totals are not equal to the sum of the confidence intervals for each treatment wave. Rather the confidence interval totals measure the uncertainty around the total *Ex Post* gross savings for the program as a whole.

Figure 1 shows the average daily savings per customer (as a percentage of control-group consumption) evaluated for each month and year since treatment began in August 2018, through September 2020. Results are sensitive to changes in weather each month and average daily savings vary accordingly across months of treatment. Notable findings include these:

- Savings in most waves increased steadily through 2019 and reached a peak in spring 2020, heavily coinciding with the initial widespread shutdown of schools and workplaces due to the COVID-19 pandemic. Savings declined through summer 2020 but appeared to increase in September. Seasonality is also a major driver in some of the month to month changes in percent savings.
- On average, across the first nine months of the 2020 program year, savings for all waves increased only marginally, consistent with the slow ramp-up we have observed from these waves since the beginning of treatment. Similar behavior programs tend to reach steady savings of 1.5% to 2% after two years of treatment, but customers with low pre-treatment consumption, such as those in Experiment 1, can take longer to achieve their maximum savings and generally achieve lower savings than those with high consumption. The impacts of the COVID-19 pandemic make it difficult to assess the program's performance in its critical third year of treatment.

**Figure 1. Average Daily Savings over Time by Wave**




## *Uplift Analysis*

Cadmus estimated Behavior Change program uplift (the effect of the program on participation in other DP&L efficiency programs) and the energy savings resulting from uplift in 2020. Participation uplift savings appeared in the regression-based estimate of Behavior Change program savings and the savings of any other DP&L efficiency programs that experienced uplift. Therefore, the Behavior Change program savings that were counted in other programs were subtracted from DP&L's residential portfolio savings to avoid counting the savings twice. Cadmus provides participation uplift (the count of cross-participation resulting from participation in the Behavior Change program) and uplift savings in the following sections. (See *Appendix H. Residential Behavior Change Program Impact Evaluation Methodology* for details on participation uplift and uplift savings estimation methodology.)

### Participation Uplift

To estimate the effect of the Behavior Change program on participation in DP&L's other efficiency programs, Cadmus compared the rates of participation between treatment and control group customers in 2020. Energy Insights Reports had a positive average effect on participation in other programs where rates of cross-program participation were greater for treatment group customers. Table 41 shows participation uplift results for 2020. The HERs appeared to decrease participation in DP&L's other programs in all treatment waves except the Marketplace Only wave, shown by the negative participation uplift rates. Cadmus observed that high control customer participation in the Energy Savings Kits program drove these results. The 2019 evaluation revealed the opposite—treatment customer participation in the Energy Savings Kits program drove the large positive uplift rates in 2019.

These results, though initially unintuitive, are a common phenomenon of similar behavior programs. The Energy Insights reports appeared to encourage treated customers to participate in other energy efficiency programs and adopt energy efficient measures earlier than they would have without the reports, but control customers may be catching up to the treatment customers in their adoption rates, resulting in negative participation uplift rates.

**Table 41. Behavior Change Program Participation Uplift for Efficiency Programs**

| Experiment Group | Treatment Wave | Rate of Participation in At Least One Other Program (per 1,000 customers) | | Participation Uplift | |
|---|---|---|---|---|---|
| | | Treatment | Control | Per 1,000 Customers | % |
| Experiment 1 | Email + Paper | 77 | 97 | -20 | -21% |
| | Email + Paper + Marketplace | 96 | 97 | -2 | -2% |
| | Email + Marketplace | 97 | 97 | -1 | -1% |
| | Marketplace | 107 | 97 | 9 | 9% |
| Experiment 2 | Paper | 68 | 72 | -4 | -6% |

Note: Values in table are rounded for reporting purposes.

**Savings Uplift**

Cadmus estimated savings uplift by comparing the average per-customer savings achieved in other energy efficiency programs between treatment and control customers. Similar to participation uplift, positive uplift indicates that treatment customers saved more, on average, from participating in other energy efficiency programs than did control customers. Because of the RCT program design, we can conclude that the Residential Behavior Change program induced customers to save more in DP&L's other energy efficiency programs.

For each of DP&L's residential energy efficiency programs, Table 42 shows the differences in average treatment and control customer cross-participant savings and the resulting uplift savings that Cadmus deducted from the program. Savings uplift does not appear aligned with participation uplift rates—participation uplift captured the differences in treatment and control customer participation in 2020 energy efficiency programs, while uplift savings incorporated measures installed in 2019 that achieved some of their first-year savings in 2020. These results suggest that treatment customers more often participated in and generated more savings from the 2019 energy efficiency programs than control customers, even though treatment customers participated in 2020 energy efficiency programs less often than control customers.

Waves in Experiment 1 that received electronic HERs and Marketplace promotional emails achieved the largest savings uplift per customer. Customers in the Paper Only and Email + Paper waves achieved near-0 kWh uplift savings (3% and 0% respectively)—these waves also saw the largest decreases in 2020 participation uplift compared to their respective control group customers. Marketplace customers continued generating positive uplift savings despite not generating any detectable savings from the Energy Insights reports.

Overall, 10% of savings evaluated for the Residential Behavior Change program were attributable to the program and DP&L's other energy efficiency programs, and 818,754 kWh were already counted in other programs in the residential portfolio. Cadmus removed uplift savings from the residential portfolio to avoid penalizing the Behavior Change program since it and the other energy efficiency programs induced these savings.

**Table 42. Behavior Change Program Electricity Energy Savings from Program Uplift**

| Treatment Wave | Average kWh Savings from Cross-Participation per Customer | | Average kWh Uplift Savings per Treatment Customer | Total Uplift Savings[a] | |
|---|---|---|---|---|---|
| | Treatment | Control | | kWh | Percentage of Behavior Change Program Savings |
| Email + Paper | 52.20 | 51.88 | 0.31 | 3,753 | 0% |
| Email + Paper + Marketplace | 62.24 | 51.88 | 10.35 | 247,097 | 13% |
| Email + Marketplace | 60.12 | 51.88 | 8.24 | 375,112 | 31% |
| Marketplace | 59.66 | 51.88 | 7.78 | 92,569 | -63% |
| Paper | 58.77 | 55.48 | 3.30 | 100,224 | 3% |
| **Total** | | | | **818,754** | **10%** |

Note: Values in table are rounded for reporting purposes. Percentages do not add up to 100% since the individual percentages reflect savings by channel and the total percentage reflect savings for the program overall.

[a] Cadmus calculated savings uplift across all 12 program months to align with the *ex ante* saving for cost-effectiveness purposes. The Behavior Change program generated savings uplift of 667,320 kWh between January and September, 2020, and align with the ex post results that cover the same portion of the 2020 program.

Table 43 shows the demand savings uplift achieved by each wave of treatment. Cadmus only included measures installed before September 30, 2020, in the demand savings uplift analysis. Overall, demand savings uplift account for just under 5% of the Residential Behavior Change program's overall demand savings.

**Table 43. Behavior Change Program Electricity Demand Savings from Program Uplift**

| Treatment Wave | Average kW Savings from Cross-Participation per Customer | | Average kW Uplift Savings per Treatment Customer | Total Uplift Savings | |
|---|---|---|---|---|---|
| | Treatment | Control | | kW | Percentage of Behavior Change Program Savings |
| Email + Paper | 0.0089 | 0.0089 | 0.0001 | 0.60 | 0% |
| Email + Paper + Marketplace | 0.0095 | 0.0089 | 0.0007 | 15.86 | 5% |
| Email + Marketplace | 0.0093 | 0.0089 | 0.0005 | 21.11 | 10% |
| Marketplace[a] | 0.0087 | 0.0089 | 0.0000 | 0.00 | 0% |
| Paper | 0.0107 | 0.0098 | 0.0009 | 27.92 | 4% |
| **Total** | | | | **65.49** | **4.54%** |

Note: Total values in table are rounded for reporting purposes. Percentages do not add up to 100% since the individual percentages reflect savings by channel and the total percentage reflect savings for the program overall.

[a] Cadmus evaluated negative uplift for this wave. Negative savings uplift indicates that control customers saved more from cross-participation in other programs than treatment customers, on average, and therefore savings are not being double counted.

### *Recommendations*

Drawn from the preceding findings, Cadmus offers one recommendation for the Residential Behavior Change program if DP&L resumes the program:

- **Monitor savings for each wave.** Energy savings from behavior programs such as DP&L's are typically lowest in the first year of the program and tend to ramp up and plateau in the second and third years of delivery. However, DP&L's program continues to save very little and has only ramped up marginally in the last 12 months of treatment. Uplight took several steps in 2020 to increase customer engagement with the reports, and thereby increase energy savings; however, these types of changes often take more than six months to have a measurable impact on program savings. Should the program be reinstated, Cadmus recommends that DP&L monitor the program savings on a quarterly basis.

# Residential Multi-Family Direct Install Program

This chapter describes Cadmus' approach for evaluating the Multi-Family Direct Install (MFDI) program, along with detailed findings and recommendations. The MFDI program provides targeted energy efficiency measures to multifamily households via walk-through audits, direct installation of energy saving measures, and assistance with the adoption of additional measures. Due to the COVID-19 pandemic, the program ended in February 2020 and was not reinstated.

## *Program Description*

The MFDI program provided free energy-saving measures to multifamily properties. Implementer staff installed the measures at no cost to the property owner or tenants. Only individually metered properties with four or more units were eligible to participate in the program. CLEAResult implemented the program.

There are several measures offered through the program:

- 9-watt general service (A19) LED light bulbs
- Smart strips
- Low-flow showerheads
- 4.5-watt globe (G25) LED light bulbs
- Kitchen faucet aerator
- Bathroom faucet aerator
- DP&L-branded LED nightlights

## *Program Summary Savings*

The program achieved 288,111 kWh and 30.4 kW in *ex ante* energy savings and demand reduction, respectively, falling short of its 3,451,209 kWh energy savings and 712.0 kW demand reduction goals. The 2020 MFDI program ended early in March 2020 due to the COVID-19 pandemic and was not reinstated. The program installed 7,304 total measures at 580 unique sites. Adjusted gross savings represent realization rates of 102% and 103% against *ex ante* energy savings and demand reduction, respectively. Table 44 lists *ex ante*, verified gross, and adjusted gross energy savings (kWh) and demand reduction (kW).

**Table 44. Residential Multi-Family Direct Install Program Claimed and Achieved Energy Savings**

| Measure | *Ex Ante* Claimed | | Verified Gross | | Adjusted Gross | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision |
| 9-watt A19 LED | 167,809 | 20.1 | 167,809 | 20.1 | 171,173 | 19.1 | ±14.2% |
| Smart strip | 56,055 | 5.5 | 56,055 | 5.5 | 50,778 | 5.9 | ±12.2% |
| Low-flow showerhead | 23,585 | 0.2 | 23,585 | 0.2 | 25,435 | 1.7 | ±16.5% |
| 4.5-watt G25 LED | 19,220 | 2.3 | 19,220 | 2.3 | 21,997 | 2.4 | ±14.2% |
| Kitchen faucet aerator | 4,230 | 0.3 | 4,230 | 0.3 | 16,619 | 0.9 | ±35.4% |
| Bathroom faucet aerator | 4,992 | 2.1 | 4,992 | 2.1 | 6,756 | 1.4 | ±19.3% |
| LED nightlight | 12,221 | 0.0 | 12,221 | 0.0 | 2,210 | 0.0 | ±10.6% |
| **Total** | **288,111** | **30.4** | **288,111** | **30.4** | **294,967** | **31.4** | **±8.0%** |

Note: Total values in table are rounded for reporting purposes.

Cadmus reviewed program tracking data and confirmed there were no major inconsistencies.

To calculate 2020 adjusted gross savings, Cadmus multiplied 2020 *ex ante* values by the average of 2018 and 2019 program year realization rates weighted by the number of units installed each program year.[23]

## *Recommendations*

- Cadmus offers no recommendations for the MFDI program.

[23] Dayton Power and Light. May 15, 2019. *2018 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 19-0775-EL-POR. http://dis.puc.state.oh.us
Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report*. Case No. 20-0916-EL-POR. http://dis.puc.state.oh.us

# Small Business Direct Install Program

This chapter describes the approach Cadmus used to evaluate the Small Business Direct Install (SBDI) program, along with detailed findings and recommendations. DP&L introduced the SBDI program in 2018 to provide targeted energy efficiency measures to small businesses (nonresidential customers with monthly electrical demand under 200 kW) at no cost to participants. The program stopped scheduling installations on September 30, 2020.

## *Program Description*

The SBDI program was designed to overcome the up-front cost barriers that small businesses face to installing energy-efficient equipment. Eligible businesses included schools, restaurants, hair salons, shopping centers, and churches. Through the program, DP&L provided, and CLEAResult implementation staff installed, complimentary energy-saving measures to nonresidential customers with monthly electric demand under 200 kW. Measures included LED lighting, LED exit signs, faucet aerators, occupancy sensors, low-flow showerheads, pre-rinse sprayers, and water heater pipe insulation. CLEAResult suspended program operations March 16 due to the COVID-19 pandemic and resumed operations June 5. Once operations resumed in June, CLEAResult added a second installation team.

## *Evaluation Overview*

To evaluate the 2020 SBDI program, Cadmus followed the researchable questions and evaluation activities outlined in Table 45.

**Table 45. Small Business Direct Install Program Key Researchable Questions**

| Researchable Question | Activity Used to Address Question |
|---|---|
| What are the program's gross electric savings and peak demand reductions? | • Engineering analysis<br>• Program database review |
| Is this program cost-effective? | • Cost-effectiveness analysis |

## *Detailed Evaluation Findings*

The 2020 SBDI program did not meet its 5,000,000 kWh energy savings goal and 1,250.0 kW demand reduction goal, only achieving 3,043,536 kWh and 676.2 kW in *ex ante* savings. Customers installed 39,146 measures at 160 participant sites, 78 fewer sites than planned due to the COVID-19 pandemic and the early program end date. Based on verified gross savings, the program achieved realization rates of 100% for both *ex ante* energy savings and demand reduction. Table 46 presents *ex ante*, verified gross, and adjusted gross energy savings and demand reduction.

**Table 46. Small Business Direct Install Program Claimed and Achieved Energy Savings**

| Measure | *Ex Ante* Claimed | | Verified Gross | | Adjusted Gross | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision |
| 2-Foot LED T8 Replacements | 910 | 0.2 | 910 | 0.2 | 881 | 0.2 | ±14.2% |
| 4-Foot LED T8 Replacements | 2,347,942 | 530.3 | 2,347,942 | 530.3 | 2,253,153 | 510.3 | ±14.2% |
| LED A-Line Lamps 9-watt | 297,815 | 70.2 | 297,815 | 70.2 | 283,627 | 66.9 | ±14.2% |
| LED BR30 Lamps 10-watt | 143,485 | 34.5 | 143,485 | 34.5 | 147,069 | 35.4 | ±14.2% |
| LED PAR30 Lamps 10-watt | 4,069 | 0.9 | 4,069 | 0.9 | 3,707 | 0.8 | ±14.2% |
| LED PAR38 Lamps 17-watt | 26,753 | 6.2 | 26,753 | 6.2 | 26,859 | 6.2 | ±14.2% |
| LED Exit Signs | 1,376 | 0.2 | 1,376 | 0.2 | 1,467 | 0.2 | ±14.2% |
| Faucet Aerator 1.5 gpm | 145,854 | 32.7 | 145,854 | 32.7 | 54,108 | 15.4 | ±11.3% |
| Occupancy Sensors (0 to 499-watt controlled) | 11,555 | 0.7 | 11,555 | 0.7 | 13,377 | 0.6 | ±17.4% |
| Pre-Rinse Spray Valve (Electric Domestic Hot Water) | 62,716 | 0.0 | 62,716 | 0.0 | 73,175 | 0.0 | ±14.2% |
| Showerhead | 436 | 0.2 | 436 | 0.2 | 372 | 0.2 | ±14.9% |
| Water Heater Pipe Insulation (Electric Domestic Hot Water) | 626 | 0.1 | 626 | 0.1 | 584 | 0.1 | ±10.0% |
| **Total** | **3,043,536** | **676.2** | **3,043,536** | **676.2** | **2,858,379** | **636.3** | **±14.4%** |

Note: Total values in table are rounded for reporting purposes.

Cadmus identified 134 unique participants,[24] 142 unique combinations of participants and building types (six participants enrolled multiple sites, some with different building types), and 160 total individual sites. Table 47 shows the breakdown of participants by building type.

**Table 47. Small Business Direct Install Program Breakdown of Participants by Building Type**

| Building Type | Count |
|---|---|
| Auto Repair | 7 |
| Fast Food Restaurant | 2 |
| Food Service | 6 |
| Health Care | 7 |
| Industrial - 1 Shift | 1 |
| Office | 21 |
| Other | 21 |
| Public Assembly | 32 |
| Public Services (non-food) | 1 |
| Retail | 39 |
| School | 2 |
| Warehouse | 3 |
| **Total** | **142** |

[24] As measured by unique combinations of contact names and phone numbers.

## Evaluation Data Collection Methods

To evaluate the SBDI program, Cadmus reviewed the program database and conducted an engineering analysis. Each of these activities is described in more detail below.

### Program Database Review

Cadmus reviewed the final 2020 tracking database for input, accuracy, and completeness of the data tracked. We also determined whether the database contained the data necessary to calculate collected savings and whether the reported savings estimates matched the measure types.

### Engineering Analysis

Cadmus used the methodologies and inputs prescribed by the Ohio TRM to calculate verified savings and adjusted gross savings for SBDI measures. Because the Ohio TRM only provides methodologies and inputs for water-saving measures in residential applications, we used nonresidential algorithms for water-saving measures (showerheads and faucet aerators) described in the Illinois TRM v8.0.

## Impact Evaluation Methodology and Findings

Cadmus reviewed the program database in 2020 to summarize the *ex ante* energy savings and demand reduction. The tracking database provided by CLEAResult included a list of all measure installations with quantities and reported savings, as well as site information needed to calculate savings for each measure. Lighting measures also included additional information for baseline and efficient measure lighting type. Cadmus determined that all required inputs for savings calculations were present. The SBDI program required customers to have an electric hot water systems before installing any water-saving measures; therefore, Cadmus assumed electric hot water saturation of 100% in its calculations.

Calculation methodologies for each measure type are described below.

### LEDs

Cadmus used two equations defined in the Ohio TRM to calculate adjusted gross energy savings (ΔkWh) and demand reduction (ΔkW) for LEDs:

$$\Delta kWh = \frac{(W_{baseline} - W_{efficient}) * ISR * HOURS * WHF_e}{1{,}000}$$

$$\Delta kW = \frac{(W_{baseline} - W_{efficient}) * ISR * WHF_d * CF}{1{,}000}$$

Table 48 shows the efficient wattage ($W_{efficient}$) and baseline wattage ($W_{baseline}$) used in savings calculations for each lighting measure. Baseline wattages for screw-in bulbs are based on the lumens equivalence approach described in the UMP[25] based on federal efficiency requirements by bulb type

[25] U.S. Department of Energy. February 2015. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. "Chapter 21: Residential Lighting Evaluation Protocol." https://energy.gov/sites/prod/files/2015/02/f19/UMPChapter21-residential-lighting-evaluation-protocol.pdf

and lumen output. Baseline wattages for linear LED T8 replacement measures are based on the most common wattages found for fluorescent and LED T8 bulbs of that length. All efficient wattages were provided to Cadmus by DP&L staff via CLEAResult and differ from the wattage ratings specified in the measure names found in the program's tracking data.

**Table 48. Small Business Direct Install Program LED Baseline and Efficient Wattages**

| Measure | Baseline wattage ($W_{baseline}$) | Efficient wattage ($W_{efficient}$) |
|---|---|---|
| 2-Foot LED T8 Replacement | 17.0 | 9.0 |
| 4-Foot LED T8 Replacement | 32.0 | 15.0 |
| LED A-Line Lamp 9-watt | 43.0 | 9.5 |
| LED BR30 Lamp 10-watt | 53.0 | 8.0 |
| LED PAR30 Lamp 10-watt | 53.0 | 13.0 |
| LED PAR38 Lamp 17-watt | 72.0 | 15.0 |

Table 49 shows the remaining inputs and assumptions for LED savings calculations based on building type, per the Ohio TRM. Cadmus used an ISR of 97% based on 2019 participant survey results. For all building types, Cadmus applied waste heat factors for energy ($WHF_e$) of 1.095 and for demand ($WHF_d$) of 1.200. LEDs yielded total energy savings of 2,715,296 kWh and demand reduction of 619.9 kW, resulting in adjusted realization rates of 96% and 97%, respectively.

**Table 49. Small Business Direct Install Program LED Savings Inputs by Building Type**

| Building Type | Annual Hours of Use (*HOU*) | Coincidence Factor (*CF*) |
|---|---|---|
| Auto Repair | 3,672 | 0.65 |
| Fast Food Restaurant | 3,672 | 0.83 |
| Food Service | 4,482 | 0.83 |
| Health Care | 3,677 | 0.78 |
| Industrial - 1 Shift | 2,857 | 0.76 |
| Office | 3,526 | 0.76 |
| Other | 3,672 | 0.65 |
| Public Assembly | 2,729 | 0.65 |
| Public Services (non-food) | 3,425 | 0.64 |
| Retail | 4,226 | 0.84 |
| School | 2,302 | 0.50 |
| Warehouse | 3,464 | 0.79 |

## LED Exit Signs

Cadmus used two equations defined in the Ohio TRM to calculate adjusted gross energy savings and demand reduction for LED exit signs:

$$\Delta kWh = \frac{(W_{baseline} - W_{efficient})}{1{,}000} * ISR * HOU * WHF_e$$

$$\Delta kWh = \frac{(W_{baseline} - W_{efficient})}{1{,}000} * ISR * WHF_d$$

Table 50 lists the inputs and assumptions used to calculate adjusted gross savings LED exit signs. Most lighting measures typically include a coincidence factor. However, because exit signs remain on continuously, a coincidence factor is not needed. LED exit signs yielded total energy savings of 1,467 kWh and demand reduction of 0.2 kW, resulting in adjusted realization rates of 107% and 102%, respectively. Realization rates exceed 100% slightly because *ex ante* savings assume an efficient wattage ($W_{efficient}$) of 2.0 watts (W).

**Table 50. Small Business Direct Install Program LED Exit Signs Savings Algorithm Inputs**

| Input | Description | Value |
|---|---|---|
| $W_{baseline}$ | Baseline wattage | 11.0 |
| $W_{efficient}$ | Efficient wattage | 1.7 |
| HOU | Annual hours of use | 8,766 |
| ISR | In-service rate | 98% |
| $WHF_e$ | Waste heat factor for energy | 1.08 |
| $WHF_d$ | Waste heat factor for demand | 1.17 |

## Kitchen Faucet Aerators

Cadmus used two equations (as defined in the Illinois TRM) to calculate adjusted gross energy savings (ΔkWh) and demand reduction (ΔkW) for kitchen faucet aerators:

$$\Delta kWh = \frac{(gpm_{base} - gpm_{low})}{gpm_{base}} * Usage * \frac{8.33 * (WaterTemp - SupplyTemp)}{RE * 3{,}412} * ISR$$

$$\Delta kW = \frac{\Delta kWh}{Hours} * CF$$

Table 51 lists the inputs and assumptions used to calculate adjusted gross savings for kitchen faucet aerators. Based on 2019 participant survey data, Cadmus applied an ISR of 83%. Kitchen faucet aerators yielded total energy savings of 54,108 kWh and demand reduction of 15.4 kW, resulting in adjusted realization rates of 37% and 47%, respectively. Discrepancies between *ex ante* and adjusted gross savings are attributable to differences in the savings algorithms. Rather than using the savings algorithm documented in the program's TRG for faucet aerators (which Cadmus used for adjusted gross savings), CLEAResult used the following algorithm and did not document the units represented in the algorithm:

$$\Delta kWh = Usage * 0.94 * 0.08455$$

**Table 51. Small Business Direct Install Program Kitchen Faucet Aerator Savings Algorithm Inputs**

| Input | Description | Value |
|---|---|---|
| $gpm_{base}$ | Baseline flow rate (gallons per minute) | 2.5 |
| $gpm_{low}$ | Efficient flow rate (gallons per minute) | 1.5 |
| Usage | Annual water use per faucet (gallons) | Depends on building type (Table 52) |
| 8.33 | Pounds (lb) per gallon of water | 8.33 |
| WaterTemp | Water temperature at point of use (°F) | Health care: 110<br>Other: 91 |
| SupplyTemp | Water main temperature upon entering building (°F) | 57.5 |
| RE | Water heater recovery efficiency | 0.98 |
| 3,412 | Btu per kWh | 3,412 |
| ISR | In-service rate | 83% |
| Hours | Annual electric DHW recovery hours for faucet use | Depends on building type (Table 52) |
| CF | Summer peak coincidence factor | Depends on building type (Table 52) |

Table 52 further describes inputs and assumptions for annual number of gallons used per faucet (Usage), annual electric domestic hot water recovery hours for faucet use (Hours), and coincidence factor (CF), all of which have unique values by building type.

**Table 52. Small Business Direct Install Program Faucet Aerator Savings Inputs by Building Type**

| Building Type | Usage | Hours | CF |
|---|---|---|---|
| Auto Repair | 5,000 | 36 | 0.0128 |
| Fast Food Restaurant | 9,581 | 69 | 0.0084 |
| Food Service | 9,581 | 69 | 0.0184 |
| Health Care | 16,425 | 187 | 0.0144 |
| Office | 2,500 | 18 | 0.0064 |
| Other | 5,000 | 36 | 0.0128 |
| Public Assembly | 11,250 | 82 | 0.0128 |
| Retail | 3,650 | 26 | 0.0043 |
| School | 9,000 | 65 | 0.0192 |
| Warehouse | 2,500 | 18 | 0.0064 |

## Occupancy Sensors

Cadmus used two equations defined in the Ohio TRM to calculate adjusted gross energy savings and demand reduction for occupancy sensors:

$$\Delta kWh = kW_{Controlled} * HOU * WHF_e * ESF$$

$$\Delta kW = kW_{Controlled} * WHF_d * ESF * CF$$

Table 53 lists the inputs and assumptions used to calculate adjusted gross savings for occupancy sensors. Since all occupancy sensors were installed by the implementer, Cadmus applied an ISR of 100%. Occupancy sensors yielded total energy savings of 13,377 kWh and demand reduction of 0.6 kW, resulting in adjusted realization rates of 116% and 96%, respectively. Discrepancies between *ex ante* and adjusted gross savings can be attributed to slight differences in waste heat factor and effective saving factor assumptions.

**Table 53. Small Business Direct Install Program Occupancy Sensors Savings Algorithm Inputs**

| Input | Description | Value |
|---|---|---|
| $kW_{Controlled}$ | Kilowatts controlled by occupancy sensors | 0.25 |
| HOU | Annual hours of use | Based on building type (Table 49) |
| $WHF_e$ | Waste heat factor for energy | 1.095 |
| $WHF_d$ | Waste heat factor for demand | 1.200 |
| ESF | Effective saving factor | 30% |
| CF | Summer peak coincidence factor | 0.15 |

## Pre-Rinse Spray Valves

Cadmus used the equation defined in the Ohio TRM to calculate adjusted gross energy savings for pre-rinse spray valves:

$$\Delta kWh = (gpm_{base} - gpm_{low}) * 60 * HOU_{day} * 365.25 * HOT_{\%} * 8.33 * \Delta T * \frac{1}{RE * 3{,}412}$$

There is no demand reduction for pre-rinse spray valves as hours of operation do not coincide with the Ohio TRM's definition of peak hours.

Table 54 lists the inputs and assumptions used to calculate adjusted gross savings for pre-rinse spray valves. Since all pre-rinse spray valves were installed by the implementer, Cadmus applied an ISR of 100%. Pre-rinse spray valves yielded total energy savings of 73,175 kWh, resulting in an adjusted realization rate of 117%. The discrepancy between *ex ante* and adjusted gross savings can be attributed to two differences in input values: daily hours of use ($HOU_{day}$) in retail applications (the tracking data assigned a value of four hours, whereas the Ohio TRM specifies two hours for non-food service facilities), and efficient flow rate ($gpm_{low}$) (*ex ante* savings assume an efficient flow rate of 1.5 gpm).

**Table 54. Small Business Direct Install Program Pre-Rinse Spray Valves Savings Algorithm Inputs**

| Input | Description | Value |
|---|---|---|
| $gpm_{base}$ | Baseline flow rate (gallons per minute) | 3.00 |
| $gpm_{low}$ | Efficient flow rate (gallons per minute) | 1.15 |
| 60 | Minutes per hour | 60 |
| $HOU_{day}$ | Daily hours of use | Full Service Restaurant: 4<br>Fast Food Restaurant: 1<br>Other: 2 |
| 365.25 | Annual days of use | 365.25 |
| $HOT_{\%}$ | Percentage of water used that is heated | 69% |
| 8.33 | Pounds (lb) per gallon of water | 8.33 |
| ΔT | Temperature rise through water heater (°F) | 70 |
| RE | Water heater recovery efficiency | 0.98 |
| 3,412 | Btu per kWh | 3,412 |

### Showerheads

Cadmus used two equations defined in the Illinois TRM to calculate adjusted gross energy savings and demand reduction for showerheads:

$$\Delta kWh = (gpm_{base} - gpm_{low}) * L * NSPD * 365.25 * \frac{8.33 * (WaterTemp - SupplyTemp)}{RE * 3{,}412} * ISR$$

$$\Delta kW = \frac{\Delta kWh}{HOU} * CF$$

Table 55 lists the inputs and assumptions used to calculate adjusted gross savings for showerheads. Showerheads yielded total energy savings of 372 kWh and demand reduction of 0.2 kW, resulting in adjusted realization rates of 85% and 95%, respectively. The discrepancy between *ex ante* and adjusted gross savings can be attributed to Cadmus' use of different water temperature assumptions based on Ohio weather data and a 2012 Cadmus water metering study.

**Table 55. Small Business Direct Install Program Showerhead Savings Algorithm Inputs**

| Input | Description | Value |
|---|---|---|
| $gpm_{base}$ | Baseline flow rate (gallons per minute) | 2.67 |
| $gpm_{low}$ | Efficient flow rate (gallons per minute) | 1.50 |
| L | Length of shower (minutes) | 8.2 |
| NSPD | Daily number of showers per showerhead | 0.25 |
| 365.25 | Annual days of use | 365.25 |
| 8.33 | Pounds (lb) per gallon of water | 8.33 |
| WaterTemp | Water temperature at point of use (°F) | 101.0 |
| SupplyTemp | Water main temperature upon entering building (°F) | 57.5 |
| RE | Water heater recovery efficiency | 0.98 |
| 3,412 | Btu per kWh | 3,412 |
| ISR | In-service rate | 98% |
| HOU | Annual electric DHW recovery hours | 50.6 |
| CF | Summer peak coincidence factor | 0.0278 |

### Pipe Insulation

Cadmus used two equations defined in the Ohio TRM to calculate adjusted gross energy savings and demand reduction for water heater pipe insulation:

$$\Delta kWh = \left(\frac{1}{R_{exist}} - \frac{1}{R_{new}}\right) * \frac{L * C * \Delta T * HOU}{RE * 3{,}412}$$

$$\Delta kW = \frac{\Delta kWh}{HOU}$$

Table 56 lists the inputs and assumptions used to calculate adjusted gross savings for pipe insulation. Since all pipe insulation was installed by the implementer, Cadmus applied an ISR of 100%. Pipe insulation yielded total energy savings of 584 kWh and demand reduction of 0.1 kW, resulting in adjusted realization rates of 93% and 95%, respectively. Discrepancies between *ex ante* and adjusted gross savings can be attributed primarily to differences in assumed efficient R values of insulated pipe (*ex ante* savings assumed a more-efficient R value of 3.0, while CLEAResult program documentation shows a less-efficient R value of 2.4).

**Table 56. Small Business Direct Install Program Pipe Insulation Savings Algorithm Inputs**

| Input | Description | Value |
|---|---|---|
| $R_{exist}$ | Baseline R value of existing pipe | 1.0 |
| $R_{new}$ | Efficient R value of insulated pipe | 2.4 |
| L | Length of pipe wrapped (feet) | 6.0 |
| C | Circumference of ¾" pipe (feet) | 0.196 |
| ΔT | Average difference between supplied water and outside air temperature (°F) | 65 |
| HOU | Annual hours of use | 8,766 |
| RE | Water heater recovery efficiency | 0.98 |
| 3,412 | Btu per kWh | 3,412 |

## *Recommendations*

Cadmus offers one recommendation for a similar SBDI program in the future.

- **Calculate *ex ante* savings for faucet aerators using the Ohio TRM.** CLEAResult used an abbreviated algorithm not included in any available TRMs, which Cadmus used for adjusted gross savings. CLEAResult could not verify the source of the abbreviated algorithm, which made it difficult for Cadmus to discern why faucet aerators achieved a low realization rate.

# Nonresidential Prescriptive Rebate Program

This chapter describes Cadmus' evaluation approach, detailed findings, and conclusions and recommendations for the Nonresidential Prescriptive Rebate program. DP&L stopped accepting Nonresidential Prescriptive rebate applications after September 30, 2020.

## *Program Description*

The Nonresidential Prescriptive Rebate program offered customers rebates for four categories of measures: lighting, compressed air, HVAC, and motors. The total program savings are attributed to four distribution channels:

- Rapid Rebate measures offered through the Nonresidential Prescriptive Rebate program, implemented by internal DP&L staff
- Nonresidential Midstream Incentive Channel measures, implemented by CLEAResult
- Efficient Products and Residential Appliance Recycling program measures that impact nonresidential customers[26]

The following sections includes savings for all four channels, though details related to measures distributed through other program channels may be found in their respective report chapters.

## *Evaluation Overview*

To evaluate the 2020 Nonresidential Prescriptive Rebate program, Cadmus followed the researchable questions and evaluation activities outlined in Table 57.

**Table 57. Key Researchable Questions for Nonresidential Prescriptive Rebate Program**

| Researchable Question | Activity Used to Address Question |
|---|---|
| How do Ohio TRM deemed savings compare with validated program savings? | • Desk Review<br>• Engineering analysis<br>• Database review |
| What are the program's gross electric savings and demand reduction? | • Engineering analysis<br>• Database review<br>• Implementation staff interviews<br>• Customer interviews |
| Is the program cost-effective? | • Cost-effectiveness analysis |

## *Detailed Evaluation Findings*

DP&L exceeded its energy savings goal of 79,990,700 kWh, achieving 114,489,139 kWh in *ex ante* savings. The program also achieved its 12,148 kW demand reduction goal, with 18,695.3 kW in *ex ante* demand reduction. Cadmus calculated 112,357,989 kWh and 17,476.0 kW in verified gross savings.

[26] *Ex ante* savings include measures from nonresidential sites in the Nonresidential Prescriptive Rebate program (including the Midstream Incentive Channel) and the Appliance Recycling program. Adjust gross savings include those same measures as well as measures from nonresidential sites in the Efficient Products program.

Based on verified gross savings, the program achieved realization rates of 98% for energy savings and 93% for demand reduction.

Table 58 shows claimed and achieved program savings, followed by key impact evaluation findings.

**Table 58. Nonresidential Prescriptive Rebate Program Claimed and Achieved Energy Savings**

| Measure | *Ex Ante* Claimed Savings | | Verified Gross Savings | | Adjusted Gross Savings | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision[a] |
| Lighting Large | 13,046,393 | 1,521.9 | 13,046,392 | 1,624.4 | 13,046,392 | 1,624.4 | 0.0% |
| Lighting Medium | 18,274,522 | 3,124.8 | 18,190,658 | 3,237.7 | 18,190,658 | 3,237.7 | 0.2% |
| Lighting Small | 19,324,136 | 3,052.5 | 19,432,402 | 2,680.3 | 19,432,402 | 2,680.3 | 0.3% |
| Compressed Air | 1,890,774 | 132.7 | 1,847,150 | 120.0 | 1,847,150 | 129.0 | 1.5% |
| Motors | 636,041 | 173.6 | 918,032 | 146.9 | 918,032 | 146.9 | 24.1% |
| HVAC | 7,000,236 | 1,342.1 | 5,534,211 | 467.5 | 5,534,211 | 466.5 | 22.2% |
| Midstream Incentive Channel | 54,261,122 | 9,341.2 | 53,333,230 | 9,184 | 46,880,281 | 8,242 | 13.7% |
| Residential Efficient Products[b] | | | | | 6,740,741 | 1,585 | 16.0% |
| Appliance Recycling Program | 55,915 | 10.0 | 55,915 | 9 | 40,238 | 7 | 5.0% |
| **Total** | **114,489,139** | **18,695.3** | **112,357,989** | **17,476.2** | **112,630,105** | **18,117.0** | **2.0%** |

Note: Total values in table are rounded for reporting purposes.

[a] Precision at 90% confidence.

[b] This represents bulbs sold through the Residential Efficient Products program that were allocated to commercial use. For adjusted savings, Cadmus allocated 4.1% of Residential Efficient Products bulbs were allocated to commercial applications based on historical study of this program.

There are several notable findings from the evaluation:

- Lighting projects, accounting for 81% of all savings in the Rapid Rebate program, exhibited minimal variability in savings. Cadmus found the annual energy savings and demand reduction were calculated appropriately and the reported documentation accurately reflected the savings calculations.
- Variable Frequency Drive (VFD) measures for new construction projects greatly impacted realization rates for the HVAC strata. Two sampled projects involved the installation of VFDs on air handling units and pumping systems at new construction facilities. The permit drawings were dated after Ohio adopted the 2010 ASHRAE 90.1 energy code. The energy code requires variable volume control for hydronic and VAV fan systems with performance that matches VFDs. Because of this, the majority of the VFDs for these two projects were required by code and did not realize energy savings
- All measures sampled within the Motor strata consisted of VFDs serving HVAC and process applications. Cadmus evaluated VFD projects by collecting the project-specific motor efficiency and applying the ESF and DSF in the savings calculation based on the end-use application. The motor efficiency typically matched or varied slightly from DP&L’s assumed value. We identified the ESF and DSF as the primary determinants for differences between the reported and evaluated savings.

## *Impact Evaluation Methodology*

Cadmus implemented several steps to achieve the evaluation goals and research objectives. This section describes the activities and processes we used throughout the impact evaluation of the 2020 Rapid Rebate program. To determine gross savings, Cadmus applied the steps outlined in Table 59. A detailed explanation of each step follows.

**Table 59. Impact Steps to Determine Evaluated Gross Savings**

| Step | Action |
|---|---|
| 1 | **Tracking Database Review:** Validate the accuracy of data in the participant database |
| 2 | **Stratification and Sampling:** Develop strata from participant database and perform sampling |
| 3 | **EM&V Plan Development:** Review sample measure data and identify appropriate International Performance Measurement and Verification Protocol methodology to apply for each sampled measure |
| 4 | **EM&V Plan Implementation:** Review project documentation, interview implementation staff, interview customer staff, collect measure data remotely |
| 5 | **Analysis:** Validate reported savings using engineering calculations, model simulations, meter data, and other forms of analysis techniques |
| 6 | **Realization Rates:** Extrapolate realization rates to population and summarize findings |

**Step 1 Tracking Database Review.** Cadmus reviewed the program tracking database to verify the accuracy of the reported energy savings, participant counts, measure descriptions, and incentive dates. For any discrepancies found, Cadmus communicated with DP&L to review and update the participant database.

**Step 2.** Cadmus stratified the population from program database into six strata: Lighting-Large, Lighting-Medium, Lighting-Small, Compressed Air, Motors, and HVAC. Within each stratum, we designed a sample to achieve ±10% precision at the two-tailed 90% confidence level for the Rapid Rebate program. Cadmus selected the sampled projects and downloaded the project data directly from DP&L's online tracking database.

**Step 3.** Cadmus received and reviewed the sampled project documentation from DP&L to understand how savings were calculated, identify the site-specific variables that could be collected based on facility staff interviews, and develop the appropriate evaluation M&V plans. The M&V plans are based on methods established by the IPMVP.

**Step 4.** Cadmus reviewed project documentation and reviewed discrepancies or associated findings with DP&L's implementation team. In some cases, we interviewed sampled project facility staff to understand the operation, control strategy, and installation success of incentivized measures.

**Step 5.** Cadmus analyzed the reported project documentation and interview data, including site measurements, photos, and reports collected by DP&L's rebate verification team. We calculated evaluated energy savings utilizing the methodologies outlined within the Ohio TRM. For measures not identified in the Ohio TRM, Cadmus calculated evaluated energy savings based on custom engineering spreadsheet analysis, energy modeling, or a utility bill analysis if the energy savings from the sampled measure exceeded 10% of the total facility's electric energy consumption.

**Step 6.** Cadmus extrapolated the results from the sampled measures to each respective stratum population and identified trends and commonalities among the findings.

## Sampling and Extrapolation Methodology

Through the Rapid Rebate program, DP&L provided incentives for 49 measure types. Cadmus combined these 49 measure types into six strata, stratifying the lighting projects based on the total *ex ante* energy savings associated with each project:

- Lighting Large: *ex ante* energy savings were greater than or equaled 500,000 kWh
- Lighting Medium: *ex ante* energy savings greater than or equal to 100,000 kWh and less than 500,000 kWh
- Lighting Small: *ex ante* energy savings less than 100,000 kWh
- Compressed Air
- Motors
- HVAC

Cadmus designed the sampling plan to achieve approximately ±20% precision at 80% confidence per strata, and ±10% precision at 90% confidence at the program level. Table 60 shows total project counts and energy savings reported in DP&L's tracking database. Table 61 summarizes project sampling.

**Table 60. Nonresidential Prescriptive Rebate Program *Ex Ante* Savings and Demand Reduction**

| Strata | Total Measures | *Ex Ante* Energy Savings (kWh) | *Ex Ante* Demand Reduction (kW) | Unique Sampled Projects |
|---|---|---|---|---|
| Lighting Large | 163 | 13,046,393 | 1,521.9 | 7 |
| Lighting Medium | 497 | 18,274,522 | 3,124.8 | 13 |
| Lighting Small | 2,152 | 19,324,136 | 3,051.5 | 19 |
| Compressed Air | 39 | 1,890,774 | 131.7 | 12 |
| Motors | 21 | 636,041 | 172.6 | 7 |
| HVAC | 244 | 7,000,236 | 1,342.1 | 18 |
| **Total** | **3,116** | **60,172,102** | **9,344.6** | **76** |

Note: Total values in table are rounded for reporting purposes.

**Table 61. Nonresidential Prescriptive Rebate Program Sampled Projects Summary**

| Strata | Sampled Projects | Sampled Projects *Ex Ante* Energy Savings (kWh) | Sampled Energy Savings Percentage of Strata | Sampled Projects *Ex Ante* Demand Reduction (kW) | Demand Reduction Percentage of Strata |
|---|---|---|---|---|---|
| Lighting Large | 7 | 6,276,215 | 48% | 750.9 | 49% |
| Lighting Medium | 13 | 2,572,194 | 14% | 281.2 | 9% |
| Lighting Small | 19 | 535,053 | 3% | 117.9 | 4% |
| Compressed Air | 12 | 529,463 | 28% | 34.6 | 26% |
| Motors | 7 | 237,535 | 37% | 52.8 | 31% |
| HVAC | 18 | 3,925,555 | 56% | 551.6 | 41% |
| **Total** | **76** | **14,076,014** | **23%** | **1,789.0** | **19%** |

Note: Total values in table are rounded for reporting purposes.

## Measurement and Verification Plan Development

Cadmus reviewed all project documentation available from DP&L, including project applications, equipment invoices, reports published by DP&L's energy engineering consultants, and savings calculation spreadsheets. For each sampled project, we developed a M&V plan established by the IPMVP. A summary of IPMVP options follows, including our logic in assigning respective methods.

- **IPMVP Option A, Retrofit Isolation: Key Parameter Measurement.** IPMVP Option A involved the use of engineering calculations and partial site/device measurements (such as fixture wattages with lighting runtimes) to verify savings resulting from specific projects where equipment energy demand did not vary over time (such as non-dimming light bulbs).
- **IPMVP Option B, Retrofit Isolation: All Parameter Measurement.** IPMVP Option B involved the use of engineering calculations and time series true kilowatt measurements to verify savings resulting from the affected system's change in energy use.
- **IPMVP Option C, Whole Facility.** IPMVP Option C involved the use of whole-facility monthly or interval energy consumption data to evaluate savings when a given energy efficiency project represented a significant portion of a metered load. This approach was contingent upon sufficient available data, generally judged as a minimum of eight months pre- and post-install or outside air temperature data from the metered period that satisfied 90% of the entire range of outside air temperatures identified in typical meteorological year data sets for the measure installation location. Option C was limited to sites where savings were reported as at least 10% of total consumption on the affected meter.

## Site Verification Visits and Engineering Measurements

After selecting projects to evaluate based on the sampling plan, Cadmus downloaded project documentation from DP&L's administrative website. To prepare for each site visit, Cadmus reviewed documentation and other relevant program information focused on calculation procedures and energy savings estimate documentation. We also reviewed DP&L's tracking spreadsheet and online application data, comparing entries to original application materials for consistency and accuracy. While Cadmus intended to perform site visits and collect documentation based on the appropriate IPMVP evaluation strategy, the impacts of the COVID-19 pandemic prevented site visits throughout the program year. Instead, Cadmus reviewed the sample project documentation collected by DP&L, interviewed DP&L's implementation team, and interviewed customers if additional verification was needed.

## Engineering Analysis and Savings Verification

Cadmus analyzed data collected through interviews or by DP&L's implementation team and calculated savings based on the IPMVP option established through the M&V plan development process. When DP&L's implementation team collected trend data, we used a variety of approaches to analyze data, including bin analysis, regression analysis, utility bill analysis, energy modeling, and custom spreadsheet analysis. In the absence of trend data, we generally followed the savings calculation methodology outlined in the Ohio TRM. When sampled project types were not identified in the Ohio TRM, we utilized savings methodologies outlined from the most relevant and recently updated TRMs within the region. These TRMs include the following:

- 2018 Mid-Atlantic Technical Reference Manual Version 8[27]
- Wisconsin Focus on Energy 2019 Technical Reference Manual[28]

## Calculating Realization Rates

Cadmus determined program-level end-use savings and demand reductions through adjusted gross savings realization rates, calculated for each major measure strata ( lighting, compressed air, HVAC and motors), breaking the lighting strata into large, medium, and small projects. This method included several steps:

1. Calculate adjusted gross savings for the sample of evaluated projects.
2. Calculate a realization rate, based on *ex ante* and adjusted gross savings, for the total sample within each strata.
3. Apply sample realization rates to the program population for each measure strata to calculate total program verified and adjusted gross savings.
4. Apply adjusted gross savings realization rates, developed for each stratum, across that population subgroup. We hand-selected eight of the 73 sampled projects due to the magnitude of claimed savings relative to the associated strata. Because Cadmus selected those projects individually (not randomly), we did not apply the evaluated results and adjusted gross savings realization rates from those projects to the stratum population.
5. Include 4.1% in adjusted kilowatt-hour savings from the Residential Efficient Products program to the Nonresidential Prescriptive Rebate program.

## *Detailed Impact Gross Savings Results*

Table 62 and Table 63 summarize the verified and adjusted energy savings and demand reduction results, respectively, by strata for the samples projects. The total realization rate in the tables below are not weighted for the strata population and therefore are not representative of the program performance. Based on verified gross savings, the program achieved realization rates of 98% for energy savings and 93% for demand reduction. (The *Nonresidential Midstream Incentive Channel* chapter discusses program details in depth.)

27 Northeast Energy Efficiency Partnership. 2018. *Mid-Atlantic Technical Reference Manual Version 8.* https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V8_0.pdf

28 Public Service Commission of Wisconsin. 2017. *Wisconsin Focus on Energy 2017 Technical Reference Manual.* https://focusonenergy.com/sites/default/files/Focus%20on%20Energy%20TRM%20-%20PY2017_1%28Archive%29.pdf

**Table 62. Sample Gross *Ex Ante* and Adjusted Gross Energy Savings**

| Measure | Number of Projects | *Ex Ante* Gross Energy Savings (kWh) | Verified Energy Savings (kWh) | Adjusted Energy Savings (kWh) | Energy Savings Realization Rate (%) |
|---|---|---|---|---|---|
| Lighting Large | 7 | 6,276,215 | 6,276,214 | 6,276,214 | 100% |
| Lighting Medium | 13 | 2,572,194 | 2,560,390 | 2,560,390 | 100% |
| Lighting Small | 19 | 535,053 | 538,050 | 538,050 | 101% |
| Compressed Air | 12 | 529,463 | 520,194 | 520,194 | 98% |
| Motors | 7 | 237,535 | 272,467 | 272,467 | 115% |
| HVAC | 18 | 3,925,555 | 873,370 | 873,370 | 22% |
| **Total** | **76** | **14,076,014** | **11,040,685** | **11,040,685** | **78%** |

Note: Total values in table are rounded for reporting purposes.

**Table 63. Sample Gross *Ex Ante* and Adjusted Gross Demand Reduction**

| Measure | Number of Projects | *Ex Ante* Gross Demand Reduction (kW) | Verified Demand Reduction (kW) | Adjusted Demand Reduction (kW) | Demand Savings Realization Rate (%) |
|---|---|---|---|---|---|
| Lighting Large | 7 | 750.9 | 801.5 | 801.5 | 107% |
| Lighting Medium | 13 | 281.2 | 291.3 | 291.3 | 104% |
| Lighting Small | 19 | 117.9 | 103.5 | 103.5 | 88% |
| Compressed Air | 12 | 34.6 | 34.0 | 34.0 | 98% |
| Motors | 7 | 52.8 | 42.2 | 42.2 | 80% |
| HVAC | 18 | 551.6 | 90.1 | 90.1 | 16% |
| **Total** | **76** | **1,789.0** | **1,362.6** | **1,362.6** | **76%** |

Note: Total values in table are rounded for reporting purposes.

A summary of major differences between *ex ante* savings and adjusted savings by measure category follows.

## Lighting Savings

Figure 2 and Figure 3 show adjusted gross savings realization rates and associated *ex ante* energy savings and reduction, respectively, for each sampled lighting project.

**Figure 2. Prescriptive Lighting Energy Savings Sample Results**

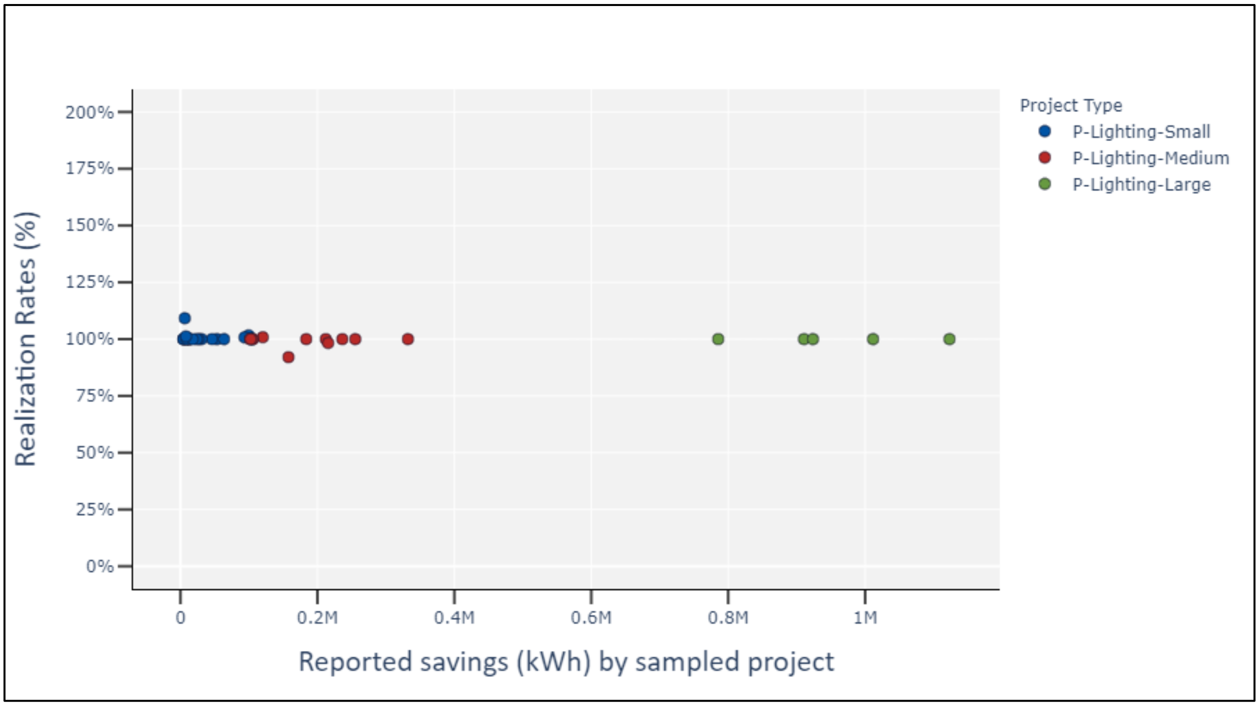
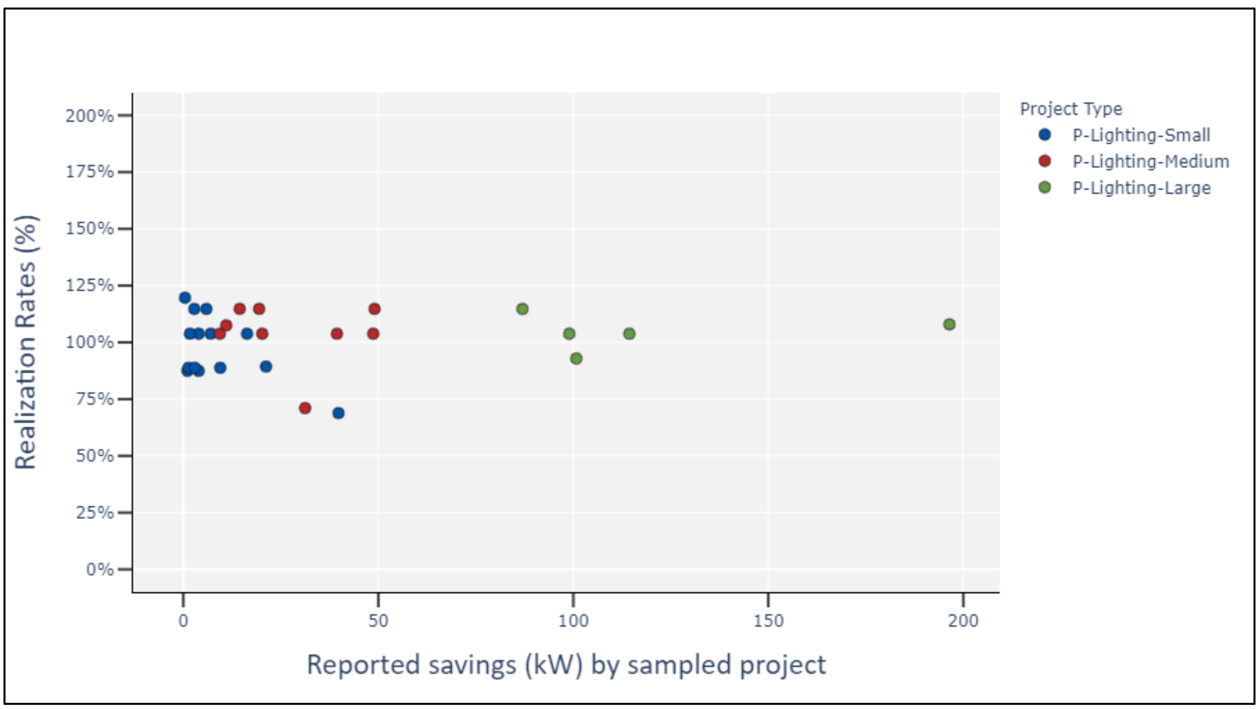



**Figure 3. Prescriptive Lighting Demand Reduction Sample Results**




Cadmus evaluated 39 lighting projects. For eight of the 39 lighting projects, Cadmus calculated lower or higher energy savings than reported. For 31 of the 39 lighting projects sampled, Cadmus calculated lower or higher demand reduction than reported. Due to the prescriptive nature of the program, deviations between deemed *ex ante* and evaluated results are expected. Annual electric energy savings realization rates did not deviate by more than 10% for any of the projects Cadmus sampled. Demand savings realization rates deviated by more than 10% for 17 of the 39 sampled projects.

Historically, the main differences between *ex ante* and adjusted energy savings were primarily due to differences in operating hours (based on light logger data). Cadmus was unable to perform site visits and install power metering equipment due to COVID-19. Instead, differences in fixture counts, fixture wattages, and the application of building-specific coincidence factors account for the bulk of discrepancies leading to variabilities in realization rates. In general, we found the annual energy savings were calculated appropriately. DP&L calculated demand reduction for all lighting projects using a coincidence factor of 0.732. Cadmus used building-specific coincidence factors from the Ohio TRM, which fell between 0.50 and 1.00 for various facility types. Overall, the coincidence factor of 0.732 used by DP&L appears to be an appropriate weighted average value across all building types in DP&L's program database as the evaluation yielded a 99% demand savings realization rate for the lighting population.

## Compressed Air

Cadmus evaluated 12 compressed air projects. All sampled projects involved rebated high-efficiency screw air compressors. Figure 4 and Figure 5 show realization rates and associated *ex ante* energy savings and demand reduction, respectively, for each sampled compressed air project.

**Figure 4. Prescriptive Compressed Air Energy Savings Sample Results**

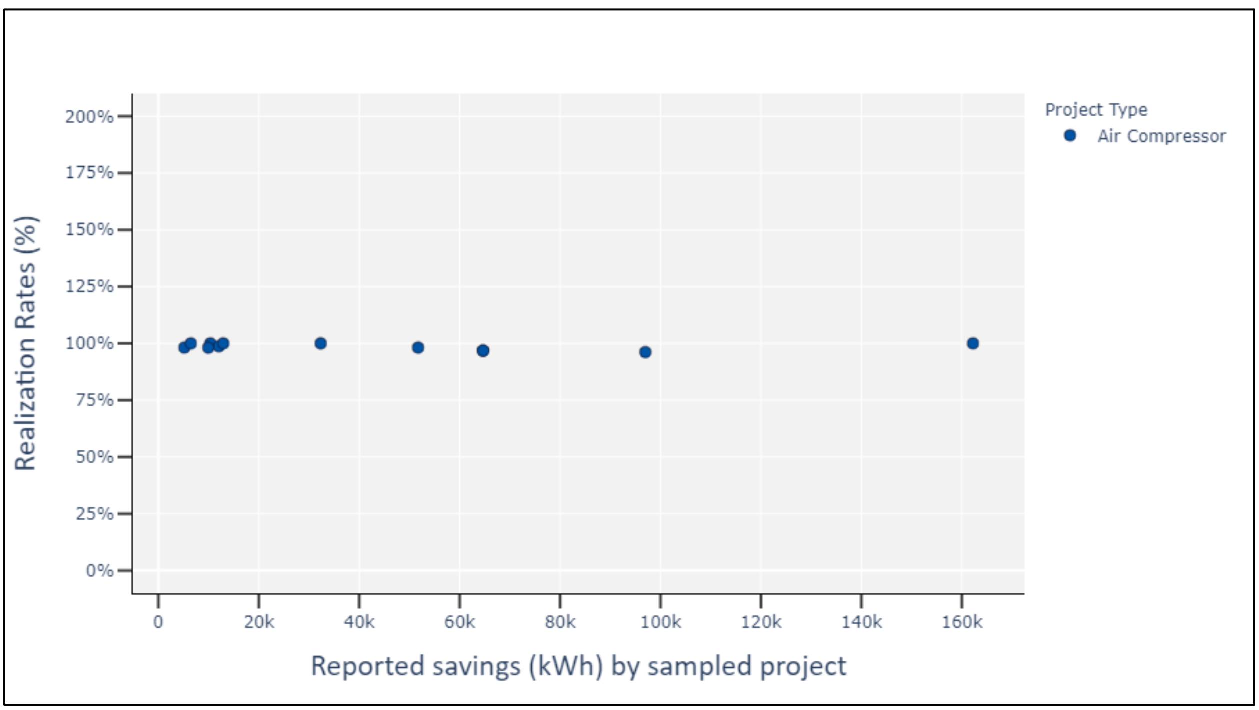
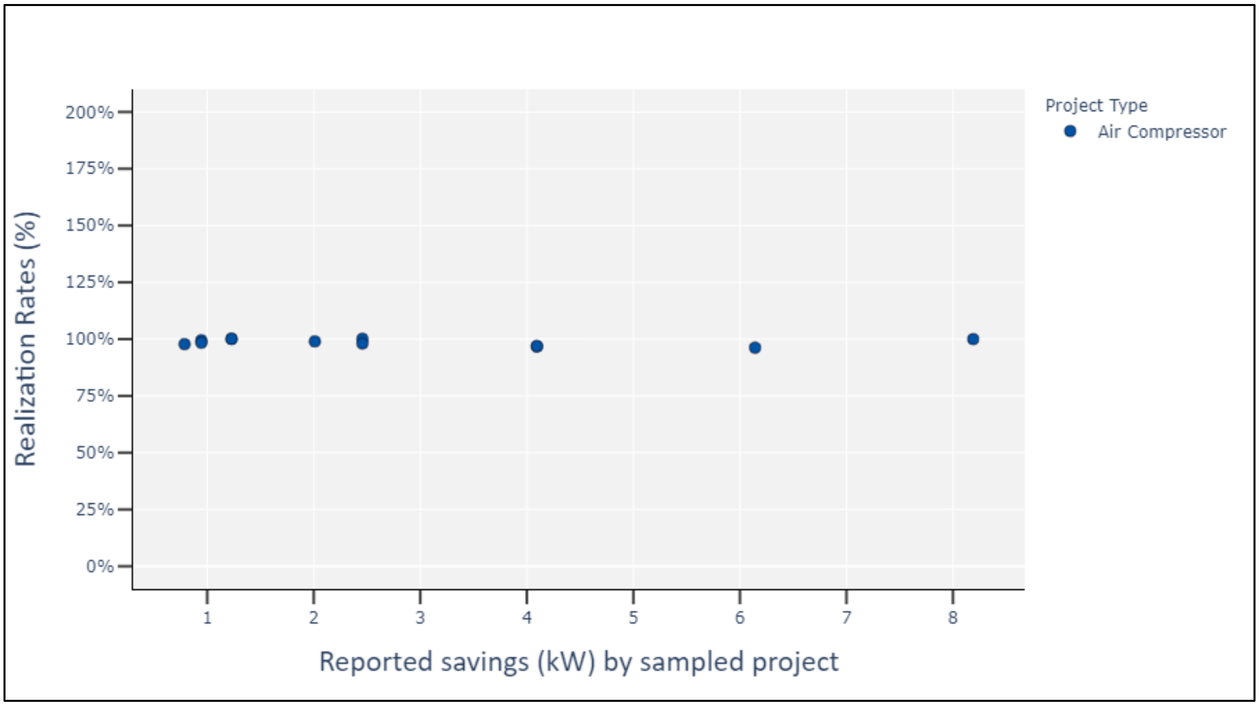


**Figure 5. Prescriptive Compressed Air Demand Reduction Sample Results**




Evaluated compressed air projects saved 98% of the reported energy savings on average. The main driver of differences between evaluated and reported savings were the inputs for motor efficiency. DP&L used an assumed motor efficiency of 90% for all projects, while Cadmus calculated savings based on the project-specific motor efficiency specified on the CAGI compressor data sheet. Otherwise, the reported savings calculation methodology appear to be appropriate and reported savings for annual energy savings and demand savings closely match the evaluated savings.

## HVAC Savings

Cadmus evaluated 18 HVAC projects including air conditioning units, heat pumps, window film, VFDs, smart thermostats, variable refrigerant systems, and chillers. Figure 6 and Figure 7 show adjusted gross savings realization rates and associated *ex ante* energy savings and demand reduction, respectively, for each sampled HVAC project.

**Figure 6. Prescriptive HVAC Energy Savings Sample Results**

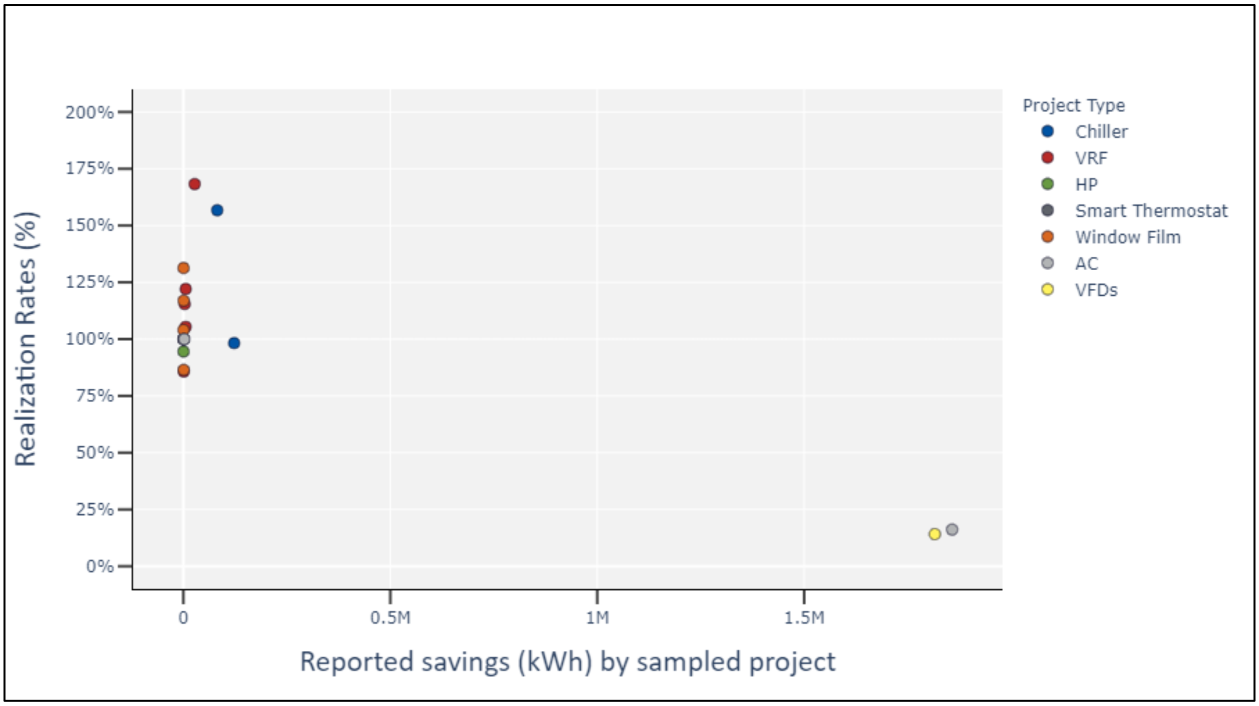



**Figure 7. Prescriptive HVAC Demand Reduction Sample Results**

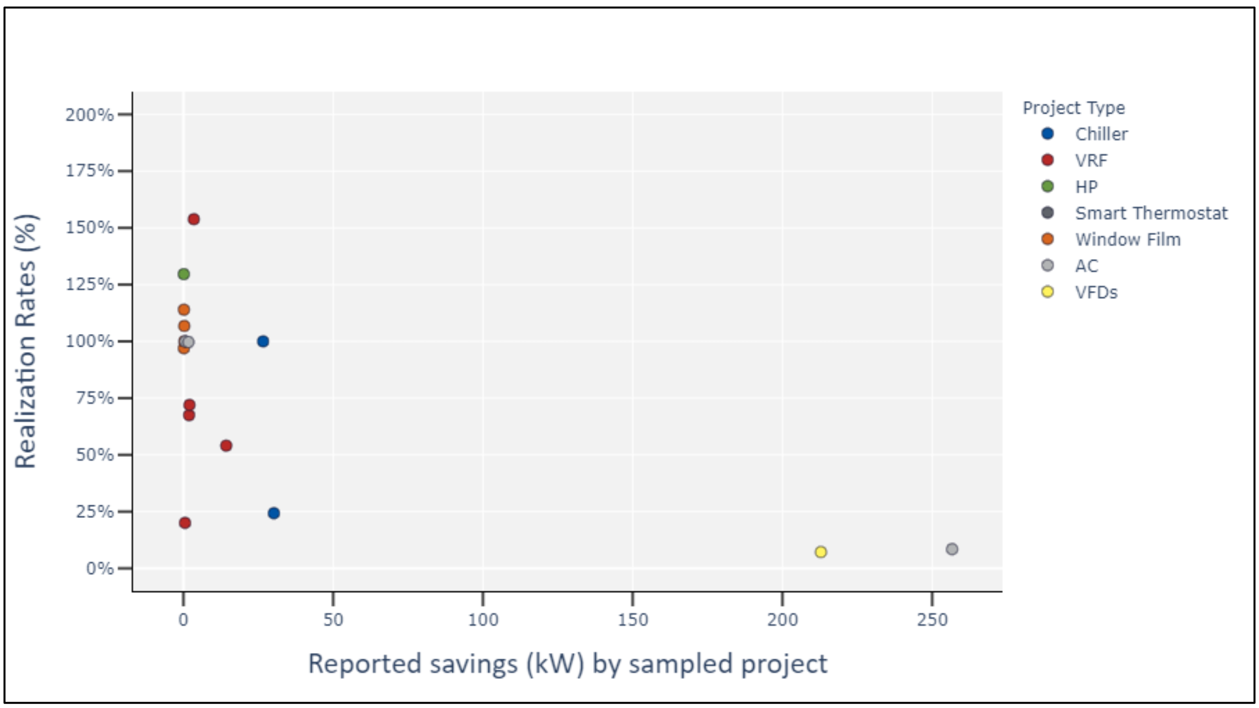



Table 64 provides details on evaluated sampled projects that exhibited less than 80% or more than 120% adjusted gross savings realization rates for energy consumption savings.

**Table 64. Sample of Detailed HVAC Projects with Large Variance between Reported and Evaluated Findings**

| Project | Project Measures | Reported Savings | | Realization Rates | | Notes |
|---|---|---|---|---|---|---|
| | | kWh | kW | kWh | kW | |
| WACN6RQ0 | (2) VFDs serving 15 hp pumps<br>(2) VFDs serving 10 hp pumps | 27,266 | 14.3 | 168% | 54% | Evaluated savings were calculated based on the Ohio TRM. Evaluated savings differ from reported due to differences in end-use demand and energy savings factors when compared to the reported demand and energy savings factors. |
| EYPH1WO3 | 144 sq ft of window film | 383 | 0.2 | 131% | 114% | Evaluated savings based on site specific deemed savings values from the Ohio TRM. The reported savings use an average value of all locations. |
| 94TFXAKE | (1) variable refrigerant flow system<br>(1) air conditioner (3) heat pumps | 5,555 | 3.5 | 122% | 154% | Differences between evaluated and reported savings are primarily due to project specific inputs instead of averaged values used by DP&L. |
| 5LPISIDW | (1) 130 ton chiller and (2) VFDs serving 40 hp chilled water pumps | 80,715 | 30.2 | 157% | 24% | VFDs serving chilled water pumps were evaluated to achieve greater energy savings based on the TRM calculation methodology but no demand savings. |
| RA2N1UVS | VFDs serving a large new construction project | 1,857,441 | 256.6 | 16% | 8% | The majority of VFDs incentivized for this new construction facility addition were required by code and do not qualify for a rebate. |
| K8PUL8TT | VFDs serving a large new construction project | 1,815,756 | 212.8 | 14% | 7% | The majority of VFDs incentivized for this new construction facility addition were required by code and do not qualify for a rebate. |

The two largest projects contributed to the greatest difference between evaluated and reported savings. Both projects involved incentives for VFDs serving air handling units and pump systems at large new construction facilities. Based on the permit drawing dates, the facilities were required to comply with ASHRAE 90.1-2010 energy code. The energy code required variable volume control for hydronic and VAV fan systems with performance that matched variable frequency drives. Because of this, the majority of the VFDs for these two projects were required by code and did not realize energy savings.

Smart thermostat projects realized 100% savings for both demand reduction and annual energy savings. Window film projects realized savings above and below the reported savings. These savings varied because DP&L used an average deemed savings value for window film regardless of facility type and location. The Ohio TRM prescribed deemed values based on facility type and location. Variability in realization rates for window film was expected due to these differences and the deemed savings value used by DP&L appeared to be appropriate.

### Motor Savings

Cadmus evaluated seven projects with VFDs within the Motors strata. The VFDs installed controlled motors between 3 hp and 200 hp. Four of the seven projects involved VFDs serving motors used in process applications. Figure 8 and Figure 9 show adjusted gross savings realization rates and associated *ex ante* energy savings and demand reduction, respectively, for each sampled Motors project.

**Figure 8. Prescriptive Motor Energy Savings Sample Results**


**Figure 9. Prescriptive Motor Demand Reduction Sample Results**

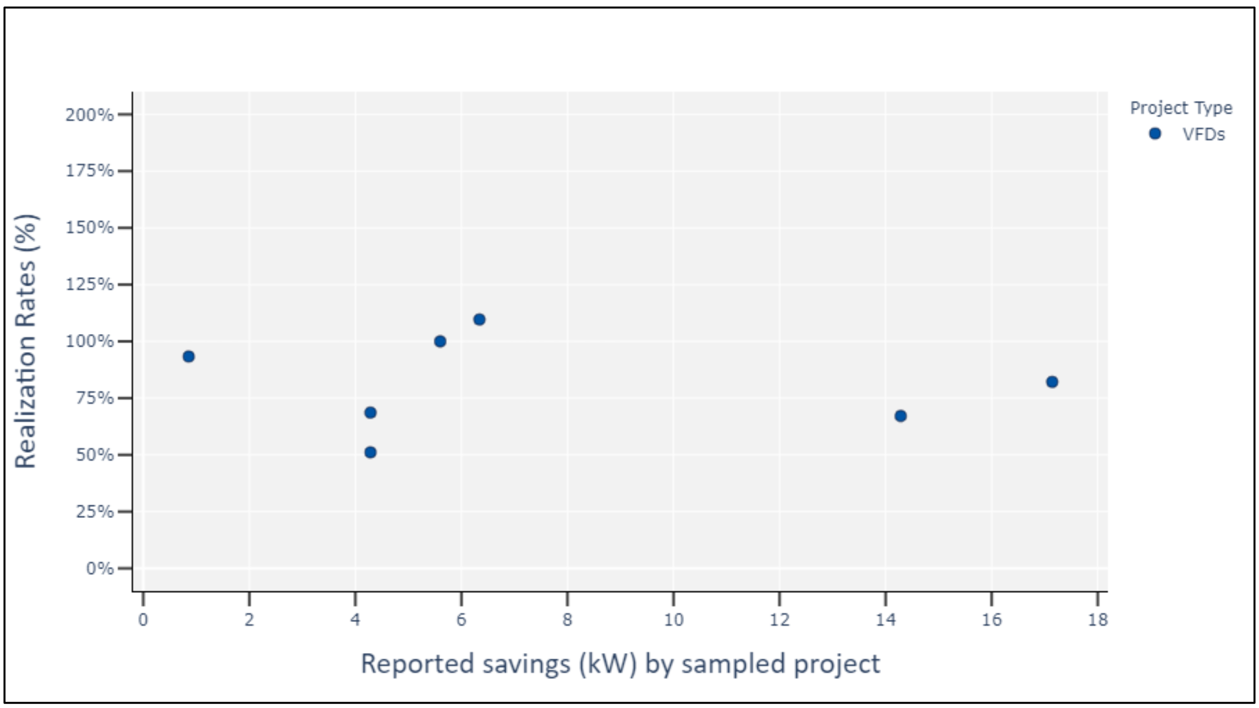



Table 65 provides details on evaluated sampled projects that exhibited less than 80% or more than 120% adjusted gross savings realization rates for energy consumption savings.

**Table 65. Sample of Detailed Motor Projects with Large Variance between Reported and Evaluated Findings**

| Project | Project Measures | Reported Savings | | Realization Rates | | Notes |
|---|---|---|---|---|---|---|
| | | kWh | kW | kWh | kW | |
| GG5SSTUK | (6) VFDs serving supply fans on air handling units | 21,276 | 6.3 | 200% | 110% | The energy savings factors for supply fans used in the evaluated savings were based on the Ohio TRM and are higher than the average energy savings factor used in the reported savings calculations. |
| RH14WAIU | (1) VFD serving a 3 hp hot water pump | 5,178 | 0.9 | 134% | 93% | Evaluated savings were calculated based on the Ohio TRM and achieved greater annual energy savings than reported due to the average energy savings factor used in the reported energy savings calculations |
| B47DI9OJ | (1) VFD serving a 60 hp process pump | 71,911 | 17.1 | 119% | 82% | Evaluated savings were calculated based on the Ohio TRM and achieved greater annual energy savings than reported due to the average energy savings factor used in the reported energy savings calculations |
| DCXQPOAR | (2) VFDs serving 20 hp process pumps | 59,926 | 14.3 | 97% | 67% | Savings were based on 20 hp motors instead of 25 hp motors due to audit performed by DP&L's consultants. |
| WPOE2318 | (2) VFDs serving 7.5 hp booster pumps | 39,371 | 4.3 | 100% | 69% | Demand savings were lower due to the evaluated demand savings factor based on Other system type within the Ohio TRM. |

DP&L reported energy savings for prescriptive VFD projects based on the Ohio TRM measure, Variable Frequency Drives for HVAC Applications, by collecting the quantity, HOU, and motor horsepower. DP&L calculations assumed motor efficiency (0.91), load factors (0.85), ESF (0.41), and DSF (0.43). To evaluate VFD projects, Cadmus collected the project-specific motor efficiency and applied the ESF and DSF in the savings calculation based on the end-use application. The motor efficiency typically matched or varied slightly from DP&L's assumed value. We identified the ESF and DSF as the primary determinants for differences between the reported and evaluated savings.

## *Recommendations*

Based on the preceding findings, Cadmus recommends the following update to be reviewed and implemented based on energy efficiency programs that are reinstated in a future Nonresidential Prescriptive Rebate program:

- **Process VFDs for new construction projects through the Custom New Construction program.** Energy codes adopted by Ohio require various energy efficiency measures such as VFDs to be installed on equipment for new construction projects. ASHRAE 20.1-2010 sections 6.5.3.2 and 6.5.4 specifies that VAV fan control and hydronic systems utilize variable volume control with minimum performance criteria that matches VFDs. Because of this, variable speed drives for many new construction applications do not qualify for the Rapid Rebate program.

# Nonresidential Midstream Incentive Channel

This chapter describes Cadmus' evaluation approach, detailed findings, conclusions, and recommendations for the Midstream Incentive Channel, a component of the Nonresidential Prescriptive Rebate program. Midstream Incentive Channel savings are ultimately attributed to the Nonresidential Prescriptive Rebate program.

## *Program Description*

The Midstream Incentive Channel historically provided time-of-sale markdowns for energy-efficient lighting and HVAC measures through commercial distributors located within DP&L's service territory. Rebated lighting measures included screw-in and pin-based LED lamps, linear fluorescent and linear LED lamps, LED fixtures, and occupancy sensors. 2020 was the first program year that DP&L provided incentives for occupancy sensors through the channel. DP&L offered incentives for HVAC measures such as air-cooled chillers, mini-split heat pumps and air conditioners, unitary air conditioners, unitary heat pumps, and VFDs in 2020. DP&L claimed early replacement and time-of-sale savings for chillers in 2020, but only claimed time-of-sale savings for all other HVAC and lighting measures. CLEAResult developed and implemented the program.

## *Evaluation Overview*

To evaluate the 2020 Midstream Incentive Channel, Cadmus followed the evaluation activities and researchable questions outlined in Table 66.

**Table 66. Key Researchable Questions for Midstream Incentive Channel Program**

| Researchable Question | Activity Used to Address Question |
|---|---|
| What are the channel's gross electric savings and demand reductions? | • Database review: verify measures are categorized correctly<br>• Engineering analysis: conduct research on savings algorithms for various measures, calculate savings accordingly |
| Is the channel cost-effective? | • Cost-effectiveness analysis |

## *Detailed Evaluation Findings*

Overall, the 2020 Midstream Incentive Channel achieved a verified gross realization rates of 98% for energy savings and 98% for demand reduction. Table 67 presents *ex ante,* verified gross, and adjusted gross energy savings for the channel.

**Table 67. Midstream Incentive Channel *Ex Ante*, Verified, and Adjusted Gross Energy Savings**

| Measures | *Ex Ante* Claimed Gross Savings | | Verified Gross Savings | | Adjusted Gross Savings | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision[a] |
| Lighting Measures | 51,637,725 | 8,924.7 | 50,709,833 | 8,767.5 | 44,208,718 | 7,853.3 | ±14.9% |
| HVAC Measures | 2,623,397 | 416.5 | 2,623,397 | 416.5 | 2,671,563 | 389.1 | ±10.0% |
| **Total** | **54,261,122** | **9,341.2** | **53,333,230** | **9,184.0** | **46,880,281** | **8,242.4** | **±14.0%** |

Note: Total values in table are rounded for reporting purposes.
[a] Precision is at 90% confidence.

HVAC *ex ante* energy savings decreased 46% from 2019 to 2020 due to a 33% decrease in HVAC sales (by equipment quantity) and updated baseline efficiencies. Lighting sales (by equipment quantity) increased just over 6% from 2019 to 2020 and expanded to include occupancy sensors for the first time. The majority of *ex ante* 2020 Midstream Incentive Channel energy savings came from high-bay/low-bay LED fixtures, followed by LED T8s and screw-in LEDs.

## HVAC Measures

In 2020, the HVAC measures listed in Table 68 constituted approximately 5% of total channel savings. Factors impacting realization rates are discussed in the *Impact Evaluation Methodology and Findings* section. Table 68 shows the percentage of *ex ante* energy savings and energy realization rate for each HVAC measure.

**Table 68. Percentage of *Ex Ante* Savings and Energy Realization Rate by HVAC Measure**

| Measure | *Ex Ante* Claimed Gross Savings | | Percent of *Ex Ante* Claimed Gross Savings | | Realization Rate | |
|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW |
| Chillers Air-Cooled | 1,452,315 | 193.9 | 55.4% | 46.6% | 100.0% | 100.0% |
| Mini-Splits | 9,185 | 0.8 | 0.4% | 0.2% | 100.0% | 100.0% |
| Unitary AC | 199,715 | 63.6 | 7.6% | 15.3% | 100.0% | 96.4% |
| Unitary HP | 2,601 | 1.1 | 0.1% | 0.3% | 106.6% | 100.0% |
| VFD | 959,580 | 157.0 | 36.6% | 37.7% | 105.0% | 84.0% |
| **Total** | **2,623,397** | **416.5**[a] | **100.0%** | **100.0%** | **101.8%** | **93.4%** |

Note: Total values in table are rounded for reporting purposes.

Cadmus followed the methodology outlined in the *2019 evaluation report*[29] to evaluate HVAC savings. DP&L updated baselines efficiencies for the 2020 program year in most cases; exceptions are outlined in the *Impact Evaluation Methodology and Findings* section.

## Lighting Measures

Lighting accounted for 95% of the Midstream Incentive Channel's energy savings. In 2020, lighting energy savings increased 32% over 2019, although the quantity of lighting equipment rebated though the channel only increased 6%. The increase in savings is largely attributable to enhanced rebate data

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[29] Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 19-0775-EL-POR. http://dis.puc.state.oh.us

collection on some purchases, which captured operating hours for selected lighting projects. Several high-volume lighting purchases were made by large industrial customers who reported close to 8,760 annual operating hours.

DP&L reported *ex ante* baseline wattages in accordance with Cadmus' recommended lumen equivalence baseline wattage bins. The adjusted realization rates were primarily driven by changes to HOU and CF. Cadmus assigned HOU and CF based on building type, whereas *ex ante* HOU and CF assignments varied by project. Table 69 shows a comparison of *ex ante* and adjusted savings inputs—including HOU, ISR, WHF for energy and demand, CF, and delta watts—as well as the overall impact of these inputs on the lighting realization rate.

**Table 69. *Ex Ante* Versus Adjusted Gross Lighting Inputs, and Overall Impact on Realization Rate**

| Weighted Input Value[a] | HOU | ISR | $WHF_e$ [b] | $WHF_d$ [b] | CF | Delta watts |
|---|---|---|---|---|---|---|
| *Ex Ante* Inputs | 4,140 | 1.00 | 1.09 | 1.20 | 0.72 | 34.47 |
| Adjusted Inputs | 3,476 | 0.98 | 1.09 | 1.19 | 0.64 | 34.57 |
| **Overall Impact** | **-16%** | **-2%** | **0%** | **-1%** | **-11%** | **0%** |

[a] Input values are weighted averages across all lighting measures in the Midstream Incentive Channel.

[b] The waste heat factors for energy ($WHF_e$) and demand ($WHF_d$) represent changes in electric space heating and cooling requirements due to the smaller quantity of waste heat produced by efficient lighting.

Table 70 shows the lighting measures that had the largest impact on the adjusted energy savings realization rate and the percentage of difference in the input values used to calculate *ex ante* and evaluated savings. Negative values indicate Cadmus' input values were lower than those used to calculate *ex ante* savings. Cumulatively, these measures account for nearly 89% of *ex ante* lighting savings.

**Table 70. Percentage *of Ex Ante* Savings and Difference in Input Assumptions by Lighting Measure**

| Measure | *Ex Ante* kWh | Percentage of *Ex Ante* kWh | Energy Realization Rate | Percentage Difference in Input Values | | | |
|---|---|---|---|---|---|---|---|
| | | | | HOU | ISR | $WHF_e$ | Delta Watts |
| High-Bay/Low-Bay | 18,667,302 | 36% | 80% | -17% | -2% | -1% | 0% |
| LED Exterior Flood | 2,765,843 | 5% | 104% | 0% | -2% | 0% | 3% |
| LED T8 | 17,149,184 | 33% | 77% | -21% | -2% | 0% | 0% |
| LED Screw-In | 7,205,605 | 14% | 112% | 21% | -2% | 0% | 0% |

There are two notable findings from the lighting evaluation:

- One LED screw-in record accounts for about 5.5% of *ex ante* savings and 16% of adjusted savings. This record represents 10,000 lamps and the realization rate was driven largely by HOU.
- Adjusted savings for LED flood lamps were driven by a difference in baseline wattage, further explained in the *Baseline Wattage* section.

## *Evaluation Data Collection Methods*

Cadmus conducted the following activities as a part of the impact evaluation: a database review, facility-type review, and engineering analysis. These activities are detailed below.

### Database Review

To evaluate the 2020 Midstream Incentive Channel, Cadmus reviewed the data provided by the implementer and verified that each measure included model numbers and reported savings. Additional information from the implementation team included clarification of the inspection hours and inspection quantity data fields, the latest QPL, deemed savings calculations for occupancy sensors, and the use of dual baselines for time-of-sale versus early retirement chillers. Cadmus recalculated *ex ante* savings using the reported savings methodology and applied an ISR to derive verified savings.

### Facility Type Review

In 2020, Cadmus used reported facility types to assign HOU from the 2010 Ohio TRM, following the process outlined in the 2019 evaluation report.[30] Where a facility type was not reported, we assigned a program-average based on the distribution of facility types reported in the 2020 program data, with an added assumption that 5% of lights were installed outdoors (exterior).

### Engineering Analysis

Cadmus started with a review of the methodologies and inputs prescribed by the 2010 Ohio TRM. Where appropriate, we referenced secondary sources, such as federal efficiency standards, building energy codes, and TRMs from other jurisdictions to identify whether we should use additional values or approaches in place of the Ohio TRM. In the case of VFDs, we deviated from the approach outlined above and applied the realization rates from the Nonresidential Prescriptive Rebate program. We based these realization rates on 2018 metering data from VFDs rebated through the Midstream Incentive Channel.

For lighting measures, we verified wattage, lumen output, and other defining characteristics by cross-checking equipment model numbers against the QPL provided by the implementer. Cadmus assigned baseline wattages using the lumen equivalence method and assigned HOU, CF, and WHFs inputs by facility type, in accordance with the Ohio TRM. We calculated program average HOU, CF, and WHF values for sales where facility type was not recorded. The *Lighting Methodology* section outlines the methodologies we used to calculate adjusted savings. These methodologies match those used in the 2019 program evaluation, with the exception of occupancy sensors, which were new to the Midstream Incentive Channel in 2020. The methodologies used to calculate occupancy sensor *ex ante* and adjusted savings are outlined in the *Lighting Controls* section.

## *Impact Evaluation Methodology and Findings*

This section outlines the methodologies Cadmus used to determine savings from HVAC and lighting measures offered through the Midstream Incentive Channel and the associated findings.

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30 Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 19-0775-EL-POR. http://dis.puc.state.oh.us

## HVAC Measures

Table 71 lists the factors impacting realization rates at the measure level. We did not include mini-splits and air-cooled chillers in the table because the adjusted realization rates for these measures were 100%.

**Table 71. Drivers of Realization Rate by HVAC Measure Type**

| Measure | Realization Rate Drivers | | |
|---|---|---|---|
| | Differences in Baseline Efficiency | Differences in Algorithms | Metering Results |
| Unitary AC | x | | |
| Unitary HP | | x | |
| VFD | | | x |

### *Air-Cooled Chillers*

Cadmus used industry standard algorithms to evaluate energy savings and demand reduction associated with air-cooled chillers.

Chillers constituted over 56% of HVAC savings; rebated chillers ranged in size from 35 tons to 350 tons. In 2019, all HVAC savings were based on time-of-sale. However, in 2020, *ex ante* savings for six of the 13 chillers were based on early retirement savings. The chiller measure historically relates only to the replacement of an existing unit at the end of its useful life or the installation of a new system in an existing building (i.e., time-of-sale).

Both adjusted and *ex ante* savings used the algorithm outlined in the Ohio TRM and dual baselines to calculate savings. Cadmus and the implementer applied one set of baselines (2003 IECC[31]) to early retirement chillers and another, more recent, set of baselines (2012 IECC[32]) to the remaining chillers. Notes in the program tracking data indicated that six chiller projects replaced older but still operational chillers. Therefore, *ex ante* and adjusted calculations used baselines from 2003 IECC for those six projects. Other *ex ante* and adjusted inputs, including cooling EFLH, CF, and baseline efficiencies, were the same. Table 72 shows the dual baseline efficiencies.

**Table 72. Air-Cooled Chillers Baseline Efficiencies**

| Chiller Size | *Ex Ante* and Adjusted Baseline Efficiencies for Early Retirement Chillers from Pre-2010 (2003 IECC) | | *Ex Ante* and Adjusted Baseline Efficiencies for Time-of-Sale Chillers (2012 IECC) | |
|---|---|---|---|---|
| | Full Load EER | IPLV EER | Full Load EER | IPLV EER |
| < 150 tons | 9.6 | 9.6 | 9.6 | 12.5 |
| ≥ 150 tons | 8.5 | 8.5 | 9.6 | 12.8 |

31 International Code Council. March 2006. *2003 International Energy Conservation Code.* https://codes.iccsafe.org/content/document/721

32 International Code Council. December 2015. *2012 International Energy Conservation Code.* https://codes.iccsafe.org/content/IECC2012P5

Early retirement chillers, with 2003 IECC baselines, account for 79% of total *ex ante* chiller energy savings in 2020. Adjusted realization rates for energy savings and demand reduction were 100%.

### *Unitary and Mini-Split Air Conditioners*

Unitary air conditioners comprised just over 7% of HVAC *ex ante* energy savings, and mini-split air conditioners made up less than a third of a percent. DP&L rebated 228 unitary air conditioning units and 13 mini-split air conditioners in 2020.

The DOE federal baselines for unitary air conditioners mandate minimum efficiencies for equipment greater than or equal to 65,000 Btu/h and less than 760,000 Btu/h in terms of IEER. Cadmus used these baseline efficiencies in place of EER values to calculate energy savings. For units less than 65,000 Btu/h, the DOE federal baselines are based on SEER. We used SEER for these small units to calculate energy savings. Several key findings emerged:

- **Air conditioner misclassification.** One air conditioner unit was misclassified as a heat pump in the tracking data; however, Cadmus evaluated it as a unitary air conditioner after reviewing the model number and confirming it was an AC unit.
- **Cadmus found that 79 air conditioners (58 sales) rebated in 2020 did not meet federal standards**. Either *ex ante* energy savings or demand reduction were zero for these sales due to the newer unit having a lower IEER than the federal baseline IEER (for energy savings) or the newer unit EER being less than the baseline EER (for demand reduction).[33] Evaluated savings were also zero.
- **Slight difference between *ex ante* and adjusted baseline EERs.** *Ex ante* and adjusted savings used the same baseline efficiencies following the federal standard as outlined above, with one minor difference. *Ex ante* savings used a baseline EER value of 11 for unitary air conditioners with a cooling capacity between 65,000 Btu/h and 135,000 Btu/h; Cadmus used a baseline EER value of 11.1. This led to a slight decrease in adjusted demand reduction for unitary air conditioners.

The adjusted realization rate for air conditioner energy savings was 100%, and the adjusted realization rate for demand reduction was 96%.

### *Unitary and Mini-Split Heat Pumps*

Seven unitary heat pumps and three mini-split heat pumps were rebated through the 2020 Midstream Incentive Channel. Cadmus determined that an eighth unit labeled as a heat pump in the tracking data

[33] Although the federal standard does not stipulate minimum EER values (used to calculate demand reduction), EM&V professionals have adopted a common approach to compute a baseline EER value from the published SEER standard. Cadmus converted from EER to SEER using the method outlined in the following paper: Wassmer, M.A. 2003. *Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations*. Masters Thesis. University of Colorado at Boulder.

was actually an air conditioner. Collectively, rebated heat pumps represent a small portion of total HVAC *ex ante* savings: 0.21%.

As mentioned in the *Unitary and Mini-Split Air Conditioners* section, one mini-split heat pump also did not meet the baseline EER. The efficient EER value was less than the baseline EER, leading to zero *ex ante* and evaluated demand savings.

Cadmus calculated heat pump savings using baselines following DOE federal standards. *Ex ante* savings used DOE federal standards in most cases, with the exception of kilowatt-hour cooling savings for units with a cooling capacity greater than or equal to 65,000 Btu/h. For unitary heat pump units with a cooling capacity greater than or equal to 65,000 Btu/h, Cadmus used IEER federal standards and the efficient-equipment IEER as reported in the tracking data. *Ex ante* savings used EER values. Both adjusted and *ex ante* demand savings calculations used EER.

Updating the heat pump algorithm to use IEER in place of EER for large heat pump units resulted in realization rates of 106.6% for energy savings and 100% for demand reduction for heat pumps overall.

#### *Variable Frequency Drives*

VFDs were the second largest contributor of savings from HVAC measures in the Midstream Incentive Channel, following air-cooled chillers, and represented almost 40% of *ex ante* HVAC energy savings.

As part of the Nonresidential Prescriptive Rebate program evaluation, Cadmus conducted site visits to verify installations and determine equipment operations specifically for the Midstream Incentive Channel in 2018. We installed power metering equipment on five of seven evaluated VFDs. We applied the average realization rates for the 2018 projects—105% for energy savings and 84% for demand reduction—to VFD measures rebated through the channel in 2020. The *Nonresidential Prescriptive Rebate Program* provides additional details on Cadmus' power metering and engineering review processes.

### Lighting Controls

Occupancy sensors were rebated through the Midstream Channel for the first time in 2020 and accounted for less than a tenth of a percent of total lighting *ex ante* savings. *Ex ante* savings used a deemed average savings per sensor value, sourced from averaging Nonresidential Prescriptive Rebate program lighting control projects. These values, 215 kWh per sensor and 0.01 kW per sensor, were applied to the 87 incentivized occupancy sensors in the Midstream Incentive Channel. Cadmus reviewed two lighting control projects from 2019 and 2020, evaluated through the Nonresidential Prescriptive Rebate program, and found these deemed savings values to be reasonable. Cadmus applied an ISR of 98.2% to the deemed savings value. The rationale of this ISR value is outlined in the *Installation Rate* section.

### Lighting Methodology

Cadmus used industry standard algorithms to evaluate energy savings and demand reduction associated with the Midstream Incentive Channel lighting measures.

Table 73 shows input values used to calculate energy savings and demand reductions for *ex ante*, verified, and adjusted gross savings for lighting measures. These inputs are weighted averages for the channel and reflect differences in savings assumptions by measure.

**Table 73. Lighting Energy Savings and Demand Reduction Calculation Inputs**

| Savings Algorithm Input[a] | *Ex Ante* Inputs[b] | Verified Inputs | Adjusted Inputs |
|---|---|---|---|
| HOU | 4,140 | 4,140 | 3,477 |
| $WHF_e$ | 1.09 | 1.09 | 1.09 |
| $WHF_d$ | 1.20 | 1.20 | 1.19 |
| ISR | 1.00 | 0.98 | 0.98 |
| ΔW[c] | 34.47 | 34.47 | 34.57 |
| CF | 0.72 | 0.72 | 0.64 |

[a] Input values are weighted averages across all lighting measures in the Midstream Incentive Channel.
[b] Cadmus calculated overall averages using inputs supplied by the implementer and data derived from the channel tracking data.
[c] These values reflect a weighted average of delta watts for all rebated bulbs. Except where otherwise noted, Cadmus calculated baselines using the lumen equivalency method, as outlined in *Chapter 21: Residential Lighting Evaluation Protocol* of the Uniform Methods Project.

Table 74 shows the percentage of difference in *ex ante* and adjusted input values for each lighting measure. HOU and CF had the greatest discrepancies.

**Table 74. Percentage Difference between Adjusted and *Ex Ante* Savings Inputs by Lighting Measure**

| Measure | *Ex Ante* kWh | *Ex Ante* kW | Percentage Difference in Input Values | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | HOU | $WHF_e$ | $WHF_d$ | ISR | Delta Watts | CF |
| High-Bay/Low-Bay | 18,667,302 | 3,116.4 | -17% | -1% | -1% | -2% | 0% | -6% |
| LED Exterior Wall Pack | 1,613,174 | - | 0% | 0% | 0% | -2% | 0% | 0% |
| LED Exterior Flood | 2,765,843 | - | 0% | 0% | 0% | -2% | 3% | N/A |
| LED Downlight Kits | 369,897 | 85.6 | 3% | 0% | -1% | -2% | 0% | -21% |
| LED T8 | 17,149,184 | 3,246.2 | -21% | 0% | -1% | -2% | 0% | -11% |
| Fluorescent T8 | 170,642 | 30.3 | -18% | 0% | -1% | -2% | 0% | -1% |
| LED and Fluorescent T5 | 2,283,896 | 311.5 | -25% | 0% | -1% | -2% | 0% | 0% |
| LED Fixtures | 1,348,314 | 255.2 | -16% | 0% | -1% | -2% | 2% | -4% |
| Occupancy Sensors | 18,705 | 0.9 | N/A | N/A | N/A | N/A | N/A | N/A |
| LED 4-Pin CFL Replacement | 38,358 | 8.7 | -7% | 0% | -1% | -2% | -1% | -9% |
| LED Exit Signs | 6,806 | 0.8 | 0% | 1% | 2% | -2% | 0% | N/A |
| LED Screw-In | 7,205,605 | 1,869.0 | 21% | 0% | -1% | -2% | 0% | -23% |
| **Total** | **51,637,725** | **8,924.7** | **-16%** | **0%** | **-1%** | **-2%** | **0%** | **-11%** |

Note: Total values in table are rounded for reporting purposes.

A detailed description of each input follows.

### *Installation Rate*

A couple challenges arise in evaluating programs employing midstream delivery: not knowing the final installation locations of purchased bulbs and not knowing whether those bulbs were installed immediately or kept in storage for future installation. During the 2015 program year, Cadmus performed a participant survey to develop a multiyear installation rate based on the percentage of lamps installed within set times from the date of purchase, as outlined in the 2019 evaluation report.[34]

This multiyear ISR accounted for lamps not installed immediately following purchase. In the 2020 evaluation, Cadmus applied the 98.2% multiyear installation rate to all lighting measures.

### *Hours of Use*

As with installation rate, HOU depend on a bulb's installed location. Cadmus assigned HOU based on facility type, as outlined in the *2019 Nonresidential Midstream Incentive Channel Report*, with one exception. Cadmus used site-specific HOU for one large sale—470 exterior flood lamps installed in a parking garage. We verified using images from Google Maps that the lights were on during the day, and therefore assumed the lights were on continuously on. Cadmus assigned a corresponding 8,760 HOU and 1.0 CF in place of the 4,306 exterior HOU outlined in the *2019 Nonresidential Midstream Incentive Channel Report*.

In 2019, average *ex ante* and adjusted HOU across the Midstream Incentive Channel differed by only 3%. In 2020, average *ex ante* and adjusted HOU differed by 16% because of the custom HOU used to calculate reported savings. In addition, average *ex ante* HOU increased 5% (3,949 to 4,140) between 2019 and 2020. Average measure-level HOU increased for nearly every lighting measure from 2019 to 2020, with the largest increases in LED and fluorescent T5 bulbs (6% increase) and LED 4-pin CFL replacements (5% increase). The measure-average HOU for high-bay/low-bay fixtures and LED T8 bulbs each increased by only 1% from 2019 to 2020, but the two measures make up almost 70% of total channel lighting savings. As such, the increase for these measures greatly impacted the overall *ex ante* 2020 average HOU. The difference in *ex ante* and adjusted HOU was primarily responsible for decreasing the overall adjusted realization rate.

Table 75 shows facility type distributions for commercial lighting and the program average HOU applied to records with an unlisted facility type (3,754 hours).

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[34] Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 19-0775-EL-POR. http://dis.puc.state.oh.us

**Table 75. Midstream Incentive Channel Commercial Lighting Facility-Type Distribution**

| Facility type | Project Percentage by Rebated Bulb Quantity[a] | Normalized Facility type Weight[b] | HOU[c] | CF[c] |
|---|---|---|---|---|
| College | 3.2% | 3.4% | 3,919 | 0.65 |
| Food Sales | 1.0% | 1.0% | 5,487 | 0.88 |
| Food Service | 2.5% | 2.7% | 4,474 | 0.79 |
| Garage | 0.0% | 0.0% | 8,556 | 0.95 |
| Health Care | 5.7% | 6.1% | 3,706 | 0.74 |
| Hotel/Motel | 4.4% | 4.8% | 3,400 | 0.35 |
| Industrial | 14.2% | 15.3% | 4,719 | 0.73 |
| Office | 19.2% | 20.7% | 3,562 | 0.73 |
| Other | 7.7% | 8.3% | 3,701 | 0.62 |
| Public Assembly | 6.0% | 6.5% | 2,801 | 0.62 |
| Public Services (non-food) | 8.8% | 9.5% | 3,465 | 0.61 |
| Retail | 9.6% | 10.4% | 4,230 | 0.80 |
| School | 4.9% | 5.3% | 2,394 | 0.48 |
| Warehouse | 5.7% | 6.1% | 3,503 | 0.75 |
| Exterior | | | 4,306 | - |
| **Total / Average** | **93%** | **100%** | **3,754** | **0.68** |

Note: Total values in table are rounded for reporting purposes.

[a] Cadmus calculated the rebate percentage from the reported facility types. The project percentages do not add up to 100% because 7% of measures were reported as exterior.

[b] Cadmus normalized the facility information from the 2020 program tracking database to estimate the probability that a measure rebated through the program is installed in any given facility type.

[c] Cadmus calculated HOU and CF values based on the assumption that, in addition to exterior lighting products, 5% of all other lamps would be installed outdoors (based on: U.S. Department of Energy. November 2017. "2015 U.S. Lighting Market Characterization." https://www.energy.gov/eere/ssl/2015-us-lighting-market-characterization).

[d] Cadmus determined exterior HOU by estimating the number of non-daylight hours per month in Ohio from U.S. Naval Observatory data.

Overall, the weighted adjusted HOU for the Midstream Incentive Channel was 3,476, compared with the weighted *ex ante* HOU of 4,140. The weighted adjusted HOU is based on hours from the Ohio TRM for records with a listed facility type, exterior hours for records with an exterior facility type (4,306), and a program-average HOU applied to records without an assigned facility type (3,754). The evaluated program-average HOU was approximately 16% lower than the *ex ante* program-average value, as shown in Table 69.

### *Waste Heat Factor*

Cadmus used the same building-type weightings developed for the HOU input to determine WHF values for energy and demand. We evaluated WHFs of 1.09 for energy savings and 1.19 for demand reduction and applied these values to purchases made through the Midstream Incentive Channel, with two exceptions:

- We evaluated LED exterior wall packs with energy and demand WHFs of 1.0
- We evaluated LED exterior flood lamps with energy and demand WHFs of 1.0

In both cases, the equipment was installed outdoors and should not affect the energy consumption of heating or cooling equipment in the building. These WHF values came from the Ohio TRM.

Separate WHFs for interior and exterior measures were also assigned to *ex ante* savings. WHFs of 1.10 for energy savings and 1.20 for demand reduction were applied to non-exterior measures and WHFs of 1.0 were used for exterior measures.

The average adjusted WHF inputs differed slightly from *ex ante* WHF inputs because Cadmus calculated WHF program-averages from the building-type weightings outlined in the *Facility Type Review* section. The evaluated program average WHFs for both energy and demand were less than 1% lower than the *ex ante* assumptions. This had very little impact on the overall adjusted realization rates.

### *Coincidence Factor*

Cadmus evaluated the summer peak CF using the same approach described above for estimating annual operating hours. Building-type distributions resulted in a 0.64 overall commercial CF. We evaluated LED wall packs and exterior flood lamps with a CF of zero, with the exception of one exterior flood lamp purchase that we verified to be on continuously. Cadmus assigned that purchase a CF of 1.0.

*Ex ante* savings used a consistent CF of 0.732 for non-exterior measures regardless of facility type. For exterior measures, the *ex ante* CF was 0, consistent with Cadmus' evaluation approach.

In 2019, the evaluated program-average CF was 6% lower than the *ex ante* CF. In 2020, the evaluated program-average CF was 11% lower. This led to a decrease in the overall adjusted realization rate.

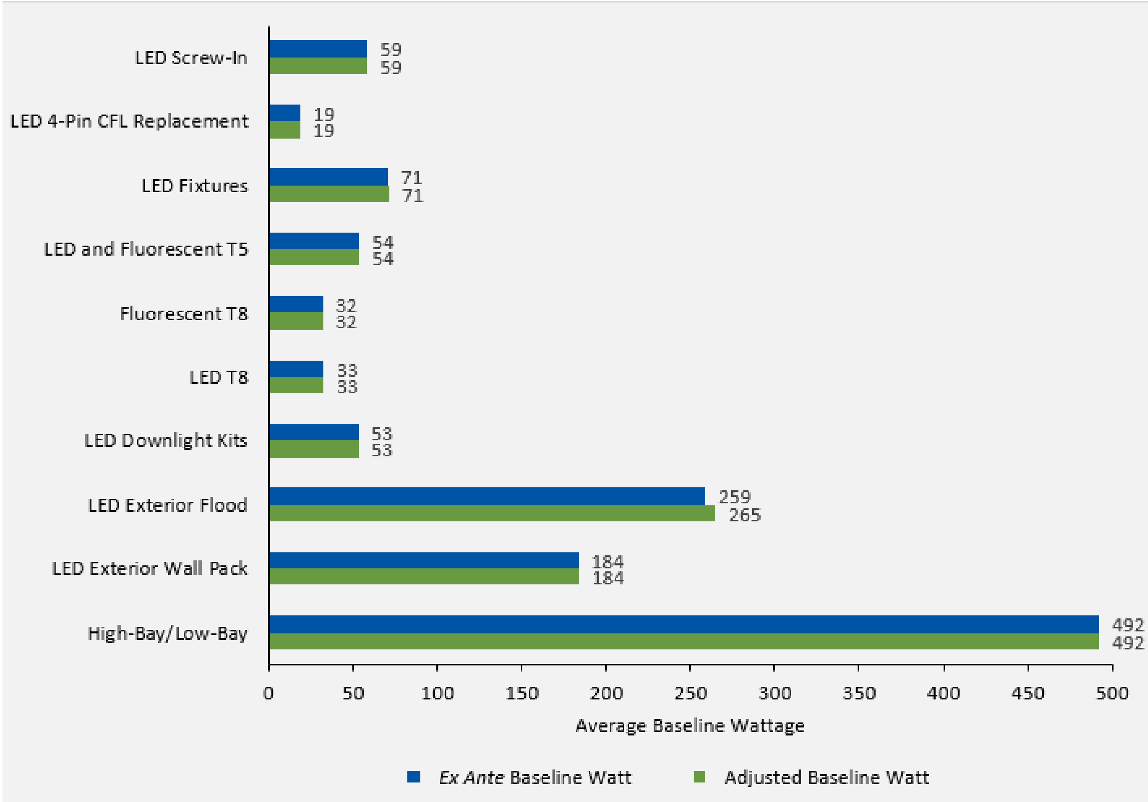
### *Baseline Wattage*

The methods Cadmus used for determining equipment baseline wattage for each lighting measures are consistent with those used in 2019, as outlined in the *2019 Nonresidential Midstream Incentive Channel Report.*[35]

Figure 10 shows a comparison of *ex ante* and adjusted baseline wattages by lighting measure type. The figure excludes exit signs and occupancy sensors because a wattage differential is used in place of baseline wattage for exit signs and wattage is not known for occupancy sensors.

[35] Dayton Power and Light. May 15, 2020. *2019 Energy Efficiency and Demand Reduction/Response Portfolio Status Report.* Case No. 19-0775-EL-POR. http://dis.puc.state.oh.us

**Figure 10. Comparison of *Ex Ante* and Adjusted Baseline Wattages by Lighting Measure Type**




DP&L updated *ex ante* savings methodologies in 2020 to use Cadmus' recommended lighting baseline wattage as outlined above in most, but not all, cases.

Overall, program-average *ex ante* and adjusted baseline wattages differed by less than 1%.

### *Efficient Wattage*

Cadmus used the QPL to determine efficient wattage. Five LED T8 records (181 lamps) were misclassified in the tracking data as LED wall packs or LED 2x4 fixtures. Cadmus reviewed the specifications sheets for these records and determined that the *ex ante* efficient wattages were incorrect as well. For these 181 LED T8s, Cadmus assigned efficient wattages matching the manufacturer specification sheets. All other efficient wattages were from the QPL.

## *Recommendations*

- Based on the preceding findings, Cadmus recommends that DP&L review and implement the following program updates, if still appropriate, in energy efficiency programs/channels it may reinstate in a future nonresidential midstream rebate program.

## HVAC

- **Offer incentives for early retirement measures through the Nonresidential Prescriptive Rebate program.** In 2020, DP&L claimed both time-of-sale and early retirement chiller savings. The Midstream Incentive Channel is designed for time-of-sale markdowns, and early retirement measures are better suited to go through the Nonresidential Prescriptive Rebate program. The program has historically provided incentives for early retirement measures and is designed to collect the needed information, such as age, size, efficiency, and verification that the existing equipment is fully functional.
- Stipulate minimum efficiency requirements for the program that exceed state or federal baseline efficiencies. Include minimum efficiencies for energy savings and demand reduction, such as the following examples:
  - Calculate energy savings using IEER for unitary heat pump units with a cooling capacity greater than or equal to 65,000 Btu/h. Federal baselines for unitary heat pumps units are based on IEER, but *ex ante* savings use EER.
  - Use an EER baseline of 11.1 for unitary air conditioning units with a cooling capacity greater than or equal to 65,000 Btu/h and less than 135,000 Btu/h. The *ex ante* baseline was 11.

## Lighting

- **Offer occupancy sensors through the Nonresidential Prescriptive Rebate program.** The program is better equipped for lighting controls such as occupancy sensors. It has provided incentives for lighting controls in the past and is equipped to collect additional project information, such as the type of lighting controls and the total wattage controlled. This information is needed to determine savings from lighting controls and is not available through the Midstream Incentive Channel.

## General

- **Design program changes and additions in collaboration with the evaluation team.** For example, in 2020, DP&L introduced occupancy sensors into the Midstream Incentive Channel and claimed early replacement savings for several chillers. These measures were labeled incorrectly in the tracking data and were not brought to the evaluator’s attention. Occupancy sensors need associated information, such as fixtures controlled, wattage controlled, and type of sensor, to determine savings. Also, the inclusion of early retirement measures requires the collection of additional data points. Collaboration between DP&L, the implementation team, and the evaluation team on future Midstream Incentive Channel updates will ensure consistency between the three groups and mitigate differences in energy saving and demand reduction calculations.

# Nonresidential Custom Rebate Program

This chapter describes the evaluation approach, detailed findings, conclusions, and recommendations for the Nonresidential Custom Rebate program.

## *Program Description*

The Nonresidential Custom Rebate program provided nonresidential customers with energy-efficient equipment purchases and industrial process improvements that are not covered by DP&L's Nonresidential Prescriptive program. DP&L delivered the Nonresidential Custom Rebate program through three channels: Custom, Retro-Commissioning, and New Construction. DP&L implemented the Custom and New Construction channels in-house, while HEAPY implemented the Retro-Commissioning channel. DP&L stopped accepting rebate applications after September 30, 2020.

## *Evaluation Overview*

To evaluate the 2020 Nonresidential Custom Rebate program, Cadmus followed the evaluation activities and researchable questions outlined in Table 76.

**Table 76. Key Researchable Questions for Nonresidential Custom Rebate Program**

| Researchable Questions | Activity Used to Address Question |
|---|---|
| What are the program's gross electric savings and demand reductions? | • Engineering analysis<br>• Database review<br>• Implementation staff interviews<br>• Customer interviews |
| Is this program cost-effective? | • Cost-effectiveness analysis |

## *Detailed Evaluation Findings*

DP&L claimed 29,286,957 kWh in *ex ante* energy savings and 4,326.2 kW in *ex ante* demand reduction (Table 77), falling short of its 35,491,825 kWh energy savings and 7,169 kW demand reduction goals. Cadmus calculated 29,338,969 kWh and 4,186.5 kW in verified gross savings. Based on verified gross savings, the program achieved realization rates of 100% for energy savings and 97% for demand reduction.

**Table 77. Nonresidential Custom Rebate Program *Ex Ante* and Achieved Energy Savings**

| Project Type | *Ex Ante* Savings | | Verified Gross Savings | | Adjusted Gross Savings | | |
|---|---|---|---|---|---|---|---|
| | kWh | kW | kWh | kW | kWh | kW | Precision[a] |
| Custom Large | 8,763,909 | 1,121.8 | 8,392,173 | 1,093.0 | 8,392,173 | 1,093.0 | 3.8% |
| Custom Medium | 4,361,986 | 540.4 | 3,749,690 | 492.7 | 3,749,690 | 492.7 | 10.4% |
| Custom Small | 342,218 | 55.0 | 347,318 | 51.7 | 347,318 | 51.7 | 1.0% |
| Retro-Commissioning | 8,474,061 | 585.3 | 8,474,061 | 585.3 | 8,474,061 | 585.3 | 0.0% |
| New Construction | 7,344,783 | 2,023.8 | 8,375,726 | 1,963.8 | 8,375,726 | 1,963.8 | 6.0% |
| **Total** | **29,286,957** | **4,326.2** | **29,338,969** | **4,186.5** | **29,338,969** | **4,186.5** | **2.2%** |

Note: Total values in table are rounded for reporting purposes.

[a] Precision at 90% confidence.

Key findings for each category of the program's offerings follow:

- Custom projects exhibited realization rates close to 100%. The reported calculation methodologies were appropriate and the verification documentation accurately reflected savings calculations for all custom measures except refrigerated display cases. Evaluated refrigerated display cases measures in the custom strata resulted in lower energy savings due to a difference in calculation methodology and equipment performance assumptions.

### *Impact Evaluation Methodology*

Cadmus implemented several steps to achieve the evaluation goals and research objectives. This section describes the activities and processes used throughout the impact evaluation of the 2020 Nonresidential Custom Rebate program. To determine gross savings, Cadmus applied the steps outlined in Table 78. A detailed explanation of each step follows.

**Table 78. Impact Steps to Determine Evaluated Gross Savings**

| Step | Action |
|---|---|
| 1 | **Tracking Database Review:** Validate the accuracy of data in the participant database |
| 2 | **Stratification and Sampling:** Develop strata from participant database and perform sampling |
| 3 | **EM&V Plan Development:** Review sample measure data and identify appropriate International Performance Measurement and Verification Protocol methodology to apply for each sampled measure |
| 4 | **EM&V Plan Implementation:** Review project documentation, interview implementation staff, interview customer staff, collect measure data remotely |
| 5 | **Analysis:** Validate reported savings using engineering calculations, model simulations, meter data, and other forms of analysis techniques |
| 6 | **Realization Rates:** Extrapolate realization rates to population and summarize findings |

**Step 1.** Cadmus reviewed the program tracking database to verify the accuracy of the reported energy savings, participant counts, measure descriptions, and incentive dates. For any discrepancies found, Cadmus communicated with DP&L to review and update the participant database.

**Step 2.** Cadmus stratified the population from program database into five strata. Within each stratum, we designed a sample to achieve ±20% precision at 80% confidence level. The sampling plan was designed to achieve ±10% precision at 90% confidence at the program level. Cadmus selected the sampled projects and downloaded the project data directly from DP&L's online tracking database.

**Step 3.** Cadmus received and reviewed the sampled project documentation from DP&L to understand how savings were calculated, identify the site-specific variables that could be collected based on facility staff interviews, and develop the appropriate evaluation M&V plans. The M&V plans are based on methods established by the IPMVP.

**Step 4.** Cadmus reviewed project documentation and reviewed discrepancies or associated findings with DP&L's implementation team. In some cases, we interviewed sampled project facility staff to understand the operation, control strategy, and installation success of incentivized measures.

**Step 5.** Cadmus analyzed the reported project documentation and interview data, including site measurements, photos, and reports collected by DP&L's implementation team. We calculated evaluated energy savings utilizing the methodologies outlined within the Ohio TRM. For measures not identified in the Ohio TRM, Cadmus calculated evaluated energy savings based on custom engineering spreadsheet analysis, energy modeling, or a utility bill analysis if the energy savings from the sampled measure exceeded 10% of the total facility's electric energy consumption.

**Step 6.** Cadmus extrapolated the results from the sampled measures to each respective stratum population and identified trends and commonalities among the findings.

## Sampling and Extrapolation Methodology

Through the Nonresidential Custom Rebate program, DP&L provided incentives for 97 unique measure types in 2020. Cadmus combined these 97 measure types into five strata: Large Custom, Medium Custom, Small Custom, Retro-Commissioning, and New Construction. We further stratified the Custom projects based on the total *ex ante* energy savings associated with each project:

- Large Custom: *ex ante* energy savings were greater than or equaled 500,000 kWh
- Medium Custom: *ex ante* energy savings greater than or equal to 100,000 kWh and less than 500,000 kWh
- Small Custom: *ex ante* energy savings less than 100,000 kWh
- Retro-Commissioning
- New Construction

Cadmus designed the sampling plan to achieve approximately ±20% precision at 80% confidence per strata, and ±10% precision at 90% confidence at the program level. Table 79 shows total project counts and energy savings reported in DP&L's tracking database. Table 80 summarizes project sampling.

**Table 79. Nonresidential Custom Rebate Program *Ex Ante* Energy Savings and Demand Reduction**

| Strata | Total Measures | *Ex Ante* Energy Savings (kWh) | *Ex Ante* Demand Reduction (kW) | Unique Sampled Projects |
|---|---|---|---|---|
| Custom Large | 8 | 8,763,909 | 1,121.8 | 5 |
| Custom Medium | 18 | 4,361,986 | 540.4 | 8 |
| Custom Small | 13 | 342,218 | 55.0 | 5 |
| Retro-Commissioning | 48 | 8,474,061 | 585.3 | 6 |
| New Construction | 58 | 7,344,783 | 2,023.8 | 13 |
| **Total** | **145** | **29,286,957** | **4,326.2** | **37** |

Note: Total values in table are rounded for reporting purposes.

**Table 80. Nonresidential Custom Rebate Program Sampled Projects Summary**

| Strata | Sampled Projects | Sampled Projects *Ex Ante* Energy Savings (kWh) | Sampled Energy Savings Percentage of Strata | Sampled Projects *Ex Ante* Demand Reduction (kW) | Demand Reduction Percentage of Strata |
|---|---|---|---|---|---|
| Custom Large | 5 | 4,215,831 | 48% | 587.5 | 52% |
| Custom Medium | 8 | 2,115,439 | 48% | 259.1 | 48% |
| Custom Small | 5 | 208,209 | 61% | 23 | 42% |
| Retro-Commissioning | 6 | 1,721,021 | 20% | 64.1 | 11% |
| New Construction | 13 | 2,527,304 | 34% | 440.8 | 22% |
| **Total** | **37** | **10,787,804** | **37%** | **1,374.5** | **32%** |

Note: Total values in table are rounded for reporting purposes.

## Measurement and Verification Plan Development

Cadmus reviewed all project documentation available from DP&L, including project applications, equipment invoices, reports published by DP&L's energy engineering consultants, and savings calculation spreadsheets. For each sampled project, we developed an M&V plan established by the IPMVP. A summary of IPMVP options follows, including our logic in assigning respective methods.

- **IPMVP Option A, Retrofit Isolation: Key Parameter Measurement.** IPMVP Option A involved the use of engineering calculations and partial site/device measurements (such as fixture wattages with lighting runtimes) to verify savings resulting from specific projects where equipment energy demand did not vary over time (such as non-dimming light bulbs).
- **IPMVP Option B, Retrofit Isolation: All Parameter Measurement.** IPMVP Option B involved the use of engineering calculations and time series true kilowatt measurements to verify savings resulting from the affected system's change in energy use.
- **IPMVP Option C, Whole Facility.** IPMVP Option C involved the use of whole-facility monthly or interval energy consumption data to evaluate savings when a given energy efficiency project represented a significant portion of a metered load. This approach was contingent upon sufficient available data, generally judged as a minimum of eight months pre- and post-install or outside air temperature data from the metered period that satisfied 90% of the entire range of outside air temperatures identified in typical meteorological year data sets for the measure installation location. Option C was limited to sites where savings were reported as at least 10% of total consumption on the affected meter.
- **IPMVP Option D, Calibrated Simulation.** Option D was applied on new construction and retrofit measures where a simulation model was used as the basis for claimed savings, and where the claimed-savings modeling files were available. We updated energy simulation models based on site observations for independent variables that impacted energy use, occupancy rates or schedules, and production data. We paid close attention to key parameters that drove savings and to measure baselines that might vary from energy code requirements or other baseline requirements.

### Verification Activities

After selecting projects to evaluate based on the sampling plan, Cadmus downloaded project documentation from DP&L's administrative website. To prepare for each site visit, Cadmus reviewed documentation and other relevant program information focused on calculation procedures and energy savings estimate documentation. We also reviewed DP&L's tracking spreadsheet and online application data, comparing entries to original application materials for consistency and accuracy. While Cadmus intended to perform site visits and collect documentation based on the appropriate IPMVP evaluation strategy, the impacts of the COVID-19 pandemic prevented travel and on-site verification for the entirety of the 2020 program year. Instead, Cadmus reviewed the sample project documentation collected by DP&L, interviewed DP&L's implementation team, and interviewed customers as needed to perform verification of projects. Cadmus evaluated projects selected for IPMVP Option D based on the energy simulation models associated with each project.

### Engineering Analysis and Savings Verification

Cadmus analyzed data collected through interviews or by DP&L's implementation team and calculated savings based on the IPMVP option established through the M&V plan development process. When DP&L's implementation team collected trend data, we used a variety of approaches to analyze data, including bin analysis, regression analysis, utility bill analysis, energy modeling, and custom spreadsheet analysis. In the absence of trend data or custom calculation methodologies, we generally followed the savings calculation methodology outlined in the Ohio TRM.

### Calculating Realization Rates

Cadmus determined program-level end-use savings and demand reductions through adjusted gross savings realization rates, calculated for each major measure strata (Custom, Retro-Commissioning, New Construction), breaking the custom strata into large, medium, and small projects. This method included several steps:

1. Calculate adjusted gross savings for the sample of site visit projects.
2. Calculate a realization rate, based on *ex ante* and adjusted gross savings, for the total sample within each strata.
3. Apply sample realization rates to the program population for each measure strata to calculate total program verified and adjusted gross savings.
4. Apply adjusted gross savings realization rates, developed for each stratum, across that population subgroup. We hand-selected 15 of the 37 sampled projects due to the magnitude of claimed savings relative to the associated strata. Because we selected those projects individually (not randomly), we did not apply the evaluated results and adjusted gross savings realization rates from those projects to the stratum population.

## *Detailed Impact Finding Gross Savings Results*

Table 81 and Table 82 summarize verified and adjusted energy savings and demand reduction results, respectively, by project type for the sample.

**Table 81. Gross *Ex Ante* Claimed and Adjusted Gross Savings for Sampled Projects**

| Project Type | Number of Projects | *Ex Ante* Gross Energy Savings (kWh) | Verified Energy Savings (kWh) | Adjusted Energy Savings (kWh) | Energy Savings Realization Rate (%) |
|---|---|---|---|---|---|
| Custom Large | 5 | 4,215,831 | 4,070,626 | 4,070,626 | 97% |
| Custom Medium | 8 | 2,115,439 | 1,818,493 | 1,818,493 | 86% |
| Custom Small | 5 | 208,209 | 211,312 | 211,312 | 101% |
| Retro-Commissioning | 6 | 1,721,021 | 1,721,021 | 1,721,021 | 100% |
| New Construction | 13 | 2,527,304 | 2,824,185 | 2,824,185 | 112% |
| **Total** | **37** | **10,787,804** | **10,645,637** | **10,645,637** | **99%** |

Note: Total values in table are rounded for reporting purposes.

**Table 82. Gross *Ex Ante* and Adjusted Gross Demand Reduction for Sampled Projects**

| Project Type | Number of Projects | *Ex Ante* Gross Demand Reduction (kW) | Verified Demand Reduction (kW) | Adjusted Demand Reduction (kW) | Demand Savings Realization Rate (%) |
|---|---|---|---|---|---|
| Custom Large | 5 | 587.5 | 574.7 | 574.7 | 98% |
| Custom Medium | 8 | 259.1 | 236.3 | 236.3 | 91% |
| Custom Small | 5 | 23.0 | 21.7 | 21.7 | 94% |
| Retro-Commissioning | 6 | 64.1 | 64.1 | 64.1 | 100% |
| New Construction | 13 | 440.8 | 452.6 | 452.6 | 103% |
| **Total** | **37** | **1,374.6** | **1,349.3** | **1,349.3** | **98%** |

A summary of major differences between *ex ante* savings and adjusted savings by measure category follows.

## Custom

DP&L provided incentives for 39 Custom projects in 2020. Cadmus evaluated 18 Custom projects accounting for 46% of all reported savings in the Custom strata. The sampled projects include lighting upgrades, chilled water plant upgrades, process upgrades, refrigeration measures, and other energy efficiency projects.

Figure 11 and Figure 12 show adjusted gross savings realization rates and associated *ex ante* energy savings and demand reduction, respectively, for each sampled Custom project.

**Figure 11. Custom Energy Savings Sample Results**

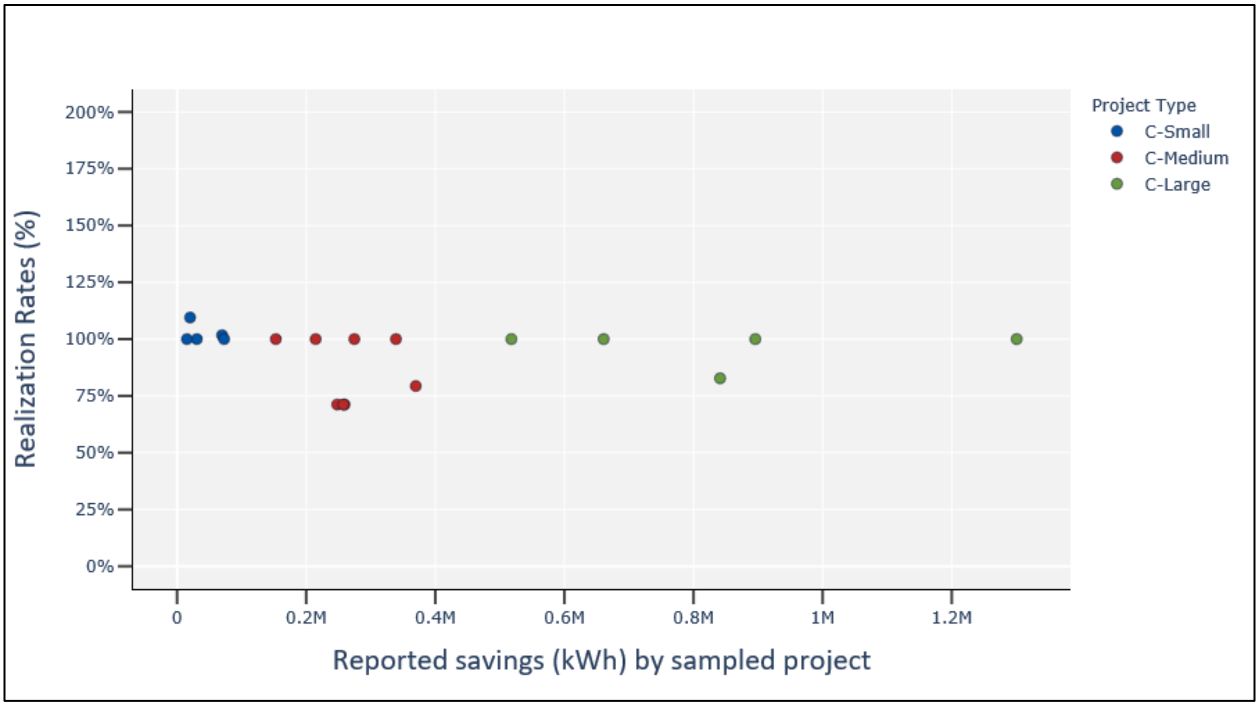
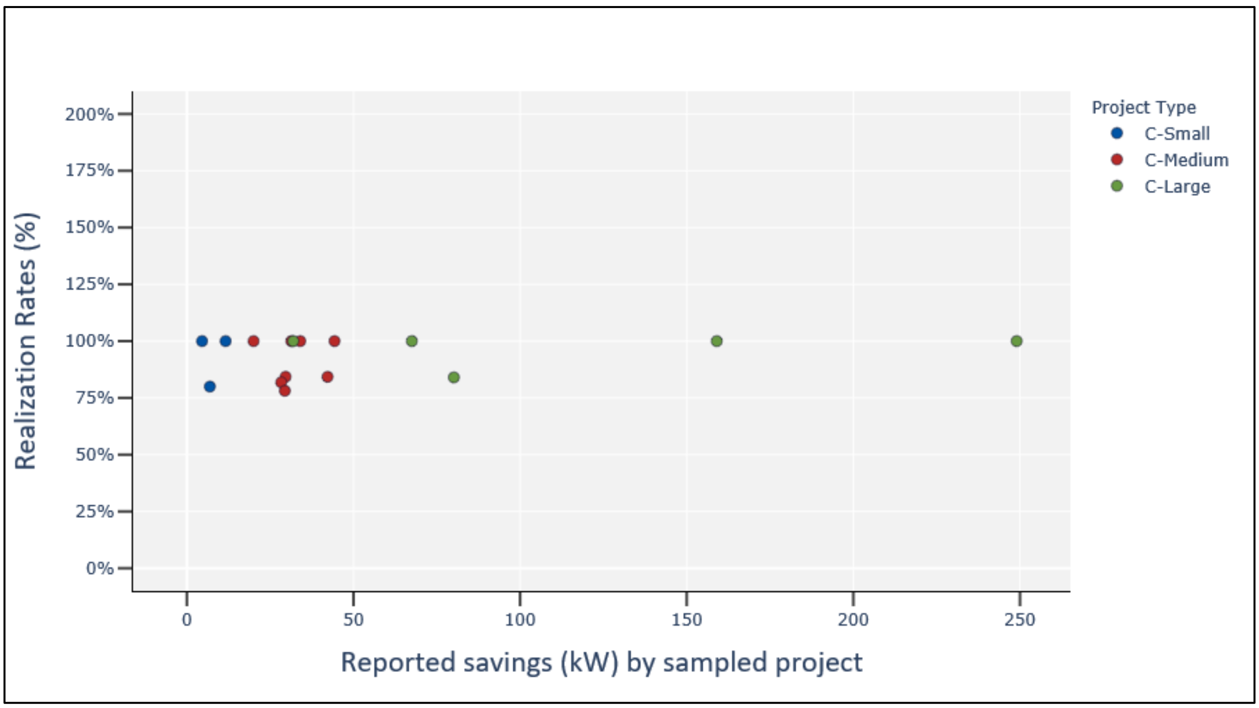



**Figure 12. Custom Demand Reduction Sample Results**




The majority of projects realized energy savings within ±20% of the reported savings. In general, Cadmus found minimal discrepancies in the Custom projects. We found the reported calculation methodologies were appropriate and the verification documentation accurately reflected savings calculations.

However, five of the 18 custom projects involved upgrades at grocery stores to high-efficiency refrigeration display cases. These projects all exhibited similar realization rates between 71% and 83% for annual energy savings and used the same calculation methodology. Cadmus evaluated the equipment specification values for baseline and installed equipment on each project and found they were correct. However, the calculations assumed the refrigeration system operates at the maximum design capacity at all times, aside from the periodic defrost cycles. The compressors on refrigeration display cases cycle on and off to maintain the display case temperature based on the amount and type of product within the cases. This cycling of compressors, referred to as the “cycling factor”, represents the average system loading relative to capacity. Cadmus applied the “cycling factor” to the energy savings calculations based on the refrigerated display case upgrade measure from the California TRM. After accounting for the cycling factor, these projects realized lower energy savings.

## Retro-Commissioning

DP&L provided incentives to customers and implementers to implement the retro-commissioning process at customer facilities in 2020. Retro-commissioning is a process to improve the efficiency, performance, and control of an existing building’s mechanical systems, digital controls, and lighting. For each retro-commissioning project, an approved study provider completed an on-site investigation, identified energy saving opportunities, and developed a retro-commissioning study report. Customers implemented the selected energy saving opportunities, generally over a period of 12 weeks, and Heapy, as the program administrator, performed measurement and verification to confirm that energy savings were achieved. Due to the impacts of the COVID-19 pandemic, Heapy could not perform on-site verification of implemented measures and, instead, collected trend data remotely from customers.

Energy savings were reported using spreadsheet calculation workbooks. These workbooks simulate equipment performance based on control strategies and setpoints observed during site visits and analyzed through trend data. Energy savings are predicted based on updated control strategies, setpoints, and proposed performance modifications. Heapy updated reported savings workbooks based on trend data collected after the energy efficiency measures were implemented.

Cadmus evaluated six retro-commissioning projects in 2020. All six projects were evaluated to achieve 100% of their reported annual energy savings and demand reduction savings. In general, Cadmus found the sampled retro-commissioning projects to be well documented with energy savings calculated appropriately. The measures implemented at the six sampled projects represent the most common retro-commissioning measures, with realistic and acceptable energy savings.

Cadmus thoroughly reviewed of all data collected by the implementers during the investigation process and by Heapy during the verification process. Collected data included the investigation report, verification report, documented communication between the implementation team and customers, trend data, calculation workbooks, photos, and notes. In some instances, Cadmus found inconsistencies with the documentation and met with the program administrator to collect additional data or updated documentation to verify performance. The COVID-19 pandemic had an outsized impact on all retro-commissioning projects in 2020. For the sampled projects, an analysis of the facility’s utility bills revealed higher energy use in 2018 and 2019 when compared to 2020. In 2020, customer facilities exhibited lower occupancy levels, internal energy use, and associated cooling loads. Data collected during the investigation phase occurred during spring and summer 2020, after most facilities transitioned to lower energy use. Because of this, the facilities' equipment energy could not be measured or verified pre- and post-COVID. As such, savings associated with the retro-commissioning projects implemented in 2020 likely do not reflect what would be achieved during a typical year. Cadmus evaluated all of retro-commissioning measures based on the savings achieved in 2020 and the persistence of savings may vary depending on the changes in each facility's use characteristics.

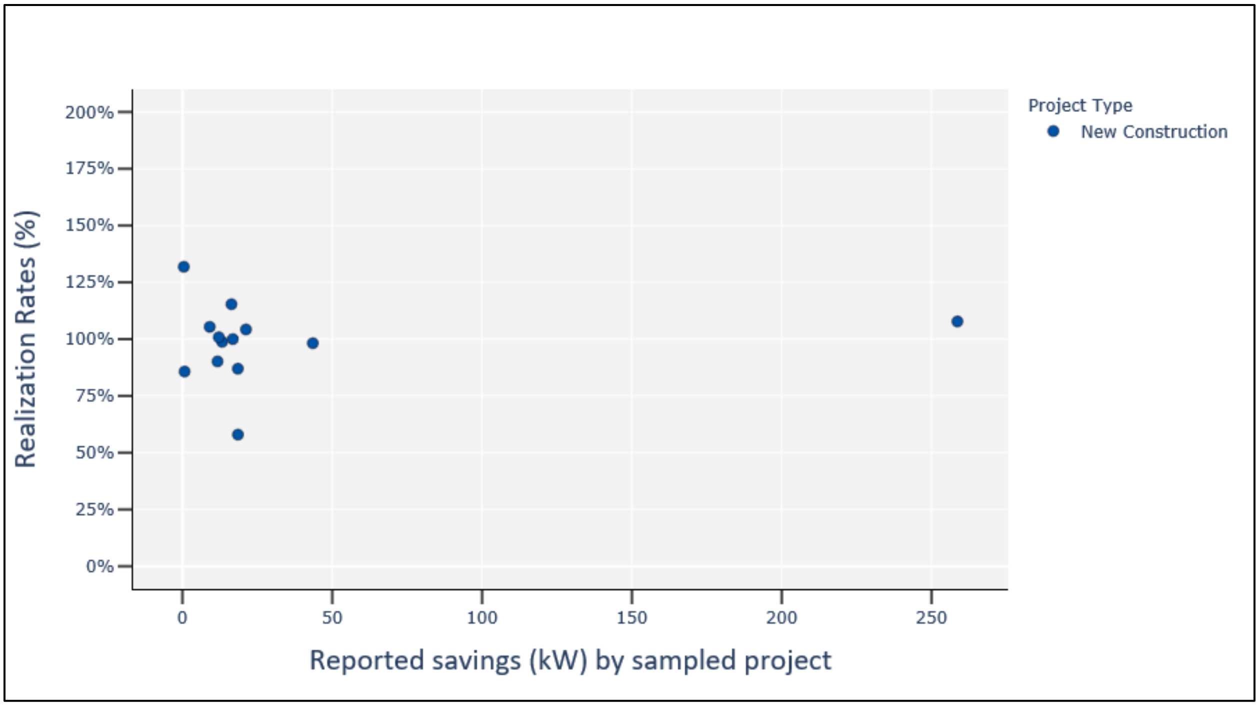
## New Construction

Cadmus sampled and evaluated 13 New Construction projects for 2020. Twelve of these projects were LPD projects involving high-efficiency space lighting design, such that the new lighting power consumption exceeded code efficiency requirements. Typically, DP&L calculated savings for these projects using the space-by-space method, with the maximum lighting wattage per floor area defined for each space type. We evaluated these projects by recalculating savings based on incentive documentation and assessing for reasonableness based on our historical experience evaluating high-efficiency lighting design. Two projects were whole-building projects involving multiple energy efficiency upgrades exceeding code compliance energy efficiency standards. Reported savings for these projects were based on energy simulation models comparing a building with energy efficiency measures meeting minimum code efficiency to the as-built building using the high-efficiency upgrades.

Figure 13 and Figure 14 show adjusted gross savings realization rates and associated *ex ante* energy savings and reduction, respectively, for each sampled New Construction project.

**Figure 13. New Construction Energy Savings Sample Results**

**Figure 14. New Construction Demand Reduction Sample Results**




Two evaluated New Construction projects had realization rates below 80% or above 120% (Table 83).

**Table 83. New Construction Projects with Large Variance between Reported and Evaluated Findings**

| Project | Project Measures | Reported Savings | | Realization Rates | | Notes |
|---|---|---|---|---|---|---|
| | | kWh | kW | kWh | kW | |
| 83OZR6Y1 | LPD reduction in 2,700 sq ft gas auditorium | 907 | 0.4 | 179% | 132% | Reported savings use a baseline LPD value lower than evaluated savings. Evaluated savings based on space-by-space calculation methodology and associated LPD requirements. |
| HT5ZXKZJ | LPD reduction in 21,800 sq ft school | 49,729 | 18.5 | 107% | 58% | Reported savings did not include waste heat factors or a coincident factor for demand savings. |

In general, minimal discrepancies were found among the 13 evaluated projects. Except for the two projects identified in Table 83, all projects realized energy savings within ±20% of their reported savings. Where discrepancies were found, the differences between reported and evaluated values for the savings calculations include total fixtures installed, square footage of space, application of coincident factors, and baseline LPD requirements.

## *Recommendations*

- Cadmus offers no recommendations for the Nonresidential Custom Rebate program.

## Cost-Effectiveness

The Total Resource Cost (TRC) test, which serves as the primary method used to determine program and portfolio cost-effectiveness, derives from the portfolio's ratio of lifecycle benefits over lifecycle incremental costs. The TRC determines whether pursuing energy efficiency proves more cost-effective overall than supplying energy. The TRC does not, however, provide the information necessary to determine whether a portfolio or program proves cost-effective from the perspective of an individual program participant, DP&L, or ratepayers.

Therefore, Cadmus calculated the following additional tests, based on the California Standard Practice Manual for the portfolio of programs and for each individual program implemented in 2020:

- Societal Cost Test (SCT)
- Utility Cost Test (UCT; also known as the program administrator cost test)
- Ratepayer Impact Measure test (RIM)
- Participant Cost Test (PCT)

As Cadmus did not include non-energy benefits in this analysis, the SCT can be only differentiated from the TRC by the discount rate: the SCT uses a 10-year Treasury bill rate (2.91%) to discount future benefits. Applying this as a discount rate for the SCT recognizes that benefits accrue to society in general rather than solely to a utility or participants. Generally, utilities experience high, weighted-capital costs, reflecting the cost of borrowing money and its associated risks. For society as a whole, this presents a low or almost nonexistent risk level, making the Treasury bill rate more appropriate for a total resource perspective.

The UCT serves as a valuation of costs and benefits directly accrued by the utility. In some ways, this means the UCT provides a more even comparison between demand- and supply-side resources, as both include only the utility cost.

The RIM, a valuation of program net benefits as perceived by ratepayers, is measured using the following:

- Electric avoided costs
- Incentive costs (that is, utility measure costs)
- Administrative costs associated with the program
- Lost revenues (equal to participant energy savings benefits)

Table 84 shows the discount rate applied to each benefit/cost test. Details are discussed in *Appendix A.*

**Table 84. Discount Rates for Benefit/Cost Tests**

| Benefit/Cost Test | Discount Rate |
|---|---|
| TRC | 7.86% |
| SCT | 2.91% |
| UTC | 7.86% |
| RIM | 7.86% |
| PCT | 10.00% |

## *Program Benefit Components*

The TRC, UCT, RIM, and SCT counted the following benefits:

- The full value of time and seasonally differentiated avoided generation costs
- Avoided capacity costs

For each energy efficiency measure included in a program, Cadmus adjusted the hourly (8,760), system-avoided costs using the hourly load shape of the end use affected by the measure, capturing the full value of time and the measure's seasonally differentiated impacts.[36]

Cadmus used adjusted gross energy savings and demand reduction to perform the benefit/cost calculations. This did not factor in non-energy benefits (such as water savings), but it did apply line loss—the percentage of energy lost during transmission and distribution—to measure-level savings that reflected total savings from the point of generation. Table 85 specifies the line-loss assumptions.[37]

**Table 85. Line Loss Assumptions Used in Cost-Effectiveness Calculations**

| Sector | Energy Line Losses | Demand Line Losses |
|---|---|---|
| Residential | 7.05% | 8.14% |
| Commercial/Industrial | 3.9% | 5.01% |

## *Program Cost Components*

For the analysis' cost component, Cadmus considered incremental measure costs or project costs, depending on the data available and the direct utility costs.

The evaluation defined incremental measure costs as follows: incremental expenses associated with installations of energy efficiency measures; and, where applicable, ongoing operation and maintenance costs. These costs included the incentive as well as the customer's contribution. Cadmus used data

36 As hourly end-use load shapes were unavailable for DP&L's service area, Cadmus developed these using available data from similar regions (adjusting for weather conditions in DP&L's service territory).

37 Line losses in Table 85 represent the percentage loss in energy and demand from the generation point to the meter.

provided by DP&L as well as secondary sources to calculate the incremental cost for each measure within each program.

Utility costs included customer payments and expenses associated with the following: program development, marketing, delivery, operation, and EM&V. Table 86 summarizes DP&L's implementation and administrative costs (with all utility costs provided by DP&L).

**Table 86. Implementation and Administrative Costs**

| Cost Category | Level | Description |
|---|---|---|
| Staff, Implementation, Vendor, and Marketing Costs | Program Level/ Portfolio Level | Costs to administer energy efficiency programs, including DP&L's fully loaded incremental personnel costs; activities associated with market research outside of EM&V, and incremental costs associated with performing program implementation tasks (such as customer service, application processing, marketing, and customer outreach). |
| Incentive Costs | Program Level | Rebates and incentives paid to customers by DP&L. |
| Direct Measure Costs | Program Level | Costs associated with paying for program measures (such as measures installed through Appliance Recycling, Income Eligible Efficiency Weatherization, School Education, MFDI, and SBDI). |
| External Vendor Evaluations | Portfolio Level | Activities associated with determining and evaluating current and potential energy efficiency programs (such as benefit/cost ratio analysis, impact and process analysis, cost per kilowatt-hour analysis, customer research, and all other analyses necessary for program evaluation). |
| Education, Awareness, and Building and Market Transformation | Portfolio Level | Cost to increase awareness of energy efficiency. |

In programs where the DP&L funds measures' full costs, such costs are modeled as direct measure costs (rather than incentives). These measures set the participant cost at zero and include direct measure costs as a participant benefit. Modeling these programs this manner ensures measure costs in the TRC and benefits in the PCT are included, and participant costs are represented correctly.

The following programs experienced direct-measure costs:

- Appliance Recycling
- Income Eligible Efficiency Weatherization (OPAE and PWC)
- School Education
- Energy Savings Kits
- Small Business Direct Install
- Multi-Family Direct Install

Some projects for the Custom and Nonresidential Prescriptive programs had missing incremental cost data. In such cases, Cadmus relied on the Ohio TRM 2010, as well as on other secondary sources to calculate incremental costs for several measures (such as lighting, HVAC units, and motors). When secondary information proved unavailable, the ratio between reported gross kilowatt-hours and incremental measure costs for projects with data was applied to projects without incremental costs; this determined total incremental costs for cost-effective reporting. For the Self-Directed Mercantile program, as project information was unavailable, Cadmus apportioned the program's *ex ante* savings using the Custom program's measure mix and incremental costs ratios as a template.

## *Overall Portfolio Cost-Effectiveness Results*

The following sections present full portfolio cost-effectiveness results and sector-specific results.

### Full Portfolio Results

Utilizing adjusted gross savings, Table 87 summarizes *ex ante* energy savings, demand impacts, and costs for DP&L's entire energy efficiency portfolio. The portfolio includes the following:

- DP&L's 10 residential sector programs: Lighting, Appliance Recycling, Income Eligible Efficiency (with OPAE and PWC program channels) Heating and Cooling Rebates, Smart Thermostats, Multi-Family Direct Install, Energy Savings Kits, Behavior Change, and School Education.
- DP&L's four nonresidential programs: Prescriptive Rebate (including the Nonresidential Midstream Incentive Channel), Custom Rebate, Small Business Direct Install, and Self-Directed Mercantile.
- Portfolio costs for education and awareness.
- EM&V costs.

**Table 87. Portfolio Energy Impacts and Costs**

| Benefit/Cost Component | 2020 Values |
|---|---|
| Gross Savings (MWh) | 229,772 |
| Capacity Savings (kW) | 34,361.6 |
| Total TRC Costs | 59,354,785 |
| Direct Participant Costs | 50,949,933 |
| **Direct Utility Costs** | **$22,865,239** |
| Incentives | $14,408,822 |
| Direct Measure Costs | $1,443,891 |
| Staff, Implementation, Vendor, and Marketing | $5,484,179 |
| External Vendor Evaluations | $853,937 |
| Increased Fuel Use from Negative Saving Measures | $21,679 |
| Education, Awareness Building and Market Transformation | $652,731 |

The portfolio passed the TRC test with a 2.26 benefit/cost ratio. All other tests had benefit/cost ratios above 1.0. Table 88 shows benefits, costs, and benefit/cost ratios for each test.

**Table 88. Portfolio Cost-Effective Test Results**

| Cost-Effective Test | Present Value Benefits | Present Value Costs | Benefit/Cost Ratio |
|---|---|---|---|
| TRC | $128,908,419 | $59,354,785 | **2.17** |
| UCT | $119,914,319 | $22,865,239 | **5.24** |
| PCT | $182,986,649 | $50,949,933 | **3.59** |
| RIM | $120,201,135 | $211,241,411 | **0.57** |
| SCT | $173,098,125 | $59,355,829 | **2.92** |

## Residential Portfolio Results

Overall, the residential portfolio proved cost-effective, with a 4.33 TRC. The Heating and Cooling Rebates and Residential Income Eligible Efficiency programs did not pass the TRC test as standalone programs. These programs, however, provided numerous non-energy benefits, such as better health and safety for low-income customers.

Cadmus estimated Behavior Change program uplift (the effect of the program on participation in other DP&L efficiency programs) and the energy savings resulting from uplift in 2020. Participation uplift savings appeared in the regression-based estimate of Behavior Change program savings and the savings of any other DP&L efficiency programs that experienced uplift. Therefore, the Behavior Change program benefits that were counted in other programs were subtracted from DP&L's residential portfolio savings to avoid counting the savings twice.

All residential portfolio programs incorporating energy efficiency lighting included avoided replacement costs as a TRC, PCT, and SCT benefit.

Table 89 and Table 90 summarize energy savings, demand impacts, and costs for DP&L's residential programs.

**Table 89. Residential Portfolio Benefits and Costs (Part 1 of 2)**

| Benefit/Cost Component | Efficient Products | Heating and Cooling Rebate | Appliance Recycling | School Education | Income Eligible |
|---|---|---|---|---|---|
| Gross Savings (MWh) | 49,773 | 6,458 | 1,959 | 3,430 | 842 |
| Capacity Savings (kW) | 5,954.0 | 1,309.1 | 334.7 | 210.5 | 92.9 |
| Total TRC Costs | $3,266,542 | $7,213,692 | $246,860 | $256,658 | $844,632 |
| Direct Participant Costs | $2,389,878 | $6,775,749 | $0 | $0 | $0 |
| Direct Utility Costs | $3,106,142 | $1,365,278 | $246,860 | $256,658 | $844,632 |
| Incentives | $2,229,477 | $927,335 | $0 | $0 | $0 |
| Direct Measure Costs | $0 | $0 | $83,060 | $0 | $668,746 |
| Staff, Implementation, Increased Fuel Use, Vendor, & Marketing Cost | $876,665 | $437,943 | $163,800 | $256,658 | $175,886 |
| **Benefit-Cost Ratios** | | | | | |
| **TRC** | | | | | |
| Present Value Benefits | $42,705,468 | $3,747,144 | $803,333 | $1,108,942 | $584,824 |
| Present Value Costs | $3,266,542 | $7,213,692 | $246,860 | $256,658 | $844,632 |
| **Benefit-Cost Ratio** | **13.07** | **0.52** | **3.25** | **4.32** | **0.69** |
| **Utility** | | | | | |
| Present Value Benefits | $36,889,211 | $3,747,144 | $793,569 | $1,038,005 | $570,136 |
| Present Value Costs | $3,106,142 | $1,365,278 | $246,860 | $256,658 | $844,632 |
| **Benefit-Cost Ratio** | **11.88** | **2.74** | **3.21** | **4.04** | **0.68** |
| **Participant** | | | | | |
| Present Value Benefits | $64,590,332 | $5,932,378 | $1,501,907 | $2,279,413 | $948,854 |
| Present Value Costs | $2,389,878 | $6,775,749 | $0 | $0 | $0 |
| **Benefit-Cost Ratio** | **27.03** | **0.88** | **N/A** | **N/A** | **N/A** |
| **RIM** | | | | | |
| Present Value Benefits | $36,889,211 | $3,747,144 | $793,569 | $1,038,005 | $570,136 |
| Present Value Costs | $68,858,245 | $7,826,245 | $1,807,144 | $2,571,195 | $1,873,661 |
| **Benefit-Cost Ratio** | **0.54** | **0.48** | **0.44** | **0.40** | **0.30** |
| **Societal** | | | | | |
| Present Value Benefits | $62,688,341 | $5,362,456 | $973,783 | $1,403,810 | $838,880 |
| Present Value Costs | $3,266,542 | $7,213,692 | $246,860 | $256,658 | $844,632 |
| **Benefit-Cost Ratio** | **19.19** | **0.74** | **3.94** | **5.47** | **0.99** |

**Table 90. Residential Portfolio Benefits and Costs (Part 2 of 2)**

| Benefit/Cost Component | Smart Thermostats | Energy Savings Kits | Multi-Family Direct Install | Behavior Change | Behavior Change Uplift Adjust | Total |
|---|---|---|---|---|---|---|
| Gross Savings (MWh) | 4,954 | 5,252 | 288 | 8,358 | -819 | 80,494 |
| Capacity Savings (kW) | 421.1 | 578 | 30.4 | 1,441.8 | -65.5 | 10,308 |
| Total TRC Costs | $1,513,282 | $357,103 | $77,848 | $348,267 | $0 | $14,124,886 |
| Direct Participant Costs | $1,409,430 | $0 | $0 | $51,565 | $0 | $10,626,622 |
| Direct Utility Costs | $655,993 | $357,103 | $77,848 | $348,267[1] | $0 | $7,258,783 |
| Incentives | $552,142 | $0 | $0 | $0 | $0 | $3,708,954 |
| Direct Measure Costs | $0 | $255,543 | $48,186 | $0 | $0 | $1,055,535 |
| Staff, Implementation, Increased Fuel Use, Vendor, & Marketing Cost | $103,852 | $101,560 | $29,662 | $326,588 | $0 | $2,472,615 |
| **Benefit-Cost Ratios** | | | | | | |
| **TRC** | | | | | | |
| Present Value Benefits | $2,458,567 | $3,031,948 | $196,082 | $1,253,987 | $(110,088.64) | $55,780,207 |
| Present Value Costs | $1,513,282 | $357,103 | $77,848 | $348,267 | $0 | $14,124,886 |
| **Benefit-Cost Ratio** | **1.62** | **8.49** | **2.52** | **3.60** | **N/A** | **3.95** |
| **Utility** | | | | | | |
| Present Value Benefits | $2,458,567 | $2,704,989 | $173,194 | $1,253,987 | $(110,088.64) | $49,518,713 |
| Present Value Costs | $655,993 | $357,103 | $77,848 | $348,267 | $0 | $7,258,783 |
| **Benefit-Cost Ratio** | **3.75** | **7.57** | **2.22** | **3.60** | **N/A** | **6.82** |
| **Participant** | | | | | | |
| Present Value Benefits | $4,537,913 | $4,927,470 | $303,513 | $2,982,714 | $(287,136.79) | $87,717,356 |
| Present Value Costs | $1,409,430 | $0 | $0 | $51,565 | $0 | $10,626,622 |
| **Benefit-Cost Ratio** | **3.22** | **N/A** | **N/A** | **57.84** | **N/A** | **8.25** |
| **RIM** | | | | | | |
| Present Value Benefits | $2,458,567 | $2,704,989 | $173,194 | $1,253,987 | $229,588 | $49,805,529 |
| Present Value Costs | $2,968,219 | $2,778,339 | $210,558 | $3,815,756 | $0 | $47,302,550 |
| **Benefit-Cost Ratio** | **0.83** | **0.97** | **0.82** | **0.33** | **N/A** | **0.51** |
| **Societal** | | | | | | |
| Present Value Benefits | $3,127,859 | $4,248,080 | $281,210 | $1,314,396 | $(115,371.61) | $80,123,443 |
| Present Value Costs | $1,513,282 | $357,103 | $77,848 | $349,312 | $0 | $14,125,930 |
| **Benefit-Cost Ratio** | **2.07** | **11.90** | **3.61** | **3.76** | **N/A** | **5.67** |

Note: Total values in table are rounded for reporting purposes.

[1] Direct utility costs for the Behavior Change program include $21,679 in increased fuel use costs due to negative saving measures.

## Nonresidential Portfolio Results

Table 91 summarizes energy savings, demand impacts, and costs for DP&L's C&I programs. Overall, the nonresidential portfolio proved cost-effective, with a 1.67 TRC. Furthermore, all programs proved cost-effective from the TRC perspective.

**Table 91. Nonresidential Portfolio**

| Benefit/Cost Component | Prescriptive | Custom | Small Business Direct Install | Mercantile | Total |
|---|---|---|---|---|---|
| Gross Savings (MWh) | 114,489 | 29,287 | 3,044 | 2,458 | 149,277 |
| Capacity Savings (kW) | 18,695.3 | 4,326.2 | 676.2 | 356.5 | 24,054 |
| Total TRC Costs | $32,400,859 | $9,927,604 | $621,000 | $773,768 | $43,723,231 |
| Direct Participant Costs | $30,519,291 | $9,044,951 | $0 | $759,069 | $40,323,311 |
| Direct Utility Costs | $9,621,886 | $3,754,785 | $621,000 | $102,116 | $14,099,788 |
| Incentives | $7,740,319 | $2,872,132 | $0 | $87,418 | $10,699,868 |
| Direct Measure Costs | $0 | $0 | $388,355 | $0 | $388,355 |
| Staff, Implementation, Increased Fuel Use, Vendor, & Marketing Cost | $1,881,567 | $882,653 | $232,645 | $14,699 | $3,011,564 |
| **Benefit-Cost Ratios** | | | | | |
| **TRC** | | | | | |
| Present Value Benefits | $54,231,849 | $15,859,304 | $1,710,468 | $1,326,591 | $73,128,212 |
| Present Value Costs | $32,400,859 | $9,927,604 | $621,000 | $773,768 | $43,723,231 |
| **Benefit-Cost Ratio** | **1.67** | **1.60** | **2.75** | **1.71** | **1.67** |
| **Utility** | | | | | |
| Present Value Benefits | $51,503,632 | $15,859,304 | $1,706,079 | $1,326,591 | $70,395,606 |
| Present Value Costs | $9,621,886 | $3,754,785 | $621,000 | $102,116 | $14,099,788 |
| **Benefit-Cost Ratio** | **5.35** | **4.22** | **2.75** | **12.99** | **4.99** |
| **Participant** | | | | | |
| Present Value Benefits | $71,370,873 | $20,172,767 | $2,032,718 | $1,692,935 | $95,269,293 |
| Present Value Costs | $30,519,291 | $9,044,951 | $0 | $759,069 | $40,323,311 |
| **Benefit-Cost Ratio** | **2.34** | **2.23** | **N/A** | **2.23** | **2.36** |
| **RIM** | | | | | |
| Present Value Benefits | $51,503,632 | $15,859,304 | $1,706,079 | $1,326,591 | $70,395,606 |
| Present Value Costs | $82,214,101 | $25,362,864 | $2,788,620 | $1,915,506 | $112,281,092 |
| **Benefit-Cost Ratio** | **0.63** | **0.63** | **0.61** | **0.69** | **0.63** |
| **Societal** | | | | | |
| Present Value Benefits | $68,129,836 | $20,873,712 | $2,225,318 | $1,745,816 | $92,974,681 |
| Present Value Costs | $32,400,859 | $9,927,604 | $621,000 | $773,768 | $43,723,231 |
| **Benefit-Cost Ratio** | **2.10** | **2.10** | **3.58** | **2.26** | **2.13** |

Note: Total values in table are rounded for reporting purposes.

# Appendices: 2020 Evaluation Report

Appendices are provided on the following pages:

- Appendix A. *Ex Post* Measure-Level Savings
- Appendix B. *Ex Ante* Measure-Level Savings
- Appendix C. Program Measure-Level Incentives
- Appendix D. Evaluated Energy Savings Calculation Sources
- Appendix E. Cost-Effectiveness Analysis Inputs
- Appendix F. Energy Savings and Demand Reduction Confidence and Precision
- Appendix G. *Ex Ante* Measure-Level Savings Documentation
- Appendix H. Residential Behavior Change Program Impact Evaluation Methodology

# Appendix A. *Ex Post* Measure-Level Savings

**Table 92. Measure-Level Savings**

| Program | Measure | Verified Gross Savings | | Adjusted Gross Savings | |
|---|---|---|---|---|---|
| | | kWh | kW | kWh | kW |
| **Residential** | | | | | |
| Efficient Products | Upstream LED | 46,255,140 | 5,531.2 | 51,566,053 | 6,325.0 |
| | Upstream Air Purifier | 99,746 | 11.4 | 99,746 | 11.4 |
| | Upstream Dehumidifier | 235,659 | 53.5 | 235,659 | 53.5 |
| | Upstream Advanced Power Strip | 712,330 | 83.2 | 712,330 | 83.2 |
| | Upstream Door Sweep | 104,791 | - | 104,791 | - |
| | Upstream Pipe Wrap | 952,529 | 108.7 | 952,210 | 108.6 |
| | Marketplace LED | 1,095,911 | 131.0 | 1,103,204 | 116.7 |
| | Marketplace LED Night Light | 34,444 | - | 34,444 | - |
| | Marketplace Low-Flow Faucet Aerator | 420 | 0.1 | 420 | 0.1 |
| | Marketplace Low-Flow Showerhead | 1,668 | 0.1 | 1,667 | 0.1 |
| | Marketplace Low-Flow Showerhead w/ Shower Start | 85 | 0.0 | 85 | 0.0 |
| | Marketplace Dehumidifier | 1,105 | 0.3 | 1,105 | 0.3 |
| | Marketplace Heat Pump Water Heater | 18,158 | 2.5 | 18,158 | 2.5 |
| | Advanced Power Strip | 246,720 | 28.8 | 237,345 | 27.7 |
| Appliance Recycling | Recycled Refrigerator | 1,513,600 | 242.0 | 1,099,993 | 174.3 |
| | Recycled Freezer | 251,288 | 40.4 | 145,419 | 23.4 |
| | Recycled Room AC | 11,500 | 17.0 | 10,683 | 13.8 |
| | Recycled Dehumidifier | 99,859 | 26.5 | 99,723 | 26.5 |
| | Energy Kit | 82,445 | 8.8 | 73,770 | 7.8 |
| Income Eligible Efficiency (OPAE) | Aerator | 1,100 | 0.2 | 968 | 0.1 |
| | Air Source Heat pump | 244,056 | 12.6 | 214,769 | 11.0 |
| | Attic Insulation | 12,027 | 0.1 | 10,584 | 0.1 |
| | Central AC | 470 | 0.3 | 414 | 0.3 |
| | Foundation wall insulation | 1,308 | 0.0 | 1,151 | 0.0 |
| | Freezer | 45,951 | 7.0 | 40,437 | 6.1 |
| | Heat Pump Water Heater | 1,673 | 0.2 | 1,472 | 0.1 |
| | LED | 141,836 | 15.5 | 124,815 | 13.7 |
| | Pipe Wrap | 56,540 | 6.4 | 49,755 | 5.7 |
| | Refrigerator | 272,718 | 41.9 | 239,992 | 36.9 |
| | Showerhead | 2,992 | 0.2 | 2,633 | 0.2 |
| | Smart Strip | 47 | 0.0 | 41 | 0.0 |
| | Water Heater Insulation | 251 | 0.0 | 221 | 0.0 |
| Income Eligible Efficiency (PWC) | Air Source Heat pump | 46,255,140 | 5,531.2 | 51,566,053 | 6,325.0 |
| | Attic Insulation | 99,746 | 11.4 | 99,746 | 11.4 |
| | Central AC | 235,659 | 53.5 | 235,659 | 53.5 |
| | Freezer | 712,330 | 83.2 | 712,330 | 83.2 |
| | LED | 104,791 | - | 104,791 | - |
| | Pipe Wrap | 952,529 | 108.7 | 952,210 | 108.6 |
| | Refrigerator | 1,095,911 | 131.0 | 1,103,204 | 116.7 |
| | Wall insulation | 34,444 | - | 34,444 | - |
| | Water Heater Insulation | 420 | 0.1 | 420 | 0.1 |

| Program | Measure | Verified Gross Savings | | Adjusted Gross Savings | |
|---|---|---|---|---|---|
| | | kWh | kW | kWh | kW |
| Heating and Cooling Rebates | ER AC 14/15 SEER | 721,966 | 293.4 | 628,111 | 255.3 |
| | ER AC 16+ SEER | 1,407,502 | 572.2 | 1,224,527 | 555.1 |
| | NC AC 14/15 SEER | 6,422 | 3.4 | 8,478 | 3.6 |
| | NC AC 16+ SEER | 23,816 | 9.7 | 22,625 | 9.4 |
| | RP AC 14/15 SEER | 35,101 | 22.6 | 30,538 | 17.4 |
| | RP AC 16+ SEER | 81,990 | 34.0 | 71,332 | 32.6 |
| | ER HP 14/15 SEER | 290,772 | 37.7 | 270,418 | 33.6 |
| | ER HP 16+ SEER | 1,445,857 | 194.7 | 1,344,647 | 204.5 |
| | NC HP 14/15 SEER | 7,119 | 1.0 | 3,560 | 0.5 |
| | NC HP 16+ SEER | 55,637 | 7.2 | 37,277 | 5.9 |
| | RP HP 14/15 SEER | 24,088 | 3.6 | 22,402 | 1.7 |
| | RP HP 16+ SEER | 103,233 | 12.5 | 96,007 | 12.6 |
| | ER GSHP 16/18 EER | 78,008 | 3.9 | 50,706 | 2.2 |
| | ER GSHP 19+ EER | 304,763 | 20.4 | 198,096 | 16.3 |
| | NC GSHP 16/18 EER | 43,783 | 2.3 | 28,459 | 1.3 |
| | NC GSHP 19+ EER | 120,693 | 9.2 | 96,555 | 6.2 |
| | RP GSHP 16/18 EER | 20,950 | 1.1 | 20,950 | 1.1 |
| | RP GSHP 19+ EER | 120,834 | 9.2 | 96,667 | 8.0 |
| | NC MS AC 16+ SEER | 810 | 0.8 | 607 | 0.6 |
| | NC MS HP 16+ SEER | 344,518 | 18.7 | 361,744 | 15.0 |
| | RP MS HP 16+ SEER | 2,517 | 0.3 | 3,247 | 0.1 |
| | Programmable Wi-Fi Thermostat with AC | 290,580 | - | 293,396 | - |
| | Programmable Wi-Fi Thermostat with HP | 140,360 | - | 141,114 | - |
| | Programmable Wi-Fi Thermostat with GSHP | 14,500 | - | 13,303 | - |
| | Smart Thermostat with AC | 383,380 | 32.6 | 386,101 | - |
| | Smart Thermostat with HP or GSHP | 137,460 | 11.7 | 138,801 | - |
| | Heat Pump Water Heater - Natural Gas Home | 8,304 | 1.1 | 8,304 | 1.1 |
| | Heat Pump Water Heater - Electric Home | 10,376 | 1.4 | 10,376 | 1.4 |
| | Air Sealing | 75,869 | 0.9 | 75,869 | 0.9 |
| | Wall Insulation | 46,232 | 1.0 | 46,232 | 1.0 |
| | Attic Insulation | 109,910 | 2.4 | 109,910 | 2.4 |
| School Education | 9W LED (2) | 3,429,553 | 210.5 | 551,624 | 58.3 |
| | LED Night Light | | | 33,799 | - |
| | Bathroom Faucet Aerator (2) | | | 354,523 | 50.7 |
| | Kitchen Faucet Aerator | | | 1,077,820 | 23.2 |
| | Efficient Showerhead | | | 1,517,060 | 75.7 |
| Smart Thermostats | CLEAResult Mail-in or In-Store Rebates (Retail) | 140,360 | 11.9 | 143,013 | - |
| | Uplight Marketplace & RaAS | 4,587,220 | 389.9 | 4,678,142 | - |
| | Vectren | 226,780 | 19.3 | 231,769 | - |
| Energy Savings Kits | 9W LED (4) | 5,252,266 | 578.4 | 2,565,354 | 271.3 |
| | Bathroom Faucet Aerator | | | 244,897 | 65.6 |

| Program | Measure | Verified Gross Savings | | Adjusted Gross Savings | |
|---|---|---|---|---|---|
| | | kWh | kW | kWh | kW |
| | Kitchen Faucet Aerator | | | 1,084,573 | 46.0 |
| | Efficient Showerhead | | | 1,110,811 | 109 |
| Behavior Change | Paper | 3,061,022 | 528.0 | 3,061,022 | 528.0 |
| | Email + Paper | 1,175,842 | 202.8 | 1,175,842 | 202.8 |
| | Email + Paper + Marketplace | 1,487,304 | 256.6 | 1,487,304 | 256.6 |
| | Email + Marketplace | 812,745 | 140.2 | 812,745 | 140.2 |
| | Marketplace | (185,335) | (32.0) | (185,335) | (32.0) |
| Multi-Family Direct Install | 5-Watt LED Globe | 19,220 | 2.3 | 21,997 | 2.4 |
| | 9-Watt LED | 167,809 | 20.1 | 171,173 | 19.1 |
| | Bath Aerator | 4,992 | 2.1 | 6,756 | 1.4 |
| | BR 30 LED | - | - | - | - |
| | Kitchen Aerator | 4,230 | 0.3 | 16,619 | 0.9 |
| | LED Night-Light | 12,221 | - | 2,210 | - |
| | Showerhead | 23,585 | 0.2 | 25,435 | 1.7 |
| | Smart Strip | 56,055 | 5.5 | 50,778 | 5.9 |
| **Nonresidential** | | | | | |
| Small Business Direct Install | 2'LEDT8Replacements | 910 | 0.2 | 881 | 0.2 |
| | 4'LEDT8Replacements | 2,347,942 | 530.3 | 2,253,153 | 510.3 |
| | LEDA-lineLamps9W | 297,815 | 70.2 | 283,627 | 66.9 |
| | LEDBR30Lamps10W | 143,485 | 34.5 | 147,069 | 35.4 |
| | LEDPAR30Lamps10W | 4,069 | 0.9 | 3,707 | 0.8 |
| | LEDPAR38Lamps17W | 26,753 | 6.2 | 26,859 | 6.2 |
| | LED-ExitSigns | 1,376 | 0.2 | 1,467 | 0.2 |
| | FaucetAerator1.5GPM | 145,854 | 32.7 | 54,108 | 15.4 |
| | OccupancySensor | 11,555 | 0.7 | 13,377 | 0.6 |
| | Pre-RinseSprayValve(ElecDHW) | 62,716 | - | 73,175 | - |
| | Showerhead | 436 | 0.2 | 372 | 0.2 |
| | WaterHeaterPipeInsulation(ElecDHW) | 626 | 0.1 | 584 | 0.1 |
| Nonresidential Prescriptive | Lighting | 50,669,452 | 7,541.4 | 50,669,452 | 7,541.4 |
| | CompressedAir | 1,847,150 | 129.0 | 1,847,150 | 129.0 |
| | Motors | 918,032 | 145.9 | 918,032 | 145.9 |
| | HVAC | 5,534,211 | 466.5 | 5,534,211 | 466.5 |
| | MidstreamLighting | 50,709,833 | 8,767.5 | 44,208,718 | 7,853.3 |
| | MidstreamHVAC | 2,623,397 | 416.5 | 2,671,563 | 389.1 |
| | UpstreamLighting | - | - | 6,740,741 | 1,585.0 |
| | ApplianceRecycling | 55,915 | 9.5 | 40,238 | 6.9 |
| Nonresidential Custom | Custom | 29,338,969 | 4,186.5 | 29,338,969 | 4,186.5 |
| **Total (without Behavior Uplift Adjustment or Mercantile)[a]** | | 224,033,053 | 32,362.2 | 228,152,768 | 33,015.7 |

Note: Total values in table are rounded for reporting purposes.

[a] Cadmus does not evaluate the Mercantile Self-Direct program. *Ex ante* savings were provided by DP&L and carried forward to verified and *ex post.*

# Appendix B. *Ex Ante* Measure-Level Savings

**Table 93. *Ex Ante* Measure-Level Savings**

| Program | Measure | Verified Participation Count (Measures) | *Ex Ante* Per Unit kWh Impact | Ex Ante Per Unit kW Impact | *Total Ex* Ante kWh Savings | Total *Ex Ante* kW Savings |
|---|---|---|---|---|---|---|
| **Residential** | | | | | | |
| Efficient Products | Upstream LED | 1,480,262 | 31.24 | 0.00 | 46,242,447 | 5,531.0 |
| | Upstream Air Purifier | 287 | 347.55 | 0.04 | 99,746 | 11.4 |
| | Upstream Dehumidifier | 2,217 | 106.30 | 0.02 | 235,659 | 53.5 |
| | Upstream Advanced Power Strip | 7,218 | 102.80 | 0.01 | 742,010 | 86.6 |
| | Upstream Door Sweep | 5,156 | 20.30 | 0.00 | 104,667 | 0.0 |
| | Upstream Pipe Wrap | 22,806 | 41.26 | 0.00 | 940,878 | 108.2 |
| | Marketplace LED | 38,343 | 28.67 | 0.00 | 1,099,319 | 131.5 |
| | Marketplace LED Night Light | 2,758 | 13.72 | 0.00 | 37,840 | 0.0 |
| | Marketplace Low-Flow Faucet Aerator | 29 | 14.48 | 0.00 | 420 | 0.1 |
| | Marketplace Low-Flow Showerhead | 23 | 72.50 | 0.00 | 1,668 | 0.1 |
| | Marketplace Low-Flow Showerhead w/ Shower Start | 1 | 84.86 | 0.01 | 85 | 0.0 |
| | Marketplace Dehumidifier | 26 | 42.50 | 0.01 | 1,105 | 0.3 |
| | Marketplace Heat Pump Water Heater | 14 | 1,297.00 | 0.18 | 18,158 | 2.5 |
| | Advanced Power Strip | 2,405 | 103.36 | 0.01 | 248,570 | 29.0 |
| Appliance Recycling | Refrigerator Replacement | 1,100 | 1,376.00 | 0.22 | 1,513,600 | 242.0 |
| | Freezer Replacement | 202 | 1,244.00 | 0.20 | 251,288 | 40.4 |
| | Room Air Conditioner | 111 | 103.60 | 0.15 | 11,500 | 17.0 |
| | Dehumidifier | 112 | 891.60 | 0.24 | 99,859 | 26.5 |
| | LED only Energy Kit | 1,216 | 67.80 | 0.01 | 82,445 | 8.8 |
| Income Eligible Efficiency (OPAE)[a] | Aerator | 25 | 44.00 | 0.01 | 1,100 | 0.2 |
| | Air Source Heat pump | 79 | 3,089.32 | 0.16 | 244,056 | 12.6 |
| | Attic Insulation | 4,735 | 2.54 | 0.00 | 12,027 | 0.1 |
| | Central AC | 2 | 235.00 | 0.15 | 470 | 0.3 |
| | Foundation wall insulation | 388 | 3.37 | 0.00 | 1,308 | 0.0 |
| | Freezer | 53 | 867.00 | 0.13 | 45,951 | 7.0 |
| | Heat Pump Water Heater | 1 | 1,672.94 | 0.17 | 1,673 | 0.2 |
| | LED | 3,835 | 36.98 | 0.00 | 141,836 | 15.5 |
| | Pipe Wrap | 514 | 110.00 | 0.01 | 56,540 | 6.4 |

| Program | Measure | Verified Participation Count (Measures) | *Ex Ante* Per Unit kWh Impact | Ex Ante Per Unit kW Impact | *Total Ex* Ante kWh Savings | Total *Ex Ante* kW Savings |
|---|---|---|---|---|---|---|
| | Refrigerator | 218 | 1,251.00 | 0.19 | 272,718 | 41.9 |
| | Showerhead | 17 | 176.00 | 0.01 | 2,992 | 0.2 |
| | Smart Strip | 1 | 47.00 | 0.01 | 47 | 0.0 |
| | Water Heater Insulation | 3 | 83.83 | 0.01 | 251 | 0.0 |
| Income Eligible Efficiency (PWC) | Air Source Heat pump | 1 | 639.00 | 0.16 | 639 | 0.2 |
| | Attic Insulation | 1,481 | 2.54 | 0.00 | 3,762 | 0.0 |
| | Central AC | 7 | 235.00 | 0.15 | 1,645 | 1.1 |
| | Freezer | 4 | 867.00 | 0.13 | 3,468 | 0.5 |
| | LED | 506 | 35.10 | 0.00 | 17,759 | 2.0 |
| | Pipe Wrap | 18 | 110.00 | 0.01 | 1,980 | 0.2 |
| | Refrigerator | 23 | 1,251.00 | 0.19 | 28,773 | 4.4 |
| | Wall insulation | 1,440 | 1.99 | 0.00 | 2,866 | 0.1 |
| | Water Heater Insulation | 1 | 83.83 | 0.01 | 84 | 0.0 |
| Heating and Cooling Rebates | ER AC 14/15 SEER | 663 | 1,089 | 0 | 721,966 | 293.4 |
| | ER AC 16+ SEER | 1,130 | 1,246 | 1 | 1,407,502 | 572.2 |
| | NC AC 14/15 SEER | 40 | 161 | 0 | 6,422 | 3.4 |
| | NC AC 16+ SEER | 53 | 449 | 0 | 23,816 | 9.7 |
| | RP AC 14/15 SEER | 179 | 196 | 0 | 34,905 | 22.5 |
| | RP AC 16+ SEER | 159 | 516 | 0 | 82,506 | 34.2 |
| | ER HP 14/15 SEER | 94 | 3,093 | 0 | 290,772 | 37.7 |
| | ER HP 16+ SEER | 438 | 3,301 | 0 | 1,445,857 | 194.7 |
| | NC HP 14/15 SEER | 8 | 890 | 0 | 7,119 | 1.0 |
| | NC HP 16+ SEER | 39 | 1,427 | 0 | 55,637 | 7.2 |
| | RP HP 14/15 SEER | 25 | 964 | 0 | 24,088 | 3.6 |
| | RP HP 16+ SEER | 71 | 1,454 | 0 | 103,233 | 12.5 |
| | ER GSHP 16/18 EER | 11 | 7,092 | 0 | 78,008 | 3.9 |
| | ER GSHP 19+ EER | 45 | 6,773 | 0 | 304,763 | 20.4 |
| | NC GSHP 16/18 EER | 7 | 6,255 | 0 | 43,783 | 2.3 |
| | NC GSHP 19+ EER | 19 | 6,352 | 0 | 120,693 | 9.2 |
| | RP GSHP 16/18 EER | 3 | 6,983 | 0 | 20,950 | 1.1 |
| | RP GSHP 19+ EER | 18 | 6,713 | 1 | 120,834 | 9.2 |
| | NC MS AC 16+ SEER | 9 | 90 | 0 | 810 | 0.8 |
| | NC MS HP 16+ SEER | 155 | 2,223 | 0 | 344,518 | 18.7 |

| Program | Measure | Verified Participation Count (Measures) | *Ex Ante* Per Unit kWh Impact | Ex Ante Per Unit kW Impact | *Total Ex* Ante kWh Savings | Total *Ex Ante* kW Savings |
|---|---|---|---|---|---|---|
| | RP MS HP 16+ SEER | 1 | 2,517 | 0 | 2,517 | 0.3 |
| | Programmable Wi-Fi Thermostat with AC | 501 | 580 | 0 | 290,580 | 0.0 |
| | Programmable Wi-Fi Thermostat with HP | 242 | 580 | 0 | 140,360 | 0.0 |
| | Programmable Wi-Fi Thermostat with GSHP | 25 | 580 | 0 | 14,500 | 0.0 |
| | Smart Thermostat with AC | 661 | 580 | 0 | 383,380 | 32.6 |
| | Smart Thermostat with HP or GSHP | 237 | 580 | 0 | 137,460 | 11.7 |
| | Heat Pump Water Heater - Natural Gas Home | 4 | 2,076 | 0 | 8,304 | 1.1 |
| | Heat Pump Water Heater - Electric Home | 8 | 1,297 | 0 | 10,376 | 1.4 |
| | Air Sealing | 113 | 671 | 0 | 75,869 | 0.9 |
| | Wall Insulation | 18 | 2,568 | 0 | 46,232 | 1.0 |
| | Attic Insulation | 106 | 1,037 | 0 | 109,910 | 2.4 |
| School Education | 9W LED (2) | 17,690 | 387.74 | 0.0238 | 3,429,553 | 210.5 |
| | LED Night Light | 8,845 | | | | |
| | Bathroom Faucet Aerator (2) | 17,690 | | | | |
| | Kitchen Faucet Aerator | 8,845 | | | | |
| | Efficient Showerhead | 8,845 | | | | |
| Smart Thermostats | CLEAResult Mail-in or In-Store Rebates (Retail) | 242 | 580.00 | 0.049 | 140,360 | 11.9 |
| | Uplight Marketplace & RaaS | 7,909 | 580.00 | 0.049 | 4,587,220 | 389.9 |
| | Vectren | 391 | 580.00 | 0.049 | 226,780 | 19.3 |
| Energy Savings Kits | 9W LED (4) | 85,368 | 246.10 | 0.0271 | 5,252,266 | 578.4 |
| | Bathroom Faucet Aerator | 21,342 | | | | |
| | Kitchen Faucet Aerator | 21,342 | | | | |
| | Efficient Showerhead | 21,342 | | | | |
| Behavior Change | Email + Paper | 10,994 | 0.37 | 0.00 | 1,596,564 | 275.4 |
| | Email + Paper + Marketplace | 22,043 | 0.23 | 0.00 | 1,951,649 | 336.7 |
| | Email + Marketplace | 41,800 | 0.07 | 0.00 | 1,191,282 | 205.5 |
| | Marketplace | 10,925 | -0.06 | 0.00 | -147,036 | -25.4 |
| | Paper | 28,989 | 0.37 | 0.00 | 3,765,545 | 649.6 |
| Multi-Family Direct Install | 5-Watt LED Globe | 609 | 31.56 | 0.0037 | 19,220 | 2.3 |
| | 9-Watt LED | 5,277 | 31.80 | 0.0038 | 167,809 | 20.1 |
| | Bath Aerator | 104 | 48.00 | 0.0200 | 4,992 | 2.1 |
| | BR 30 LED | 0 | 0.00 | 0.0000 | 0 | 0.0 |
| | Kitchen Aerator | 90 | 47.00 | 0.0030 | 4,230 | 0.3 |

| Program | Measure | Verified Participation Count (Measures) | *Ex Ante* Per Unit kWh Impact | Ex Ante Per Unit kW Impact | *Total Ex* Ante kWh Savings | Total *Ex Ante* kW Savings |
|---|---|---|---|---|---|---|
| | LED Night-Light | 580 | 21.07 | 0.0000 | 12,221 | 0.0 |
| | Showerhead | 89 | 265.00 | 0.0020 | 23,585 | 0.2 |
| | Smart Strip | 555 | 101.00 | 0.0100 | 56,055 | 5.5 |
| Small Business Direct Install | 2' LED T8 Replacements | 31 | 29 | 0.007 | 910 | 0.2 |
| | 4' LED T8 Replacements | 35,171 | 67 | 0.015 | 2,347,942 | 530.3 |
| | LED A-line Lamps 9W | 2,507 | 119 | 0.028 | 297,815 | 70.2 |
| | LED BR30 Lamps 10W | 972 | 148 | 0.036 | 143,485 | 34.5 |
| | LED PAR30 Lamps 10W | 28 | 145 | 0.033 | 4,069 | 0.9 |
| | LED PAR38 Lamps 17W | 129 | 207 | 0.048 | 26,753 | 6.2 |
| | LED - Exit Signs | 17 | 81 | 0.010 | 1,376 | 0.2 |
| | Faucet Aerator 1.5 GPM | 229 | 637 | 0.143 | 145,854 | 32.7 |
| | Occupancy Sensor | 47 | 246 | 0.014 | 11,555 | 0.7 |
| | Pre-Rinse Spray Valve (Elec DHW) | 6 | 10,453 | 0.000 | 62,716 | 0.0 |
| | Showerhead | 4 | 109 | 0.054 | 436 | 0.2 |
| | Water Heater Pipe Insulation (Elec DHW) | 5 | 125 | 0.01 | 626 | 0.1 |
| Non-Residential Prescriptive: HVAC | Unitary and split system A/C 241,000 - 760,000 BTUH (20-63.33 tons) | 9 | 8,380 | 0.00 | 75,418 | 0.0 |
| | Variable frequency drive up to 250 HP | 71 | 86,353 | 15.48 | 6,131,069 | 1,099.4 |
| | Unitary and split system A/C 136,000 - 240,000 BTUH (11.33-20 tons) | 13 | 4,487 | 0.00 | 58,336 | 0.0 |
| | Air Cooled Chiller 150 tons or greater | 3 | 104,985 | 23.35 | 314,955 | 70.1 |
| | Air cooled chiller <150 tons | 6 | 30,008 | 5.26 | 180,050 | 31.6 |
| | Window film | 30 | 1,169 | 0.46 | 35,069 | 13.7 |
| | Variable Refrigerant Flow System 65,000 - 135,000 BTUH | 6 | 2,951 | 1.79 | 17,704 | 10.8 |
| | Smart Thermostat | 17 | 539 | 0.00 | 9,164 | 0.0 |
| | Unitary and split system A/C < 65,000 BTUH (<5.4 tons) | 35 | 630 | 0.49 | 22,051 | 17.3 |
| | Unitary and split system A/C 65,000 - 135,000 BTUH (5.4-11.25 tons) | 31 | 1,846 | 1.45 | 57,241 | 45.0 |
| | Air source heat pump > 240,000 BTUH | 1 | 17,502 | 9.40 | 17,502 | 9.4 |
| | Variable Refrigerant Flow System < 65,000 BTUH | 7 | 1,512 | 0.92 | 10,583 | 6.4 |
| | Packaged terminal air conditioning | 3 | 2,796 | 2.53 | 8,388 | 7.6 |

| Program | Measure | Verified Participation Count (Measures) | *Ex Ante* Per Unit kWh Impact | Ex Ante Per Unit kW Impact | *Total Ex* Ante kWh Savings | Total *Ex Ante* kW Savings |
|---|---|---|---|---|---|---|
| | Air source heat pump < 65,000 BTUH | 4 | 365 | 0.14 | 1,460 | 0.6 |
| | Energy recovery ventilation > 450 CFM | 3 | 3,484 | 2.74 | 10,452 | 8.2 |
| | Outside air economizer with two enthalpy sensors | 1 | 14,399 | 0.00 | 14,399 | 0.0 |
| | Variable Refrigerant Flow System > 240,000 BTUH | 2 | 13,928 | 8.47 | 27,857 | 16.9 |
| | Variable Refrigerant Flow System 136,000 - 240,000 BTUH | 2 | 4,269 | 2.59 | 8,537 | 5.2 |
| Non-Residential Prescriptive: Lighting | LED Replacing 151 W to 200 W HID or Fluorescent | 144 | 41,496 | 7.54 | 5,975,353 | 1,085.7 |
| | LED Replacing 51 W to 100 W HID or Fluorescent | 228 | 7,075 | 1.38 | 1,613,139 | 315.6 |
| | Exterior - LED replacing 175W or less | 354 | 6,038 | 0.00 | 2,137,581 | 0.0 |
| | Exterior - LED replacing 176W to 250W | 178 | 9,511 | 0.00 | 1,693,025 | 0.0 |
| | Exterior - LED replacing 251W or greater | 534 | 15,154 | 0.00 | 8,092,271 | 0.0 |
| | LED Replacing 101 W to 150 W HID or Fluorescent | 208 | 18,372 | 3.95 | 3,821,312 | 820.9 |
| | LED Replacing 351 W to 500 W HID or Fluorescent | 140 | 49,345 | 9.50 | 6,908,263 | 1,330.1 |
| | Lighting controls | 36 | 17,178 | 0.63 | 618,424 | 22.6 |
| | Delamping T8 (# linear feet) | 11 | 17,622 | 3.52 | 193,842 | 38.7 |
| | LED Re-Lamping $1 per foot | 464 | 24,398 | 5.30 | 11,320,846 | 2,458.2 |
| | Energy Star LED screw-in base lamps (replacing CFL) | 62 | 2,618 | 0.69 | 162,324 | 42.5 |
| | Energy Star LED luminaires or screw-in base lamps (replacing incandescent) | 134 | 8,648 | 1.82 | 1,158,872 | 244.2 |
| | LED Replacing 50 W or less HID or Fluorescent | 77 | 6,407 | 1.22 | 493,324 | 94.2 |
| | Exterior LED recessed downlight luminaires or screw-in base lamps (replacing CFL, Energy Star certified) | 14 | 2,046 | 0.00 | 28,648 | 0.0 |
| | LED Replacing 201 W to 350 W HID or Fluorescent | 110 | 27,088 | 4.95 | 2,979,697 | 544.4 |
| | Delamping HID | 9 | 187,809 | 21.01 | 1,690,279 | 189.1 |
| | LED Replacing 501 W or greater HID or Fluorescent | 10 | 129,719 | 47.57 | 1,297,193 | 475.7 |
| | LED or Electroluminescent exit sign | 32 | 1,599 | 0.20 | 51,173 | 6.3 |
| | Exterior LED recessed downlight luminaires or screw-in base lamps (replacing incandescent, ENERGY STAR certified) | 41 | 4,713 | 0.00 | 193,220 | 0.0 |
| | Delamping T12 (# linear feet) | 12 | 8,646 | 2.49 | 103,753 | 29.8 |
| | Exterior Re-Lamping LED Tube | 8 | 1,294 | 0.00 | 10,348 | 0.0 |
| | Exterior - LED or Induction (operating hours < 8,760) replacing 251W or greater | 3 | 30,581 | 0.00 | 91,744 | 0.0 |

| Program | Measure | Verified Participation Count (Measures) | *Ex Ante* Per Unit kWh Impact | Ex Ante Per Unit kW Impact | *Total Ex* Ante kWh Savings | Total *Ex Ante* kW Savings |
|---|---|---|---|---|---|---|
| | Exterior - LED or Induction (operating hours < 8,760) replacing 176W to 250W | 2 | 4,405 | 0.00 | 8,810 | 0.0 |
| | Vending equipment controller | 1 | 1,612 | 0.00 | 1,612 | 0.0 |
| Non-Residential Prescriptive: Compressed Air | Air compressor 1 - 100 HP Variable Speed | 28 | 63,229 | 4.18 | 1,770,413 | 117.1 |
| | No-loss drain | 5 | 10,523 | 1.86 | 52,616 | 9.3 |
| | Air compressor 1 - 100 HP Load/No Load | 6 | 11,291 | 0.89 | 67,745 | 5.4 |
| Non-Residential Prescriptive: Motors | Variable frequency drive up to 250 HP | 20 | 31,774 | 8.63 | 635,471 | 172.6 |
| | Premium Efficiency Motor 3HP | 1 | 570 | 0.02 | 570 | 0.0 |
| Nonresidential Prescriptive: Midstream Incentives | High-Bay/Low-Bay | 10,677 | 1,748 | 0.29 | 18,667,302 | 3,116.4 |
| | LED Exterior Wall Pack | 2,693 | 599 | 0.00 | 1,613,174 | 0.0 |
| | LED Exterior Flood | 3,081 | 898 | 0.00 | 2,765,843 | 0.0 |
| | LED Downlight Kits | 2,542 | 146 | 0.03 | 369,897 | 85.6 |
| | LED T8 | 229,600 | 75 | 0.01 | 17,149,184 | 3,246.2 |
| | Fluorescent T8 | 5,553 | 31 | 0.01 | 170,642 | 30.3 |
| | LED and Fluorescent T5 | 12,936 | 177 | 0.02 | 2,283,896 | 311.5 |
| | LED Fixtures | 9,129 | 148 | 0.03 | 1,348,314 | 255.2 |
| | Occupancy Sensors | 87 | 215 | 0.01 | 18,705 | 0.9 |
| | LED 4-Pin CFL Replacement | 1,736 | 22 | 0.01 | 38,358 | 8.7 |
| | LED Exit Signs | 82 | 83 | 0.01 | 6,806 | 0.8 |
| | LED Screw-In | 45,912 | 157 | 0.04 | 7,205,605 | 1,869.0 |
| | Chillers Air-cooled | 13 | 111,717 | 14.92 | 1,452,315 | 193.9 |
| | Mini-splits | 16 | 574 | 0.05 | 9,185 | 0.8 |
| | Unitary AC | 228 | 876 | 0.28 | 199,715 | 63.6 |
| | Unitary HP | 7 | 372 | 0.16 | 2,601 | 1.1 |
| | Variable Frequency Drive | 23 | 41,721 | 6.83 | 959,580 | 157.0 |
| Nonresidential Prescriptive: Upstream Lighting | LED Lamps | 0 | 0 | 0 | 0 | 0 |
| Nonresidential Appliance Recycling | Refrigerator Replacement | 33 | 1,376.00 | 0.22 | 45,408 | 7.3 |
| | Freezer Replacement | 6 | 1,244.00 | 0.20 | 7,464 | 1.2 |
| | Room Air Conditioner | 3 | 103.60 | 0.15 | 311 | 0.5 |
| | Dehumidifier | 2 | 891.60 | 0.24 | 1,783 | 0.5 |
| | LED only Energy Kit | 14 | 67.80 | 0.01 | 949 | 0.1 |

| Program | Measure | Verified Participation Count (Measures) | *Ex Ante* Per Unit kWh Impact | Ex Ante Per Unit kW Impact | *Total Ex* Ante kWh Savings | Total *Ex Ante* kW Savings |
|---|---|---|---|---|---|---|
| Nonresidential Custom | C-New Construction | 58 | 126,634 | 34.89 | 7,344,783 | 2,023.8 |
| | C-Large | 8 | 1,095,489 | 140.23 | 8,763,909 | 1,121.8 |
| | C-Retrocommissioning | 48 | 176,543 | 12.19 | 8,474,061 | 585.3 |
| | C-Small | 13 | 26,324 | 4.23 | 342,218 | 55.0 |
| | C-Medium | 18 | 242,333 | 30.02 | 4,361,986 | 540.4 |
| | | | | | | |
| **Total without Mercantile[b]** | | | | | **228,132,805** | **34,070.6** |

Note: Total values in table are rounded for reporting purposes.

[a] Participant count for the Income Eligible Efficiency program represents measure count. The exception to this is the insulation and air sealing measures where it represents participants

[b]Cadmus does not evaluate the Mercantile Self-Direct program. *Ex ante* savings were provided by DP&L and carried forward to verified and *ex post.*

# Appendix C. Program Measure-Level Incentives

**Table 94. Program Measure-Level Incentives**

| Program | Measure | Incentives |
|---|---|---|
| **Residential** | | |
| Efficient Products | Upstream LED | $0.25 - $3.75 per lamp (Average: $1.34) |
| | Upstream Air Purifier | $25 |
| | Upstream Dehumidifier | $25 |
| | Upstream Advanced Power Strip | $10 |
| | Upstream Door Sweep | $3 |
| | Upstream Pipe Wrap | $1 |
| | Marketplace LED | $1.50 |
| | Marketplace LED Night Light | $1.50 |
| | Marketplace Low-Flow Faucet Aerator | $0 |
| | Marketplace Low-Flow Showerhead | $0 |
| | Marketplace Low-Flow Showerhead w/ Shower Start | $0 |
| | Marketplace Dehumidifier | $25 |
| | Marketplace Heat Pump Water Heater | $400 |
| | Advanced Power Strip | $10 |
| Appliance Recycling | Recycled Freezer | $50.00 |
| | Recycled Refrigerator | $50.00 |
| | Recycled Room AC | $20.00 |
| | Recycled Dehumidifier | $20.00 |
| | Energy Kit | Provided at no cost to customer |
| Income Eligible Efficinecy (OPAE) | Aerator | Services provided at no cost to customer. Cap of $5,000 in measure costs per home. In addition, agencies can charge 15% of the administrative cost for total installations. |
| | Air Source Heat pump | |
| | Attic Insulation | |
| | Central AC | |
| | Foundation wall insulation | |
| | Freezer | |
| | Heat Pump Water Heater | |
| | LED | |
| | Pipe Wrap | |
| | Refrigerator | |
| | Showerhead | |
| | Smart Strip | |
| | Water Heater Insulation | |
| Income Eligible Efficinecy (PWC) | Air Source Heat pump | Services provided at no cost to customer. Agencies can charge 15% of the administrative cost for total installations. |
| | Attic Insulation | |
| | Central AC | |
| | Freezer | |
| | LED | |
| | Pipe Wrap | |
| | Refrigerator | |
| | Wall insulation | |
| | Water Heater Insulation | |
| Heating and Cooling Rebates | ER AC 14/15 SEER | $100 |
| | ER AC 16+ SEER | $150-$300 |

| Program | Measure | Incentives |
|---|---|---|
| | NC AC 14/15 SEER | $100 |
| | NC AC 16+ SEER | $150-$300 |
| | RP AC 14/15 SEER | $100 |
| | RP AC 16+ SEER | $150-$300 |
| | ER HP 14/15 SEER | $150 |
| | ER HP 16+ SEER | $250-$400 |
| | NC HP 14/15 SEER | $150 |
| | NC HP 16+ SEER | $250-$400 |
| | RP HP 14/15 SEER | $150 |
| | RP HP 16+ SEER | $250-$400 |
| | ER GSHP 16/18 EER | $800 |
| | ER GSHP 19+ EER | $1,000 |
| | NC GSHP 16/18 EER | $800 |
| | NC GSHP 19+ SEER | $1,000 |
| | RP GSHP 16/18 EER | $800 |
| | RP GSHP 19+ EER | $1,000 |
| | NC MS AC 14/15 SEER | $150 |
| | NC MS AC 16+ SEER | $150 |
| | RP MS AC 14/15 SEER | $150 |
| | RP MS AC 16+ SEER | $150 |
| | NC MS HP 14/15 SEER | $200 |
| | NC MS HP 16+ SEER | $200 |
| | RP MS HP 14/15 SEER | $200 |
| | RP MS HP 16+ SEER | $200 |
| | ECM | $50 |
| | ECM with New AC | $50 |
| | ECM with New HP | $25 |
| | Programmable Wi-Fi Thermostat with AC | $20 |
| | Programmable Wi-Fi Thermostat with HP | $40 |
| | Programmable Wi-Fi Thermostat with GSHP | $40 |
| | Smart Thermostat with AC | $50-$75 |
| | Smart Thermostat with HP or GSHP | $50-$75 |
| | Heat Pump Water Heater - Natural Gas Home | $400 |
| | Heat Pump Water Heater - Electric Home | $400 |
| | Air Sealing | $150 |
| | Wall Insulation | $350 |
| | Attic Insulation | $150 |
| School Education | 9W LED (2) | Services provided at no cost to customer |
| | LED Night Light | |
| | Bathroom Faucet Aerator (2) | |
| | Kitchen Faucet Aerator | |
| | Efficient Showerhead | |
| Smart Thermostats | CLEAResult Mail-in or In-Store Rebates (Retail) | $60 |
| | Uplight Marketplace & RaAS | $61 |
| | Vectren | |
| Energy Savings Kits | 9W LED (4) | Services provided at no cost to customer |
| | Bathroom Faucet Aerator | |
| | Kitchen Faucet Aerator | |

| Program | Measure | Incentives |
|---|---|---|
| | Efficient Showerhead | |
| Behavior Change | Home Energy Reports (Paper) | Services provided at no cost to customer |
| | Home Energy Reports (Email) | Services provided at no cost to customer |
| | Marketplace Promotional Emails | Services provided at no cost to customer |
| Multi-Family Direct Install | 5-Watt LED Globe | Services provided at no cost to customer |
| | 9-Watt LED | |
| | Bath Aerator | |
| | BR 30 LED | |
| | Kitchen Aerator | |
| | LED Night-Light | |
| | Showerhead | |
| | Smart Strip | |
| **Commercial** | | |
| Small Business Direct Install | 2' LED T8 Replacements | Services provided at no cost to customer |
| | 4' LED T8 Replacements | |
| | LED A-line Lamps 9W | |
| | LED BR30 Lamps 10W | |
| | LED PAR30 Lamps 10W | |
| | LED PAR38 Lamps 17W | |
| | LED - Exit Signs | |
| | Faucet Aerator 1.5 GPM | |
| | Occupancy Sensor | |
| | Pre-Rinse Spray Valve (Elec DHW) | |
| | Showerhead | |
| | Water Heater Pipe Insulation (Elec DHW) | |
| Nonresidential Prescriptive | Unitary and split system A/C 241,000 - 760,000 BTUH (20-63.33 tons) | $40 per ton |
| | Variable frequency drive up to 250 HP | $40 per HP |
| | Unitary and split system A/C 136,000 - 240,000 BTUH (11.33-20 tons) | $50 per ton |
| | Air Cooled Chiller 150 tons or greater | $40 per ton |
| | Air cooled chiller <150 tons | $60 per ton |
| | Window film | $1.50 per sqft |
| | Variable Refrigerant Flow System 65,000 - 135,000 BTUH | $50 per ton |
| | Smart Thermostat | $50 per unit |
| | Unitary and split system A/C < 65,000 BTUH (<5.4 tons) | $40 per ton |
| | Unitary and split system A/C 65,000 - 135,000 BTUH (5.4-11.25 tons) | $40 per ton |
| | Air source heat pump > 240,000 BTUH | $50 per ton |
| | Variable Refrigerant Flow System < 65,000 BTUH | $50 per ton |
| | Packaged terminal air conditioning | $50 per ton |
| | Air source heat pump < 65,000 BTUH | $40 per ton |
| | Energy recovery ventilation > 450 CFM | $1 per CFM |
| | Outside air economizer with two enthalpy sensors | $250 per unit |
| | Variable Refrigerant Flow System > 240,000 BTUH | $50 per ton |
| | Variable Refrigerant Flow System 136,000 - 240,000 BTUH | $50 per ton |
| | LED Replacing 151 W to 200 W HID or Fluorescent | $50 per unit |
| | LED Replacing 51 W to 100 W HID or Fluorescent | $15 per unit |

| Program | Measure | Incentives |
|---|---|---|
| | Exterior - LED replacing 175W or less | $35 per unit |
| | Exterior - LED replacing 176W to 250W | $60 per unit |
| | Exterior - LED replacing 251W or greater | $90 per unit |
| | LED Replacing 101 W to 150 W HID or Fluorescent | $25 per unit |
| | LED Replacing 351 W to 500 W HID or Fluorescent | $75 per unit |
| | Lighting controls | $0.04 per connected watt |
| | Delamping T8 (# linear feet) | $1.2 per linear ft |
| | LED Re-Lamping $1 per foot | $1 per linear ft |
| | Energy Star LED screw-in base lamps (replacing CFL) | $3 per unit |
| | Energy Star LED luminaires or screw-in base lamps (replacing incandescent) | $6 per unit |
| | LED Replacing 50 W or less HID or Fluorescent | $10 per unit |
| | Exterior LED recessed downlight luminaires or screw-in base lamps (replacing CFL, Energy Star certified) | $3 per unit |
| | LED Replacing 201 W to 350 W HID or Fluorescent | $60 per unit |
| | Delamping HID | $0.05 per watt |
| | LED Replacing 501 W or greater HID or Fluorescent | $90 per unit |
| | LED or Electroluminescent exit sign | $8 per unit |
| | Exterior LED recessed downlight luminaires or screw-in base lamps (replacing incandescent, ENERGY STAR certified) | $6 per unit |
| | Delamping T12 (# linear feet) | $2.25 per linear ft |
| | Exterior Re-Lamping LED Tube | $0.75 per unit |
| | Exterior - LED or Induction (operating hours < 8,760) replacing 251W or greater | $90 per unit |
| | Exterior - LED or Induction (operating hours < 8,760) replacing 176W to 250W | $60 per unit |
| | Vending equipment controller | $50 per unit |
| | Air compressor 1 - 100 HP Variable Speed | $125 per horsepower |
| | No-loss drain | $100 per unit |
| | Air compressor 1 - 100 HP Load/No Load | $45 per horsepower |
| | Variable frequency drive up to 250 HP | $40 per horsepower |
| | Premium Efficiency Motor 3HP | $25 per unit |
| Nonresidential Prescriptive: Midstream Incentives | High-Bay/Low-Bay | $3.00 - $180.00 per unit |
| | LED Exterior Wall Pack | $25.00 - $90.00 per unit |
| | LED Exterior Flood | $1.00 - $120.00 per unit |
| | LED Downlight Kits | $3.00 - $15.00 per unit |
| | LED T8 | $0.00 - $75.00 per unit |
| | Fluorescent T8 | $0.50 - $1.00 per unit |
| | LED and Fluorescent T5 | $1.00 - $6.00 per unit |
| | LED Fixtures | $2.00 - $75.00 per unit |
| | Occupancy Sensors | $15.00 - $15.00 per unit |
| | LED 4-Pin CFL Replacement | $3.00 - $10.00 per unit |
| | LED Exit Signs | $8.00 - $15.00 per unit |
| | LED Screw-In | $1.00 - $10.00 per unit |
| | Chillers Air-cooled | $60.00 per ton |
| | Mini-splits | $50.00 - $150.00 per unit |
| | Unitary AC | $36.00 - $40.00 per ton |
| | Unitary HP | $80.00 - $320.00 per unit |

| Program | Measure | Incentives |
|---|---|---|
| | Variable Frequency Drive | $40.00 per hp |
| Nonresidential Custom | Custom NC | 5-10% savings over baseline: $0.05 / kWh and $50 / kW |
| | | > 10% savings over baseline: $0.08 / kWh and $75 / kW |
| | | > 20% savings over baseline: $0.10 / kWh and $100 / kW |
| | Custom NC-LPD | (LPDbaseline - LPDactual) * gross lighted area * $0.30 |
| | Custom-HVAC | $0.10 per kWh saved + $100 per kW saved. |
| | Custom-Lighting | $0.05 per kWh saved + $50 per kW saved. |
| | Custom-Other | $0.08 per kWh saved + $100 per kW saved. |
| | Custom-Retrocommissioning | $0.08 per kWh saved + $100 per kW saved. |

# Appendix D. Evaluated Energy Savings Calculation Sources

**Table 95. Evaluated Energy Savings Calculation Sources**

| Program | Measure | Source |
|---|---|---|
| **Residential** | | |
| Efficient Products | Marketplace LED | 2010 Ohio TRM. Joint Utility Comments were used to update the waste heat factor for demand. Adjusted savings use weighted waste heat factors to account for 8% of bulbs installed outside. Baseline wattages based on as found wattages from WI 2017 site visits. The LED lifetime ISR of 0.91 is based on benchmarking LED ISR values and following UMP guidelines to account for future installations from storage |
| | Low-Flow Faucet Aerator | Indiana TRM v2.2. Adjusted gross calculations were calculated using internal engineering algorithms, and 2012 Cadmus water metering study data. Specific inputs such as water temperature, recovery efficiency, and coincidence factor taken from 2010 Ohio TRM. |
| | Low-Flow Showerhead | Indiana TRM v2.2. Adjusted gross calculations were calculated using internal engineering algorithms, and 2012 Cadmus water metering study data. Specific inputs such as water temperature, recovery efficiency, and coincidence factor taken from 2010 Ohio TRM. |
| | Low-Flow Showerhead w/ Shower Start | Mid-Atlantic TRM. Adjusted gross calculations were calculated using internal engineering algorithms, and 2012 Cadmus water metering study data. Specific inputs such as water temperature, recovery efficiency, and coincidence factor taken from 2010 Ohio TRM. |
| | Heat Pump Water Heater | 2010 Ohio TRM. |
| | Advanced Power Strip | 2010 Ohio TRM. |
| | Dehumidifier | 2019 Ohio TRM. |
| | Air Purifier | 2019 Ohio TRM. |
| | Upstream LED | 2010 Ohio TRM. Joint Utility Comments were used to update the waste heat factor for demand. Adjusted savings use weighted waste heat factors to account for 8% of bulbs installed outside. Evaluated savings reflect 95.9% of bulbs sold to account for 4.1% of the bulbs sold being installed in commercial applications. Baseline wattages based on as found wattages from WI 2017 site visits. The LED lifetime ISR of 0.91 is based on benchmarking LED ISR values and following UMP guidelines to account for future installations from storage |
| | LED Night-Lights | Indiana TRM v2.2 |
| | Door Sweep | Illinois TRM 2017 v6.0. Volume 3: Residential Measures. |
| | Pipe Wrap | Illinois TRM 2018 v7.0. Volume 3: Residential Measures. |
| Appliance Recycling | Refrigerator | kWh and kW calculated by multiplying 2019 ex Ante values by kWh and kW, respectively, realization rates from 2015-2017 program years |
| | Freezer | kWh and kW calculated by multiplying 2019 ex Ante values by kWh and kW, respectively, realization rates from 2015-2017 program years |

| Program | Measure | Source |
|---|---|---|
| | Room AC | kWh and kW calculated by multiplying 2019 ex Ante values by kWh and kW, respectively, realization rates from 2015-2017 program years |
| | Dehumidifier | kWh and kW calculated by multiplying 2019 ex Ante values by kWh and kW, respectively, realization rates from 2015-2017 program years |
| | Kit LEDs | kWh and kW calculated by multiplying 2019 ex Ante values by kWh and kW, respectively, realization rates from 2017-2018 program years |
| Income Eligible Efficiency (OPAE) | All Measures | kWh and kW calculated by multiplying 2019 ex Ante values by kWh and kW, respectively, realization rates from 2015-2017 program years |
| Income Eligible Efficiency (PWC) | All Measures | kWh and kW calculated by multiplying 2019 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| Heating and Cooling Rebates | AC Early Retirement (all SEERs) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | AC Std Replacement (all SEERs) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | AC New Construction (all SEERs) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | GSHP Early Retirement/Std/New Construction (all EERs) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | HP Early Retirement (all SEERs) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | HP Std Replacement (all SEERs) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | HP New Construction (all SEERs) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | Mini-split AC Std Replacement (all SEERs) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | Mini-split AC New Construction (all SEERs) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | Mini-split HP New Construction (all SEERs) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | Smart Thermostats | Savings from 2020(PY2019) billing analysis |
| | Wi-Fi Programmable Thermostats | Savings from 2020(PY2019) billing analysis |
| | ECM with furnace | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |

| Program | Measure | Source |
|---|---|---|
| | Heat pump water heaters (both heating fuels) | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| | Air sealing and insulation | kWh and kW calculated by multiplying PY2020 ex Ante values by kWh and kW, respectively, realization rates from 2017 program year |
| School Education | 9W LED (2) | 2010 Ohio TRM. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. ISR from 2017 parent follow-up survey. Baseline wattage as-found from Efficient Products. |
| | LED Night Light | 2015 Indiana TRM. ISR from 2018 family participant survey and 2017 parent follow-up survey. |
| | Bathroom Faucet Aerator (2) | 2008 Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms and 2013 Cadmus water metering study data. ISR from 2017 parent follow-up survey, average household size from 2018 family installation survey, electric water heater saturation from 2019 family installation survey. |
| | Kitchen Faucet Aerator | 2009 Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms and 2013 Cadmus water metering study data. ISR from 2017 parent follow-up survey, average household size from 2018 family installation survey, electric water heater saturation from 2019 family installation survey. |
| | Efficient Showerhead | 2010 Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms and 2013 Cadmus water metering study data. ISR from 2017 parent follow-up survey, average household size from 2018 family installation survey, electric water heater saturation from 2019 family installation survey. |
| Smart Thermostats | Rebates for Retail | Per thermostat savings from 2020 billing analysis were applied to current year quantities<br>Per unit savings for secondary thermostats were derived from historical ISRs from participant surveys |
| | DP&L Marketplace | |
| | RaaS | |
| | Vectren Purchased | |
| Energy Savings Kits | 9W LED (4) | 2010 Ohio TRM. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. ISR from 2017 parent follow-up survey. Baseline wattage as-found from Efficient Products. |
| | Bathroom Faucet Aerator | 2010 Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms, 2016 participant survey results, and 2013 Cadmus water metering study data. |
| | Kitchen Faucet Aerator | 2010 Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms, 2016 participant survey results, and 2013 Cadmus water metering study data. |
| | Efficient Showerhead | 2010 Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms, 2016 participant survey results, and 2013 Cadmus water metering study data. |
| Behavior Change | Home energy reports (paper, email), Marketplace Promotional Emails | 2017 Uniform Methods Project. Chapter 17: Residential Behavior Protocol. Separate regression models for Experiment 1 (Email) and Experiment 2 (Paper), and estimated separate treatment effects for each wave of treatment in Experiment 1. |
| Multi-Family Direct Install | 5-Watt LED Globe | kWh and kW calculated by multiplying 2020 ex ante values by the average of the 2018 and 2019 realization rates (weighted by number of units installed in 2018 and 2019) |
| | 9-Watt LED | kWh and kW calculated by multiplying 2020 ex ante values by the average of the 2018 and 2019 realization rates (weighted by number of units installed in 2018 and 2019) |

| Program | Measure | Source |
| --- | --- | --- |
| | Bath Aerator | kWh and kW calculated by multiplying 2020 ex ante values by the average of the 2018 and 2019 realization rates (weighted by number of units installed in 2018 and 2019) |
| | Kitchen Aerator | kWh and kW calculated by multiplying 2020 ex ante values by the average of the 2018 and 2019 realization rates (weighted by number of units installed in 2018 and 2019) |
| | LED Night-Light | kWh and kW calculated by multiplying 2020 ex ante values by the average of the 2018 and 2019 realization rates (weighted by number of units installed in 2018 and 2019) |
| | Showerhead | kWh and kW calculated by multiplying 2020 ex ante values by the average of the 2018 and 2019 realization rates (weighted by number of units installed in 2018 and 2019) |
| | Smart Strip | kWh and kW calculated by multiplying 2020 ex ante values by the average of the 2018 and 2019 realization rates (weighted by number of units installed in 2018 and 2019) |
| **Commercial** | | |
| Small Business Direct Install | 2' LED T8 Replacements | 2010 Ohio TRM. Efficient wattage based on CLEAResult program documentation. Baseline wattage based on common T8 model wattage. ISR based on 2019 participant survey. |
| | 4' LED T8 Replacements | 2010 Ohio TRM. Efficient wattage based on CLEAResult program documentation. Baseline wattage based on common T8 model wattage. ISR based on 2019 participant survey. |
| | LED A-line Lamps 9W | 2010 Ohio TRM. Efficient wattage based on CLEAResult program documentation. Baseline wattage based on EISA standards. ISR based on 2019 participant survey. |
| | LED BR30 Lamps 10W | 2010 Ohio TRM. Efficient wattage based on CLEAResult program documentation. Baseline wattage based on EISA standards. ISR based on 2019 participant survey. |
| | LED PAR30 Lamps 10W | 2010 Ohio TRM. Efficient wattage based on CLEAResult program documentation. Baseline wattage based on EISA standards. ISR based on 2019 participant survey. |
| | LED PAR38 Lamps 17W | 2010 Ohio TRM. Efficient wattage based on CLEAResult program documentation. Baseline wattage based on EISA standards. ISR based on 2019 participant survey. |
| | LED - Exit Signs | 2010 Ohio TRM. Efficient wattage based on CLEAResult program documentation. Baseline wattage based on Efficiency Vermont TRM. |
| | Faucet Aerator 1.5 GPM | 2019 Illinois TRM and 2013 Cadmus water metering study data. Efficient flow rate based on CLEAResult program documentation. ISR based on 2019 participant survey. Water main temperature based on weather data in Dayton, OH. Building and water heater fuel types provided in tracking data. |
| | Occupancy Sensor | 2010 Ohio TRM. Kilowatts controlled based on Indiana TRM V2.2. Building types provided in tracking data. |
| | Pre-Rinse Spray Valve (Elec DHW) | 2010 Ohio TRM. Efficient flow rate based on CLEAResult program documentation. Building types provided in tracking data. |
| | Showerhead | 2019 Illinois TRM and 2013 Cadmus water metering study data. Efficient flow rate and number of showers per day based on CLEAResult program documentation. Water main temperature based on weather data in Dayton, OH. Building and water heater fuel types provided in tracking data. |

| Program | Measure | Source |
|---|---|---|
| | Water Heater Pipe Insulation (Elec DHW) | 2010 Ohio TRM. Efficiency rating and length of pipe insulation based on CLEAResult program documentation. |
| Nonresidential Prescriptive | HVAC | See comment 5 below. |
| | Lighting | See comment 5 below. |
| | Motors | See comment 5 below. |
| | Other | See comment 5 below. |
| | Midstream Lighting | Cadmus used the HOU and CF in the 2010 Ohio TRM corresponding to the reported facility type for each record. If a facility type was not reported, Cadmus used a weighted program-average HOU and CF with a 5% adjustment to account for the percentage of commercial lamps installed outside. For exterior facility types, U.S. Naval Observatory data were used to estimate the number of non-daylight hours per year in Ohio. Program-average WHFs were calculated using a facility type-weighted average of 2010 Ohio TRM interior and exterior values. In-service rate was evaluated based on an online survey of customers who participated through the distributor channel in 2015.<br><br>Where the Ohio TRM did not contain a measure or was outdated, Cadmus used a TRM from a different region to determine lumen equivalence baseline wattage bins, and also performed primary research to supplement the lumen bins. Cadmus selected the TRM based on a review of the most up-to-date lumen equivalence bins for that measure. Cadmus used the lumen equivalence maps in the Pennsylvania TRM's Interim Measure Protocol for exterior and high-bay/low-bay products, LED fixtures (2x2, 2x4, 1x4), and pin-based LED bulbs. For LED downlight fixtures, Cadmus referenced the Wisconsin TRM. LED exit signs savings were based on the Ohio TRM. For screw-in LED bulbs, Cadmus performed a literature review of federal baselines and assigned baseline wattages based on federal standard lumen bins (energy.gov and nrel.gov). Lastly, Cadmus used data from the Consortium of Energy Efficiency, the Design Light Cosortium, and product data available through online retailer websites to determine lumen bins for linear fluorescent and linear LED lamps (T8 and T5). |
| | Midstream HVAC | Cadmus used the algorithms outlined in the Ohio TRM for air-cooled chillers, mini-split air conditioners and heat pumps, unitary air conditioners, and unitary heat pumps. Cadmus used DOE federal baseline standards and IECC 2012 baselines in place of the baselines listed in the Ohio TRM, which are outdated.<br><br>Cadmus evaluated seven midstream VFDs through site visits and power metering in 2018. These projects were leveraged and the cumulative realization rates—105% for energy and 84% for demand—were applied to the VFD measures incented through the Midstream Incentive program. |
| Nonresidential Custom | Lighting | Custom savings calculations |
| | Other | Custom savings calculations |

# Appendix E. Cost-Effectiveness Analysis Inputs

## *Utility Assumptions*

Utility assumptions apply to all programs and measures, including the assumptions that follow.

***Avoided Costs*** are the full value of time and seasonally differentiated generation and capacity costs. For each energy efficiency measure included in a program, hourly (8,760) system-avoided costs are adjusted by the hourly load shape of the end use affected by the measure, capturing the full value of time and seasonally differentiated impacts of the measure.

***Line Loss*** is the percentage of energy lost during transmission and distribution. In DSM Portfolio Pro Plus, energy and capacity line losses are applied to measure-level savings to reflect total savings from the point of generation. Table 96 presents line loss assumptions for the 2020 Evaluation Measurement and Verification Report.[38]

**Table 96. Line Loss Assumptions Used in Cost-Effectiveness Calculations**

| Sector | Energy Line Losses | Demand Line Losses |
|---|---|---|
| Residential | 7.05% | 8.14% |
| **Commercial/Industrial** | **3.90%** | **5.01%** |

***Retail Rates***, provided by DP&L, include electric rates for all customer classes eligible for DSM programs. Table 97 provides retail rate assumptions for the 2019 Evaluation Measurement and Verification Report.

**Table 97. Retail Rates Used in Cost-Effectiveness Calculations**

| Sector | Retail Rate | Escalator |
|---|---|---|
| Residential | $0.130 | 0% |
| Residential Heating | $0.120 | 0% |
| Commercial | $0.097 | 0% |
| Industrial | $0.092 | 0% |

***Load Shapes*** show hourly energy use over a year for each end use included in DSM Portfolio Pro. Cadmus used the same hourly end-use load shapes that were developed as part of prior program evaluations. Those load shapes were developed using available data from similar regions and adjusting for weather conditions in DP&L's service territory.

***Discount Rates* are used to determine the net present value of each program's benefits.** Table 98 shows discount rates used in 2020. The TRC, UTC, and RIM test discount rates are based on DP&L's weighted cost of capital; the SCT discount rate is based on a 10-year Treasury bill rate; the PCT rate represents a hurdle rate. Cadmus will update discount rates in subsequent years, as new data become available.

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38 Line losses in Table 96 represent the percentage loss in energy and demand from the point of generation to the meter.

**Table 98. Discount Rates Used in Cost-Effectiveness Calculations**

| Benefit/Cost Test | Discount Rate |
|---|---|
| TRC | 7.86% |
| SCT | 2.91% |
| UTC | 7.86% |
| RIM | 7.86% |
| PCT | 10.00% |

***Peak Definitions*** are used to determine time or seasonal differentiations between rates and avoided costs. Additionally, to calculate peak load impacts from energy efficiency measures, end-use load shapes are used to identify the average reduction in demand over the DP&L system's top 100 peak demand hours.

***Externalities and Indirect Benefits*** are additional, non-energy benefits associated with installing energy-efficiency measures. For the 2019 analysis, Cadmus only included Operation and Maintenance benefits for lighting measures to account for avoided replacement costs associated with lighting measures that have a longer estimated useful life than their baselines.

## Program Assumptions

***Sectors/Segments*** identify the customer class to which each program's participants belong. Sectors for DP&L include residential, commercial, and industrial. Segments used in DSM Portfolio Pro Plus include single-family, multifamily, small office, large retail, and schools (tailored to DP&L's service territory). Sectors and segments dictate retail rates and load shapes used during analysis.

***Utility Administrative Costs*** include expenses associated with program development, marketing, delivery, operation, and EM&V. Such non-measure-specific costs are assessed at the program or portfolio levels. Cadmus used the cost categories shown in Table 99**.**

**Table 99. Implementation and Administrative Costs**

| Cost Category | Level | Description |
|---|---|---|
| Staff, Implementation, Vendor, and Marketing Costs | Program Level/ Portfolio Level | Costs to administer energy efficiency programs, including DP&L's fully loaded incremental personnel costs; activities associated with market research outside of EM&V, and incremental costs associated with performing program implementation tasks (such as customer service, application processing, marketing, and customer outreach). |
| Incentive Costs | Program Level | Rebates and incentives paid to customers by DP&L. |
| Direct Measure Costs | Program Level | Costs associated with paying for program measures (such as measures installed through Appliance Recycling, Income Eligible Efficiency, School Education, Multi-Family Direct Install, Small Business Direct Install, and Energy Savings Kits). |
| External Vendor Evaluations | Portfolio Level | Activities associated with the determination and evaluation of current and potential energy efficiency programs (such as benefit/cost ratio analysis, impact and process analysis, cost per kilowatt-hour analysis, customer research, all other analyses necessary for program evaluation). |
| Education, Awareness, and Building and Market Transformation | Portfolio Level | Cost to increase awareness of energy efficiency. |

## *Measure Assumptions*

***Measure Life*** is used during the calculation of total lifetime benefits for each measure. The life of each measure is based on information from the Ohio TRM 2010, program-supported documentation, and secondary research.

***End Use*** is used to assign each measure to a specific load shape. Examples of end uses in DSM Portfolio Pro Plus include water heating, HVAC, and lighting.

***Savings*** are annual kWh savings associated with the installation of each energy efficiency measure. Savings used in DSM Portfolio Pro Plus are ex ante savings.

***Incremental Cost*** is the expense associated with the installation of energy efficiency measures and ongoing operation and maintenance costs, where applicable. These costs include the entire cost of installing the efficient measure minus the cost of installing the baseline measure. These costs do not net out incentive payments to the customer. The incremental cost is based on data provided by DP&L and on secondary research.

***Incentive Level*** is the dollar amount of the rebate paid to a customer by DP&L, which provided the incentive amount for each program.

***Freeridership*** is the percentage of participants who would have taken the same action/installed the same measure in the program's absence. Cadmus assumed a net-to-gross ratio of 1.0 for the 2020 analysis.

***Spillover*** is the percentage of participants who installed additional energy saving measures without incentives due to their participation in the program. Spillover was not calculated for the 2020 analysis.

***Participation*** is the number of customers who participated in the program or the quantity of measures verified by Cadmus

# Appendix F. Energy Savings and Demand Reduction Confidence and Precision

Cadmus used a multifaceted approach to construct error bounds for final kilowatt-hour savings estimates resulting from variations in methods across programs and, in some cases, within individual programs. To determine the uncertainty level, we considered two types of errors: measurement (or modeling) errors and sampling errors. Measurement errors refer to the level of uncertainty around engineering parameters derived from simulation or professional judgment. Sampling errors refer to uncertainty introduced by use of sampled data to infer characteristics of the overall population.

For engineering calculations using simulated or assumed parameters, we assumed measurement errors to have a relative precision of ±10%. This level of accuracy is regarded as a minimum for results in the evaluation industry. Results taken from outside evaluations or based on engineering analysis are likely to be reliable within these bounds.

An example of this includes the EFLHs used in many of the HVAC savings calculations. These values come from simulations conducted by the U.S. Environmental Protection Agency and, as such, have no sampling error. They are not, however, deterministic (average EFLHs presumably deviate from these values). Absent documentation on this level of uncertainty, we assumed they were accurate within the industry standard threshold of ±10% relative precision at a 90% confidence interval.

Sampling error was calculated for parameters estimated through some form of sampling. These data included survey results, meter data, and secondary sources. Sampled data were used in the evaluation of several programs to estimate parameters for use in per-unit savings calculations (such as installation rates) or in the consumption of specific equipment types (such as in billing analysis).

In some cases, uncertainty of estimates derived from multiple sources. For example, for summed estimates (such as those for total program savings), we calculated the root of the sum of the squared standard errors to estimate the confidence interval:[39]

$$Confidence\ Interval_{\bar{X}+\bar{Y}} = (\bar{X}+\bar{Y}) \pm 1.645 \cdot \sqrt{\left(\frac{s_{\bar{X}}^2}{n_{\bar{X}}}\right) + \left(\frac{s_{\bar{Y}}^2}{n_{\bar{Y}}}\right)}$$

In some cases, Cadmus computed an estimate as the product of two other estimates. For example, evaluating ARP gross per-unit savings calculations involved combining full-year gross estimates from a regression-based metering analysis, with average annual running times estimated from participant

[39] This approach to aggregation errors follows methods outlined in the following report: Schiller, Steven et al. 2007. "National Action Plan for Energy Efficiency." *Model Energy Efficiency Program Impact Evaluation Guide.* Appendix D.

surveys. For these results, Cadmus calculated combined standard errors for the final estimates. In cases where the relationship was multiplicative, we used the following formula:[40]

$$Confidence\ Interval_{\bar{X}\cdot\bar{Y}} = \bar{X}\cdot\bar{Y} \pm 1.645 \cdot \sqrt{\bar{Y}^2\left(\frac{s_{\bar{X}}^2}{n_{\bar{X}}}\right) + \bar{X}^2\left(\frac{s_{\bar{Y}}^2}{n_{\bar{Y}}}\right) + \left(\frac{s_{\bar{X}}^2}{n_{\bar{X}}}\right)\left(\frac{s_{\bar{Y}}^2}{n_{\bar{Y}}}\right)}$$

Table 100 shows precision estimates with the associated sources of uncertainty for each residential program.

**Table 100. Residential Energy Savings Precision**

| Program | Precision at 90% | Sources of Uncertainty |
|---|---|---|
| Residential Efficient Products | ± 14.9% | • TRM algorithms and assumptions<br>• Nonresidential allocation from 2015 survey<br>• Cadmus water metering study<br>• LED ISR based on benchmarking of ISR value from five different studies |
| Appliance Recycling | ± 5.8% | • Model analysis<br>• 2014, 2015, 2016, 2017 participant survey part-use survey inputs<br>• Participant survey<br>• TRM algorithms and assumptions |
| Income Eligible Efficiency (OPAE) | ± 6.9% | • Billing analysis<br>• TRM algorithms and assumptions<br>• Showerhead and aerator measure inputs from Cadmus 2012 Michigan water study |
| Income Eligible Efficiency (PWC) | ± 5.6% | • Billing analysis,<br>• TRM algorithms and assumptions<br>• Showerhead and aerator measure inputs from Cadmus 2012 Michigan water study |
| Heating and Cooling Rebates | ± 4.5% | • Secondary meter data<br>• Billing analysis<br>• Participant survey<br>• TRM algorithms and assumptions |
| School Education | ± 15.2% | • 2018 survey<br>• Family installation survey<br>• Cadmus water metering study and TRM algorithms and assumptions |
| Energy Savings Kits | ± 10.6% | • 2018 survey<br>• Family installation survey<br>• Cadmus water metering study and TRM algorithms and assumptions |
| Behavior Change | ± 42.0% | • Modeling error |
| Smart Thermostats | ± 19.1% | • Billing analysis and 2018 survey |

[40] Goodman, Leo. "The Variance of the Product of K Random Variables." *Journal of the American Statistical Association.* 1962.

## Nonresidential

For C&I programs, DP&L provided Cadmus with a project database that included calculated and deemed (*ex ante*) claimed savings values for each nonresidential project. Cadmus performed site visits and engineering desk reviews to calculate adjusted gross savings for a sample of projects. This included using these activities to estimate realization rates, which we then applied to projects outside of the samples to obtain realized savings estimates. We divided projects selected for site visits and desk review samples into Prescriptive and Custom Rebate programs and performed the analyses separately.

For the Prescriptive Rebate program, we first estimated savings, standard errors, and precision levels by measure type, then aggregated these results into the program-level savings estimate, standard error, and precision. As lighting projects spanned an especially wide range of *ex ante* savings values (from 26 kWh to over 5 million kWh), we divided prescriptive lighting savings by strata, according to the aggregate reported *ex ante* claimed savings for each project. We then allocated each project to each stratum according to the proportional representation across the population.

Further, given the heterogeneity in measure-level energy savings for other prescriptive measures beyond lighting (such as HVAC and motors), Cadmus designed three additional strata to capture variance for these measures. Table 101 reports cut points and distribution of sites for each prescriptive strata.

**Table 101. Nonresidential Prescriptive Lighting Stratification**

| Statistic | Small | Medium | Large | Compressed Air | Motors | HVAC |
|---|---|---|---|---|---|---|
| **kWh Range** | **<100,000** | **100,000-500,000** | **>500,000** | **N/A** | **N/A** | **N/A** |
| Number of Measures | 2,152 | 497 | 163 | 39 | 21 | 244 |
| Total *ex ante* kWh | 19,324,136 | 18,274,522 | 13,046,393 | 1,890,774 | 636,041 | 7,000,236 |

Cadmus also separated custom projects into four strata: large custom, medium custom, small custom, and new construction. Table 102 reports cut points and distribution of sites for each custom strata.

**Table 102. Nonresidential Custom Stratification**

| Statistic | Small | Medium | Large | NC | RCx |
|---|---|---|---|---|---|
| **kWh Range** | **<100,000** | **100,000-500,000** | **>500,000** | **N/A** | **N/A** |
| Number of Measures | 13 | 18 | 8 | 58 | 48 |
| Total *ex ante* kWh | 342,218 | 4,361,986 | 8,763,909 | 7,344,783 | 8,474,061 |

Verification samples targeted projects in the large strata. This emphasis reduced uncertainty in overall savings estimates by directly verifying a large proportion of savings. Cadmus obtained total savings estimates and precision levels with 90% confidence, as shown in Table 103.

**Table 103. Nonresidential Gross Energy Savings, Prescriptive and Custom**

| Prescriptive Program Savings | | Custom Program Savings | |
|---|---|---|---|
| Total Estimated Savings (kWh) | Precision at 90% Confidence | Total Estimated Savings (kWh) | Precision at 90% Confidence |
| 58,968,844 | 2.0% | 29,338,969 | 2.2% |

Energy savings estimates for individual measure categories follow in Table 104. Precision at 90% confidence is provided for each estimate. Categories with large kilowatt-hour savings totals have tighter precision than those with small savings totals as the team allocated evaluation resources with the goal of producing efficient, program-level estimates.

**Table 104. Nonresidential Summary of Energy Savings Precision Estimates**

| Measure Type | Reported Savings (kWh) | Estimated Savings (kWh) | Realization Rate | Precision at 90% Confidence |
|---|---|---|---|---|
| C-Large | 8,763,909 | 8,392,173 | 96% | 3.83% |
| C-Medium | 4,361,986 | 3,749,690 | 86% | 10.42% |
| C-New Construction | 7,344,783 | 8,375,726 | 114% | 5.96% |
| C-Retrocommissioning | 8,474,061 | 8,474,061 | 100% | 0.00% |
| C-Small | 342,218 | 347,319 | 101% | 0.96% |
| P-Compressed Air | 1,890,774 | 1,847,150 | 98% | 1.53% |
| P-HVAC | 7,000,236 | 5,534,211 | 79% | 22.2% |
| P-Lighting-Large | 13,046,393 | 13,046,392 | 100% | 0.0% |
| P-Lighting-Medium | 18,274,522 | 18,190,658 | 100% | 0.25% |
| P-Lighting-Small | 19,324,136 | 19,432,402 | 101% | 0.32% |
| P-Motors | 636,041 | 918,032 | 144% | 24.10% |
| Midstream Lighting | 51,637,725 | 44,208,718 | 86% | 14.87% |
| Midstream VFDs | 2,623,397 | 2,671,563 | 102% | 10.00% |
| SBDI | 3,043,536 | 2,858,379 | 94% | 11.28% |
| MFDI | 288,111 | 294,967 | 102% | 8.90% |
| Residential Efficient Products[a] | 8,022,184 | 6,740,741 | 84% | 31.16% |
| Appliance Recycling at Nonresidential Sites | 55,915 | 40,238 | N/A | 6.06% |
| **Total** | **155,074,012** | **145,122,420** | **94%** | **4.87%** |

Note: Total values in table are rounded for reporting purposes.

[a] Bulbs sold through the Residential Efficient Products program and allocated to the Commercial program. For Verified and adjusted savings, 4.1% upstream residential lighting bulbs were allocated to commercial applications

# Appendix G. *Ex Ante* Measure-Level Savings Documentation

**Table 105. *Ex Ante* Measure-Level Savings Documentation**

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| **Residential** | | | | |
| **Efficient Products** | | | | |
| Marketplace LEDs | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11 - 16. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on as found wattages from WI 2017 site visits. The LED lifetime ISR of 0.91 is based on benchmarking LED ISR values and following UMP guidelines to account for future installations from storage | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11 - 16. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on as found wattages from WI 2017 site visits. The LED lifetime ISR of 0.91 is based on benchmarking LED ISR values and following UMP guidelines to account for future installations from storage |
| Low-Flow Faucet Aerator | 2016 Energy Kits participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 Energy Savings Kits participant survey. | 2016 Energy Kits participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 Energy Savings Kits participant survey. |
| Low-Flow Showerhead | 2016 Energy Kits participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 93-94; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 Energy Savings Kits participant survey. | 2016 Energy Kits participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 94-95; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 Energy Savings Kits participant survey. |
| Low-Flow Showerhead w/ Shower Start | 2016 Energy Kits participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 93-94; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. Efficiency Maine TRM | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 Energy Kits participant survey. Amount of wasted shower time for thermostatic shutoff from Efficiency Maine TRM | 2016 Energy Kits participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 94-95; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. Efficiency Maine TRM | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 Energy Kits participant survey. Amount of wasted shower time for thermostatic shutoff from Efficiency Maine TRM |
| Heat Pump Water Heater | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 86-89 | 2010 Ohio draft TRM Deemed Per Unit Savings | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 86-89 | 2010 Ohio draft TRM Deemed Per Unit Savings |
| Advanced Power Strip | 2010 draft Ohio TRM, pages 76-77 | 2010 Ohio draft TRM Deemed Per Unit Savings | 2010 draft Ohio TRM, pages 76-77 | 2010 Ohio draft TRM Deemed Per Unit Savings |
| Dehumidifier | 2019 Ohio TRM, pages 12-14 | 2019 Ohio TRM Deemed Per Unit Savings | 2019 Ohio TRM, pages 12-14 | 2019 Ohio TRM Deemed Per Unit Savings |
| Air Purifier | 2019 Ohio TRM, pages 4-5 | 2019 Ohio TRM Deemed Per Unit Savings | 2019 Ohio TRM, pages 4-5 | 2019 Ohio TRM Deemed Per Unit Savings |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| Upstream LED | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11 - 16. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on as found wattages from WI 2017 site visits. The LED lifetime ISR of 0.91 is based on benchmarking LED ISR values and following UMP guidelines to account for future installations from storage. Percentage of lamps and savings allocated to the commercial prescriptive program, 95% allocated to Upstream LED and 5% allocated to commercial prescriptive. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11 - 16. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on as found wattages from WI 2017 site visits. The LED lifetime ISR of 0.91 is based on benchmarking LED ISR values and following UMP guidelines to account for future installations from storage. Percentage of lamps and savings allocated to the commercial prescriptive program, 95% allocated to Upstream LED and 5% allocated to commercial prescriptive. |
| LED Night-Light | 2017 parent follow-up survey. 2015 Indiana TRM Version 2.2. Pages 135-136. | Calculated using 2010 draft Ohio TRM and 2015 Indiana TRM Version 2.2 algorithms. ISR derived from 2018 family participant survey and 2017 parent follow-up survey. Baseline wattage of 5.0W used from the IN TRM and efficient wattage of 0.3W used based on manufacturer specification sheet. | 2017 parent follow-up survey. 2015 Indiana TRM Version 2.2. Pages 135-136. | Calculated using 2010 draft Ohio TRM and 2015 Indiana TRM Version 2.2 algorithms. ISR derived from 2018 family participant survey and 2017 parent follow-up survey. Baseline wattage of 5.0W used from the IN TRM and efficient wattage of 0.3W used based on manufacturer specification sheet. |
| Door Sweep | Illinois TRM v6.0. Volume 3: Residential Measures. Pages 271-272. | Illinois TRM v6.0 Deemed Per Unit Savings. Did not apply Air Sealing Adjustment factor from the IL TRM. Saturations of electrical resistance heaters and heat pumps applied per implementer saturation values. | Illinois TRM v6.0. Volume 3: Residential Measures. Pages 271-272. | Illinois TRM v6.0 Deemed Per Unit Savings. Did not apply Air Sealing Adjustment factor from the IL TRM. Saturations of electrical resistance heaters and heat pumps applied per implementer saturation values. |
| Pipe Wrap | Illinois TRM v6.0. Volume 3: Residential Measures. Pages 189-190. | Calculated using Illinois TRM v6.0 algorithms. Electric DHW saturation applied per implementer assumptions. Length of pipe wrap assumed to be in 6 feet increments. Insulated R-value of 5 assumed for all sections of pipe wrap. | Illinois TRM v6.0. Volume 3: Residential Measures. Pages 189-190. | Calculated using Illinois TRM v6.0 algorithms. Electric DHW saturation applied per implementer assumptions. Length of pipe wrap assumed to be in 6 feet increments. Insulated R-value of 5 assumed for all sections of pipe wrap. |
| **Appliance Recycling** | | | | |
| Refrigerator Replacement | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Deemed Per Unit Savings | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Summer Peak Demand Savings |
| Freezer Replacement | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Deemed Per Unit Savings | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Summer Peak Demand Savings |
| Room Air Conditioner Recycling | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Deemed Per Unit Savings | 2020 draft Ohio TRM updated September 23, 2019 under Case No. 09-0512-GE-UNC. Pages 50-52 | 2019 Ohio draft TRM Summer Peak Demand Savings |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| Dehumidifier Recycling | Technical Support Document: Energy Efficiency Program for Consumer Product and Commercial and Industrial Equipment: Residential Dehumidifiers. U.S. Department of Energy. May 2015. Available online: http://www.regulations.gov/#!documentDetail;D=EERE-2012-BT-STD-0027-0030 | Technical Support Document: Energy Efficiency Program for Consumer Product and Commercial and Industrial Equipment: Residential Dehumidifiers. U.S. Department of Energy. May 2015. Available online: http://www.regulations.gov/#!documentDetail;D=EERE-2012-BT-STD-0027-0030 | Technical Support Document: Energy Efficiency Program for Consumer Product and Commercial and Industrial Equipment: Residential Dehumidifiers. U.S. Department of Energy. May 2015. Available online: http://www.regulations.gov/#!documentDetail;D=EERE-2012-BT-STD-0027-0030 | Technical Support Document: Energy Efficiency Program for Consumer Product and Commercial and Industrial Equipment: Residential Dehumidifiers. U.S. Department of Energy. May 2015. Available online: http://www.regulations.gov/#!documentDetail;D=EERE-2012-BT-STD-0027-0030 |
| 9W LED | ARP Participant Survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11 - 16. | Calculated using the inputs and algorithms in the 2010 draft Ohio TRM. Baseline wattage determined using ARP participant survey. Installation rate based on energy savings kits participant survey. | ARP Participant Survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11 - 16. | Calculated using the inputs and algorithms in the 2010 draft Ohio TRM. Installation rate and baseline wattage determined using ARP participant survey. |
| **Income Eligible Efficiency (OPAE)** | | | | |
| Aerator | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; Potential Study; Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using the algorithm listed in the 2010 draft Ohio TRM. Algorithm inputs stems from potential study, Cadmus and Opinion Dynamics metering study, and the draft 2010 Ohio TRM. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; Potential Study; Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using the algorithm listed in the 2010 draft Ohio TRM. Algorithm inputs stems from potential study, Cadmus and Opinion Dynamics metering study, and the draft 2010 Ohio TRM. |
| Air Sealing | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 104-107 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data and an assumed 30% cap on CFM reduction | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 104-107 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data and an assumed 30% cap on CFM reduction |
| Air Source Heat pump | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33-35 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33-35 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data |
| Attic Insulation | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 36-39 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 36-39 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data |
| Central AC | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30-32 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30-32 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data |
| Freezer | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Deemed Per Unit Savings | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Summer Peak Demand Savings |
| LED | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11 - 16. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baselines are based on EISA standards dependent on lumen output | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11 - 16. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baselines are based on EISA standards dependent on lumen output |
| Pipe Wrap | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 97-98. | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 97-98. | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| Refrigerator | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Deemed Per Unit Savings | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Summer Peak Demand Savings |
| Showerhead | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 93-94; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 94-95; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. |
| Smart Strip | 2010 draft Ohio TRM, pages 76-77 | 2010 Ohio draft TRM Deemed Per Unit Savings | 2010 draft Ohio TRM, pages 76-77 | 2010 Ohio draft TRM Deemed Per Unit Savings |
| Sump Pumps/Well Pump | Custom deemed savings value calculated by implementation team | Deemed unit savings value | Custom deemed savings value calculated by implementation team | Deemed unit savings value |
| Water Heater Insulation | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 131-132 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 131-132 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data |
| Water Heater Tank Setback | Cadmus estimate. Based on evaluation work performed in other jurisdictions in 2012. | Deemed savings value. Based on analysis used for EmPOWER 2012 and WI FoE 2012. Assumes a ten degree turn down and captures savings from standby losses, leaks and clothes washers. | Cadmus estimate. Based on evaluation work performed in other jurisdictions in 2012. | Deemed savings value. Based on analysis used for EmPOWER 2012 and WI FoE 2012. Assumes a ten degree turn down and captures savings from standby losses, leaks and clothes washers. |
| **Income Eligible Efficiency (PWC)** | | | | |
| Aerators | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; Potential Study; Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using the algorithm listed in the 2010 draft Ohio TRM. Algorithm inputs stems from potential study, Cadmus and Opinion Dynamics metering study, and the draft 2010 Ohio TRM. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; Potential Study; Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using the algorithm listed in the 2010 draft Ohio TRM. Algorithm inputs stems from potential study, Cadmus and Opinion Dynamics metering study, and the draft 2010 Ohio TRM. |
| Air Source Heat pump | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33-35 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33-35 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data |
| Attic Insulation | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 36-39 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 36-39 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data |
| Central AC | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30-32 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30-32 | 2010 Ohio draft TRM Deemed Savings Calculation with inputs from tracking data |
| Freezers | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Deemed Per Unit Savings | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | Savings factor from ACEEE Report multiplied by Cadmus calculated yearly DHW consumption |
| LEDs | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11 - 16. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baselines are based on EISA standards dependent on lumen output | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11 - 16. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baselines are based on EISA standards dependent on lumen output |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| Refrigerator | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Deemed Per Unit Savings | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 23-25 | 2010 Ohio draft TRM Summer Peak Demand Savings |
| Showerheads | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 93-94; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | ncix | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 94-95; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. |
| **Heating and Cooling Rebates** | | | | |
| ER AC 14/15 SEER | Cadmus post-fixed effects model. | Estimates calculated by Cadmus using a post-fixed effects model. Calculation methodology provided on pages 53 - 56 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 78 - 81. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| ER AC 16+ SEER | Cadmus post-fixed effects model. | Estimates calculated by Cadmus using a post-fixed effects model. Calculation methodology provided on pages 53 - 56 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 78 - 81. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| NC AC 14/15 SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30 - 32. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30 - 32. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| NC AC 16+ SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30 - 32. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30 - 32. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| RP AC 14/15 SEER | Cadmus post-fixed effects model. | Estimates calculated by Cadmus using a post-fixed effects model. Calculation methodology provided on pages 53 - 56 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30 - 32. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| RP AC 16+ SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30 - 32. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 30 - 32. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| ER GSHP 16/18 EER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 82 - 85. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| ER GSHP 19+ EER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 82 - 85. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| NC GSHP 16/18 EER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 82 - 85. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| NC GSHP 19+ SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 82 - 85. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| RP GSHP 16/18 EER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 82 - 85. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| RP GSHP 19+ EER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 82 - 85. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| ER HP 14/15 SEER | Cadmus post-fixed effects model. | Estimates calculated by Cadmus using a post-fixed effects model. Calculation methodology provided on pages 53 - 56 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33 - 35. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| ER HP 16+ SEER | Cadmus post-fixed effects model. | Estimates calculated by Cadmus using a post-fixed effects model. Calculation methodology provided on pages 53 - 56 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33 - 35. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| NC HP 14/15 SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33 - 35. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33 - 35. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| NC HP 16+ SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33 - 35. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33 - 35. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| RP HP 14/15 SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33 - 35. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33 - 35. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| RP HP 16+ SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33 - 35. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 33 - 35. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| NC MS AC 16+ SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 67 -69 and engineering calculations based on secondary data. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 59 - 62 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | Engineering calculations and secondary data. | Estimates calculated by Cadmus using engineering algorithms and secondary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| RP MS HP 16+ SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 67 -69 and engineering calculations based on secondary data. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 59 - 62 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | Engineering calculations and secondary data. | Estimates calculated by Cadmus using engineering algorithms and secondary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| NC MS HP 14/15 SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 67 -69 and engineering calculations based on secondary data. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 59 - 62 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | Engineering calculations and secondary data. | Estimates calculated by Cadmus using engineering algorithms and secondary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| NC MS HP 16+ SEER | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 67 -69 and engineering calculations based on secondary data. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 59 - 62 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | Engineering calculations and secondary data. | Estimates calculated by Cadmus using engineering algorithms and secondary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| HVAC - Programmable Thermostat with AC | 2019 evaluation report results | 580 kWh, from page 59 of 2019 report. | Engineering calculations based on secondary data. | Estimates calculated by program implementer using engineering formulas. |
| HVAC - Programmable Thermostat with HP | 2019 evaluation report results | 580 kWh, from page 59 of 2019 report. | Engineering calculations based on secondary data. | Estimates calculated by program implementer using engineering formulas. |
| HVAC - Programmable Thermostat with GSHP | 2019 evaluation report results | 580 kWh, from page 59 of 2019 report. | Engineering calculations based on secondary data. | Estimates calculated by program implementer using engineering formulas. |
| HVAC - Smart Thermostat with AC | 2019 evaluation report results | 580 kWh, from page 59 of 2019 report. | Engineering calculations based on secondary data. | Estimates calculated by program implementer using engineering formulas. |
| HVAC - Smart Thermostat with HP or GSHP | 2019 evaluation report results | 580 kWh, from page 59 of 2019 report. | Engineering calculations based on secondary data. | Estimates calculated by program implementer using engineering formulas. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| ECM with New AC | Cadmus post-fixed effects model. | Estimates calculated by Cadmus using a post-fixed effects model. Calculation methodology provided on pages 53 - 56 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | Engineering calculations and secondary data. | Estimates calculated by Cadmus using engineering algorithms and secondary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| ECM | Cadmus post-fixed effects model. | Estimates calculated by Cadmus using a post-fixed effects model. Calculation methodology provided on pages 53 - 56 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | Engineering calculations and secondary data. | Estimates calculated by Cadmus using engineering algorithms and secondary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| ECM with New HP | Engineering calculations based on secondary data. | Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology provided on pages 59 - 62 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. | Engineering calculations and secondary data. | Estimates calculated by Cadmus using engineering algorithms and secondary data. Calculation methodology provided on pages 62 - 65 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR. |
| Heat Pump Water Heater - Gas Home | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 86-88. | Deemed savngs taken from value for homes with fossil fuel heating systems. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 86-88. | Deemed savings taken from value for homes with fossil fuel heating systems. |
| Heat Pump Water Heater - Electric Home | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 86-88. | Deemed savings taken from value for homes with electric heat pump heating. Measure data did not indicate whether the home was heated with electric resistance or heat pump systems. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 86-88. | Deemed savings taken from value for homes with electric heat pump heating. Measure data did not indicate whether the home was heated with electric resistance or heat pump systems. |
| Air Sealing | Deemed savings based on a custom engineering study. | Deemed savings provided by implementor. | Deemed savings based on a custom engineering study. | Deemed savings provided by implementor. |
| Wall Insulation | Deemed savings based on a custom engineering study. | Deemed savings provided by implementor. | Deemed savings based on a custom engineering study. | Deemed savings provided by implementor. |
| Attic Insulation | Deemed savings based on a custom engineering study. | Deemed savings provided by implementor. | Deemed savings based on a custom engineering study. | Deemed savings provided by implementor. |
| **School Education** | | | | |
| 9W LED | 2017 parent follow-up survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11-16. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. Pages 8-10. | Calculated using 2010 draft Ohio TRM algorithm and inputs. ISR derived from 2018 participant survey. Lifetime ISR determined using UMP protocol. Baseline wattage as-found from Efficient Products. | 2017 parent follow-up survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11-16. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. Pages 8-10. | Calculated using 2010 draft Ohio TRM algorithm and inputs. ISR derived from 2018 participant survey. Lifetime ISR determined using UMP protocol. Baseline wattage as-found from Efficient Products. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| LED Night Light | 2017 parent follow-up survey. 2015 Indiana TRM Version 2.2. Pages 135-136. | Calculated using 2010 draft Ohio TRM and 2015 Indiana TRM Version 2.2 algorithms. ISR derived from 2018 family participant survey and 2017 parent follow-up survey. | 2017 parent follow-up survey. 2015 Indiana TRM Version 2.2. Pages 135-136. | Calculated using 2010 draft Ohio TRM and 2015 Indiana TRM Version 2.2 algorithms. ISR derived from 2018 family participant survey and 2017 parent follow-up survey. |
| Bathroom Faucet Aerators (2 in each kit) | 2018 family home installation survey. 2017 parent follow-up survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2017 parent follow-up survey. | 2018 family home installation survey. 2017 parent follow-up survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2017 parent follow-up survey. |
| Kitchen Faucet Aerator | 2018 family home installation survey. 2017 parent follow-up survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2017 parent follow-up survey. | 2018 family home installation survey. 2017 parent follow-up survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2017 parent follow-up survey. |
| Efficient Showerhead | 2018 family home installation survey. 2017 parent follow-up survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2017 parent follow-up survey. | 2018 family home installation survey. 2017 parent follow-up survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2017 parent follow-up survey. |
| **Smart Thermostats** | | | | |
| CLEAResult Mail-in or In-Store Rebates (Retail) | 2019 evaluation report results | 580 kWh, from page 59 of 2019 report. | Engineering calculations based on secondary data. | Estimates calculated by program implementer using engineering formulas. |
| Uplight Marketplace & RaAS | 2019 evaluation report results | 580 kWh, from page 59 of 2019 report. | Engineering calculations based on secondary data. | Estimates calculated by program implementer using engineering formulas. |
| Vectren | 2019 evaluation report results | 580 kWh, from page 59 of 2019 report. | Engineering calculations based on secondary data. | Estimates calculated by program implementer using engineering formulas. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| **Energy Savings Kits** | | | | |
| 9W LED (4) | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11-16. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. Pages 8-10. | Calculated using 2010 draft Ohio TRM algorithm and inputs. ISR derived from 2016 participant survey. Lifetime ISR determined using UMP protocol. Baseline wattage as-found from Efficient Products. | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11-16. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. Pages 8-10. | Calculated using 2010 draft Ohio TRM algorithm and inputs. ISR derived from 2016 participant survey. Lifetime ISR determined using UMP protocol. Baseline wattage as-found from Efficient Products. |
| Bathroom Faucet Aerator | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 participant survey. | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 participant survey. |
| Kitchen Faucet Aerator | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 participant survey. | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 participant survey. |
| Efficient Showerhead | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 participant survey. | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 participant survey. |
| **Behavior Change** | | | | |
| Home Energy Reports & Marketplace Promotional Emails | Used ex post savings calculation as ex ante. Ex ante savings include projected savings from Oct 2020 - Dec 2020, while verified and adjusted gross savings do not. | Used ex post savings calculation as ex ante. Ex ante savings include projected savings from Oct 2020 - Dec 2020, while verified and adjusted gross savings do not. | Used ex post savings calculation as ex ante. Ex ante savings include projected savings from Oct 2020 - Dec 2020, while verified and adjusted gross savings do not. | Used ex post savings calculation as ex ante. Ex ante savings include projected savings from Oct 2020 - Dec 2020, while verified and adjusted gross savings do not. Calculated coincidence factor using assumptions in the 2019 Illinois TRM. |
| **Multi-Family Direct Install** | | | | |
| 5-Watt LED Globe | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11-16. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. Pages 8-10. | Calculated using 2010 draft Ohio TRM algorithm and inputs. Baseline wattage as-found from Efficient Products. | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11-16. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. Pages 8-10. | Calculated using 2010 draft Ohio TRM algorithm and inputs. Baseline wattage as-found from Efficient Products. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| 9-Watt LED | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11-16. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. Pages 8-10. | Calculated using 2010 draft Ohio TRM algorithm and inputs. Lifetime ISR determined using UMP protocol. Baseline wattage as-found from Efficient Products. | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11-16. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. Pages 8-10. | Calculated using 2010 draft Ohio TRM algorithm and inputs. Baseline wattage as-found from Efficient Products. |
| Bath Aerator | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 participant survey. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. ISR determined using 2016 participant survey. |
| BR 30 LED | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11-16. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. Pages 8-10. | Calculated using 2010 draft Ohio TRM algorithm and inputs. Lifetime ISR determined using UMP protocol. Baseline wattage as-found from Efficient Products. | 2016 participant survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 11-16. DOE Uniform Methods Project, Ch. 21: Residential Lighting Evaluation Protocol. Pages 8-10. | Calculated using 2010 draft Ohio TRM algorithm and inputs. Baseline wattage as-found from Efficient Products. |
| Kitchen Aerator | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. |
| LED Night-Light | 2015 Indiana TRM Version 2.2. Pages 135-136. | Calculated using 2010 draft Ohio TRM and 2015 Indiana TRM Version 2.2 algorithms. | 2015 Indiana TRM Version 2.2. Pages 135-136. | Calculated using 2010 draft Ohio TRM and 2015 Indiana TRM Version 2.2 algorithms. |
| Showerhead | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 96-97; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 96-97; 2013 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum Pages 1-16. | Calculated using 2010 draft Ohio TRM algorithm. Inputs stem from 2013 Cadmus and Opinion Dynamics metering study and draft 2010 Ohio TRM. |
| Smart Strip | 2010 draft Ohio TRM, pages 76-77 | 2010 draft Ohio TRM, pages 76-77 | 2010 draft Ohio TRM, pages 76-77 | 2010 draft Ohio TRM, pages 76-77 |
| **Nonresidential** | | | | |
| **Small Business Direct Install** | | | | |
| Faucet Aerator 1.5 GPM | 2018 Illinois TRM V6.0 Volume 2. Pages 90-97. | Abbreviated version of algorithm | 2018 Illinois TRM V6.0 Volume 2. Pages 90-97. | Inputs and algorithms from the Illinois TRM with ISR for direct install. Hours and CF based on facility type provided in tracking data |
| LED - Exit Signs | 2015 Indiana TRM Version 2.2. Pages 288-290. | Deemed prescriptive value from IN TRM. | 2015 Indiana TRM Version 2.2. Pages 288-290. | Deemed prescriptive value from IN TRM. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| 2' LED T8 Replacements | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on common T8 wattages | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on common T8 wattages |
| 4' LED T8 Replacements | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on common T8 wattages | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on common T8 wattages |
| LED A-line Lamps 9W | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on EISA standards dependent on lumen output | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on EISA standards dependent on lumen output |
| LED BR30 Lamps 10W | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on EISA standards dependent on lumen output | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on EISA standards dependent on lumen output |
| LED PAR30 Lamps 10W | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on EISA standards dependent on lumen output | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on EISA standards dependent on lumen output |
| LED PAR38 Lamps 17W | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on EISA standards dependent on lumen output | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | In addition to using the inputs and algorithms in the 2010 draft Ohio TRM, baseline wattages based on EISA standards dependent on lumen output |
| Occupancy Sensors (0-499W controlled) | 2015 Indiana TRM Version 2.2. Pages 267-270. | Inputs and algorithms from the Indiana TRM | 2015 Indiana TRM Version 2.2. Pages 267-270. | Inputs and algorithms from the Indiana TRM with coincidence factor of 0.64 for all facility types |
| Pre-Rinse Spray Valve (Elec DHW) | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | 2010 Ohio draft TRM Savings Calculation with inputs from tracking data | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 153-156. | 2010 Ohio draft TRM Savings Calculation with inputs from tracking data |
| Showerhead | 2018 Illinois TRM V6.0 Volume 2. Pages 98-102. | Inputs and algorithms from the Illinois TRM with ISR for direct install | 2018 Illinois TRM V6.0 Volume 2. Pages 98-102. | Inputs and algorithms from the Illinois TRM with ISR for direct install. Hours and CF based on facility type provided in tracking data |
| Water Heater Pipe Insulation (Elec DHW) | 2015 Indiana TRM Version 2.2. Pages 77-79. | In addition to inputs and algorithms in the Indiana TRM, assumed 3/4" pipe diameter and 6' length of pipe wrap provided by program | 2015 Indiana TRM Version 2.2. Pages 77-79. | In addition to inputs and algorithms in the Indiana TRM, assumed 3/4" pipe diameter and 6' length of pipe wrap provided by program |
| **Nonresidential Prescriptive (HVAC)** | | | | |
| Air cooled chiller - any size | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 146 - 148. | Estimates calculated by DP&L using draft Ohio TRM and primary data. Estimated equivalent full load hours from the TRM are averaged across all system types with and without economizers (1,645 EFLH). | 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 146 - 148. | Estimates calculated by DP&L using draft Ohio TRM. Summer Peak Coincidence Factor (CF) from the TRM is used for this measure. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| Air source heat pump < 65,000 BTUH (split or single package) | 2010 draft Ohio TRM pages 197 - 200. | Baseline efficiencies from TRM. Efficient SEER of 14.0 and efficient HSPF of 8.2 used in calculation. Full load cooling hours are 942 and full load heating hours are 810. | 2010 draft Ohio TRM pages 197 - 200. | Baseline efficiencies from TRM. Efficient SEER of 14.0 and efficient HSPF of 8.2 used in calculation. |
| Air source heat pump 65,000 - 135,000 BTUH | 2010 draft Ohio TRM pages 197 - 200. | Baseline efficiencies from TRM. Efficient EER of 11.0 and efficient COP of 2.2 used in calculation. Full load cooling hours are 942 and full load heating hours are 810. | 2010 draft Ohio TRM pages 197 - 200. | Baseline efficiencies from TRM. Efficient EER of 11.0 and efficient COP of 2.2 used in calculation. |
| Energy recovery ventilation > 450 CFM | October 2009 draft Ohio TRM page 137. | No changes from TRM. | October 2009 draft Ohio TRM page 137. Measure was not included in 2010 draft Ohio TRM | No changes from TRM. |
| HVAC occupancy sensor | October 2009 draft Ohio TRM page 141. | Efficiency of 14 SEER used in calculation. Full load cooling hours are 942. | October 2009 draft Ohio TRM page 141. | Efficiency of 14 SEER used in calculation. |
| Outside air economizer with two enthalpy sensors | Cadmus engineering analysis, assuming 12% energy savings. | The savings from economizers will vary by building application, loads and climate. Typically a 12 percent savings can be achieved. Assumed 10 ton unit, 11 EER, and 1,000 cooling load hours. Energy savings of 1,309 kWh per year. | Cadmus engineering analysis, assuming 12% energy savings. | The savings from economizers will vary by building application, loads and climate. Typically a 12 percent savings can be achieved. Assumed 10 ton unit and 11 EER. Demand savings of .36kW. |
| Packaged terminal air conditioning and heat pumps | Technical Reference Manual 2010 for Pennsylvania Act 129 Energy Efficiency and Conservation Program pages 55 - 59 | Baseline values from ASHRAE 90.1-2007. Energy savings of 247 kWh per ton. | Technical Reference Manual 2010 for Pennsylvania Act 129 Energy Efficiency and Conservation Program pages 55 - 59 | Baseline values from ASHRAE 90.1-2007. Demand savings of 0.25 per ton. |
| Unitary and split system A/C 65,000 - 135,000 BTUH (5.4-11.25 tons) | 2010 draft Ohio TRM, pages 194 - 196. | Baseline efficiencies from TRM unless otherwise known. Efficient EER of 11.0 used in calculation. Full load cooling hours are 942. | 2010 draft Ohio TRM, pages 194 - 196. | Baseline efficiencies from TRM unless otherwise known. Efficient EER of 11.0 used in calculation. |
| Unitary and split system A/C < 65,000 BTUH (<5.4 tons) | 2010 draft Ohio TRM, pages 194 - 196. | Baseline efficiencies from TRM unless otherwise known. Efficient SEER of 14.0 used in calculation. Full load cooling hours are 942. | 2010 draft Ohio TRM, pages 194 - 196. | Baseline efficiencies from TRM unless otherwise known. Efficient SEER of 14.0 used in calculation. |
| Unitary and split system A/C > 760,000 BTUH (>63.33 tons) | 2010 draft Ohio TRM, pages 194 - 196. | Baseline efficiencies from TRM unless otherwise known. Efficient EER of 9.7 used in calculation. Full load cooling hours are 942. | 2010 draft Ohio TRM, pages 194 - 196. | Baseline efficiencies from TRM unless otherwise known. Efficient EER of 9.7 used in calculation. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| Unitary and split system A/C 136,000 - 240,000 BTUH (11.33-20 tons) | 2010 draft Ohio TRM, pages 194 - 196. | Baseline efficiencies from TRM unless otherwise known. Efficient EER of 10.8 used in calculation. Full load cooling hours are 942. | 2010 draft Ohio TRM, pages 194 - 196. | Baseline efficiencies from TRM unless otherwise known. Efficient EER of 10.8 used in calculation. |
| Unitary and split system A/C 241,000 - 760,000 BTUH (20-63.33 tons) | 2010 draft Ohio TRM, pages 194 - 196. | Baseline efficiencies from TRM unless otherwise known. Efficient EER of 10.0 used in calculation. Full load cooling hours are 942. | 2010 draft Ohio TRM, pages 194 - 196. | Baseline efficiencies from TRM unless otherwise known. Efficient EER of 10.0 used in calculation. |
| Variable frequency drive up to 250 HP | Engineering calculations based on primary and secondary data, including the 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 207- 209. | Estimates calculated by Cadmus using primary data, secondary data, and the draft Ohio TRM. Application information of the existing motor efficiency, brake horsepower and application type are not collected. Estimated efficiency of the motor that is driven by the VFD is assumed to 91%. An overall percent savings of 30% is used as an average where the TRM percent savings range from 9.2% to 53.5% depending on baseline conditions. Instead of brake horsepower, nominal motor horsepower and 85% load factor is assumed. | Engineering calculations based on primary and secondary data, including the 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 207- 209. | Estimates calculated by Cadmus using primary data, secondary data, and the draft Ohio TRM. Application information of the existing motor efficiency, brake horsepower and application type are not collected. Estimated efficiency of the motor that is driven by the VFD is assumed to 91%. An overall percent savings of 30% is used as an average where the TRM percent savings range from 3% to 34.8% depending on baseline conditions. Instead of brake horsepower, nominal motor horsepower and 85% load factor is assumed. |
| Variable Refrigerant Flow System < 65,000 BTUH | Calculation savings methodology reflect similar methodology used for heat pump systems: 2010 draft Ohio TRM, pages 197-200. | Base efficiency, new efficiency, and HOU are application specific. | Calculation savings methodology reflect similar methodology used for heat pump systems: 2010 draft Ohio TRM, pages 197-200. | Base efficiency, new efficiency, and HOU are application specific. |
| Variable Refrigerant Flow System 136,000 - 240,000 BTUH | Calculation savings methodology reflect similar methodology used for heat pump systems: 2010 draft Ohio TRM, pages 197-200. | Base efficiency, new efficiency, and HOU are application specific. | Calculation savings methodology reflect similar methodology used for heat pump systems: 2010 draft Ohio TRM, pages 197-200. | Base efficiency, new efficiency, and HOU are application specific. |
| Water cooled chiller > 300 tons | 2010 draft Ohio TRM, pages 147 - 148. | EFLH is an average of the 3 system types for Dayton, resulting in 1,645 EFLH. | 2010 draft Ohio TRM, pages 147 - 148. | No changes from TRM. |
| Window film | 2010 draft Ohio TRM, pages 214 - 217. | ΔkWh is average of "light industrial, small office and small retail" resulting in 266. | 2010 draft Ohio TRM, pages 214 - 217. | ΔkW is average of "light industrial, small office and small retail" resulting in .14. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| **Nonresidential Prescriptive (Lighting)** | | | | |
| Delamping HID | 2010 draft Ohio TRM, pages 169 - 172. | Actual lamp wattage removed including ballast is used. HOU is application specific. | 2010 draft Ohio TRM, pages 169 - 172. | Actual lamp wattage removed including ballast is used. Coincidence factor is the average of the first 13 building type measures .732. |
| Delamping T12 (# linear feet) | 2010 draft Ohio TRM, pages 169 - 172. | 72 watts per 4-foot lamp is used to calculated savings. HOU is application specific. | 2010 draft Ohio TRM, pages 169 - 172. | 72 watts per 4-foot lamp is used to calculated savings. Coincidence factor is the average of the first 13 building type measures .732. |
| Delamping T8 (# linear feet) | 2010 draft Ohio TRM, pages 169 - 172. | 23 watts per 4-foot lamp is used to calculated savings. HOU is application specific. | 2010 draft Ohio TRM, pages 169 - 172. | 23 watts per 4-foot lamp is used to calculated savings. Coincidence factor is the average of the first 13 building type measures .732. |
| Energy Star LED luminaires or screw-in base lamps (replacing incandescent) | 2010 draft Ohio TRM, pages 161 - 162. | Base efficiency, new efficiency, and HOU are application specific. | 2010 draft Ohio TRM, pages 161 - 162. | Base efficiency and new efficiency are application specific. Coincidence factor is the average of the first 13 building type measures .732. |
| Energy Star LED screw-in base lamps (replacing CFL) | 2010 draft Ohio TRM, pages 161 - 162. | Base efficiency, new efficiency, and HOU are application specific. | 2010 draft Ohio TRM, pages 161 - 162. | Base efficiency and new efficiency are application specific. Coincidence factor is the average of the first 13 building type measures .732. |
| Exterior - LED replacing 175W or less | Simple savings formula using 8760 hours. | Efficient fixture wattage is subtracted from baseline fixture including ballast wattage | Simple savings formula. | Efficient fixture wattage is subtracted from baseline fixture including ballast wattage |
| Exterior - LED or Induction (8,760 operating hours) replacing 176W to 250W | Simple savings formula using 8760 hours. | Efficient fixture wattage is subtracted from baseline fixture including ballast wattage | Simple savings formula. | Efficient fixture wattage is subtracted from baseline fixture including ballast wattage |
| Exterior - LED or Induction (8,760 operating hours) replacing 251W or greater | Simple savings formula using 8760 hours. | Efficient fixture wattage is subtracted from baseline fixture including ballast wattage | Simple savings formula. | Efficient fixture wattage is subtracted from baseline fixture including ballast wattage |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| Exterior - LED or Induction (operating hours < 8,760) replacing 176W to 250W | Simple savings formula using 4380 hours. | Efficient fixture wattage is subtracted from baseline fixture including ballast wattage | Simple savings formula. | Efficient fixture wattage is subtracted from baseline fixture including ballast wattage |
| Exterior - LED or Induction (operating hours < 8,760) replacing 251W or greater | Simple savings formula using 4380 hours. | Efficient fixture wattage is subtracted from baseline fixture including ballast wattage | Simple savings formula. | Efficient fixture wattage is subtracted from baseline fixture including ballast wattage |
| Exterior LED recessed downlight luminaires or screw-in base lamps (replacing incandescent, ENERGY STAR certified) | 2010 draft Ohio TRM, pages 161 - 162. | Base efficiency, new efficiency, and HOU are application specific. | 2010 draft Ohio TRM, pages 161 - 162. | No demand savings are collected. |
| Exterior LED recessed downlight luminaires or screw-in base lamps (replacing incandescent, ENERGY STAR certified)1 | 2010 draft Ohio TRM, pages 161 - 162. | Base efficiency, new efficiency, and HOU are application specific. | 2010 draft Ohio TRM, pages 161 - 162. | No demand savings are collected. |
| Exterior Re-Lamping LED Tube | 2010 draft Ohio TRM, pages 169 - 172. | Base efficiency, new efficiency, and HOU are application specific. | 2010 draft Ohio TRM, pages 169 - 172. | No demand savings are collected. |
| LED or Electroluminescent exit sign | 2010 draft Ohio TRM, pages 183 - 184. | No changes from TRM. | 2010 draft Ohio TRM, pages 183 - 184. | No changes from TRM. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| LED Re-Lamping $1 per foot | 2010 draft Ohio TRM, pages 169 - 172. | Base efficiency, new efficiency, and HOU are application specific. | 2010 draft Ohio TRM, pages 169 - 172. | Base efficiency and new efficiency are application specific. Coincidence factor is the average of the first 13 building type measures .732. |
| LED Replacing 50 W or less HID or Fluorescent | Simple savings formula using specific project HOU assumptions. | Baseline efficiency, new efficiency, and HOU is application specific. | Simple savings formula. | Baseline efficiency and new efficiency is application specific |
| LED Replacing 51 W to 100 W HID or Fluorescent | Simple savings formula using specific project HOU assumptions. | Baseline efficiency, new efficiency, and HOU is application specific. | Simple savings formula. | Baseline efficiency and new efficiency is application specific |
| LED Replacing 101 W to 150 W HID or Fluorescent | Simple savings formula using specific project HOU assumptions. | Baseline efficiency, new efficiency, and HOU is application specific. | Simple savings formula. | Baseline efficiency and new efficiency is application specific |
| LED Replacing 151 W to 200 W HID or Fluorescent | Simple savings formula using specific project HOU assumptions. | Baseline efficiency, new efficiency, and HOU is application specific. | Simple savings formula. | Baseline efficiency and new efficiency is application specific |
| LED Replacing 201 W to 350 W HID or Fluorescent | Simple savings formula using specific project HOU assumptions. | Baseline efficiency, new efficiency, and HOU is application specific. | Simple savings formula. | Baseline efficiency and new efficiency is application specific |
| LED Replacing 351 W to 500 W HID or Fluorescent | Simple savings formula using specific project HOU assumptions. | Baseline efficiency, new efficiency, and HOU is application specific. | Simple savings formula. | Baseline efficiency and new efficiency is application specific |
| LED Replacing 501 W or greater HID or Fluorescent | Simple savings formula using specific project HOU assumptions. | Baseline efficiency, new efficiency, and HOU is application specific. | Simple savings formula. | Baseline efficiency and new efficiency is application specific |
| Occupancy sensor controlling 100 watts or more | 2010 draft Ohio TRM method with adjusted controlled wattage on Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM. | Baseline efficiency, new efficiency, and HOU is application specific. | 2010 draft Ohio TRM method with adjusted controlled wattage on Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM. | Baseline efficiency and new efficiency is application specific |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| Vending equipment controller | 2010 draft Ohio TRM, pages 274 - 275. | Assumed all equipment was for refrigerated vending machines at 400 watts baseline and an ESF of 46%. | 2010 draft Ohio TRM, pages 274 - 275. | No demand savings are collected. |
| **Nonresidential Prescriptive (Compressed Air)** | | | | |
| Air compressor 1 - 100 HP Load/No Load | 2010 draft Ohio TRM with specific project HOU assumptions. Pages 272 - 273. | Use nominal hp; assumed 90% motor efficiency and ESF of 10%. | 2010 draft Ohio TRM, pages 272 - 273. | Use nominal hp; assumed 90% motor efficiency and ESF of 10%. |
| Air compressor 1 - 100 HP Variable Speed | 2010 draft Ohio TRM with specific project HOU assumptions. Pages 272 - 273. | Use nominal hp; assumed 90% motor efficiency and ESF of 26%. | 2010 draft Ohio TRM, pages 272 - 273. | Use nominal hp; assumed 90% motor efficiency and ESF of 26%. |
| No-loss drain | Engineering calculations based on Best Practices for Compressed Air Systems. | Operation pressure, quantity of drains and HOU are application specific. | Engineering calculations based on Best Practices for Compressed Air Systems. | Operation pressure and quantity of drains are application specific. |
| **Nonresidential Prescriptive (Motors and Drives)** | | | | |
| Premium Efficiency Motor 3HP | 2010 draft Ohio TRM with specific project HOU assumptions. Pages 265 - 268. | Assumed baseline efficiency based on 1800 RPM ODP; actual efficiency based on NEMA required standard. | 2010 draft Ohio TRM, pages 265 - 268. | Assumed baseline efficiency based on 1800 RPM ODP; actual efficiency based on NEMA required standard. |
| Variable frequency drive up to 250 HP | Engineering calculations based on primary and secondary data, including the 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 207- 209. | Estimates calculated by Cadmus using primary data, secondary data, and the draft Ohio TRM. Application information of the existing motor efficiency, brake horsepower and application type are not collected. Estimated efficiency of the motor that is driven by the VFD is assumed to 91%. An overall percent savings of 30% is used as an average where the TRM percent savings range from 9.2% to 53.5% depending on baseline conditions. Instead of brake horsepower, nominal motor horsepower and 85% load factor is assumed. | Engineering calculations based on primary and secondary data, including the 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC. Pages 207- 209. | Estimates calculated by Cadmus using primary data, secondary data, and the draft Ohio TRM. Application information of the existing motor efficiency, brake horsepower and application type are not collected. Estimated efficiency of the motor that is driven by the VFD is assumed to 91%. An overall percent savings of 30% is used as an average where the TRM percent savings range from 3% to 34.8% depending on baseline conditions. Instead of brake horsepower, nominal motor horsepower and 85% load factor is assumed. |
| **Nonresidential Prescriptive (Midstream Incentives Channel)** | | | | |
| High-Bay/Low-Bay | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins used per Cadmus recommendation. | Actual lamp wattage is used, and baselines are determined through lumen equivalence. WHF is from Ohio 2010 TRM, page 171. ISR is assumed to be 100%. | Simple savings formula is used. Calculations are based on the Ohio 2010 TRM. Baselines are determined through lumen equivalence. | Actual lamp wattage is used, and the baselines are determined through lumen equivalence. WHF is from Ohio 2010 TRM, page 171. CF is 0.732. ISR is assumed to be 100%. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| LED Exterior Wall Pack | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins from the 2016 PA TRM IMP used per Cadmus recommendation. | Actual lamp wattage is used, and the baseline is determined through lumen equivalence using a table from the PA Interim-Measures Protocol (IMP). WHF is from Ohio 2010 TRM, page 171. ISR is assumed to be 100%. | Simple savings formula is used. Calculations are based on the Ohio 2010 TRM. WHF is from Ohio 2010 TRM, page 171. Demand savings are 0 since the measure is exterior. | Actual lamp wattage is used, and baselines are determined through lumen equivalence. Demand savings are 0 since the measure is exterior. ISR is assumed to be 100%. |
| LED Exterior Flood | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins from the 2016 PA TRM IMP used per Cadmus recommendation for majority of records. | Actual lamp wattage is used, and the baseline is determined through lumen equivalence using a table from the PA Interim-Measures Protocol (IMP). WHF is from Ohio 2010 TRM, page 171. ISR is assumed to be 100%. | Simple savings formula is used. Calculations are based on the Ohio 2010 TRM. WHF is from Ohio 2010 TRM, page 171. Demand savings are 0 since the measure is exterior. | Actual lamp wattage is used, and baselines are determined through lumen equivalence. Demand savings are 0 since the measure is exterior. ISR is assumed to be 100%. |
| LED Downlight Kits | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins from the 2018 and 2019 Wisconsin TRM used per Cadmus recommendation. | Actual lamp wattage is used, and baselines were based on lumen equivalence. WHF is from Ohio 2010 TRM, page 171. ISR is assumed to be 100%. | Simple savings formula is used. Calculations are based on the Ohio 2010 TRM. Baselines were based on lumen equivalence. | Actual lamp wattage is used, and the baselines were based on lumen equivalence. WHF is from Ohio 2010 TRM, page 171. CF is 0.732. ISR is assumed to be 100%. |
| LED T8 | Simple savings formula is used. Calculations are based on the Ohio TRM. HOU and baseline wattages were provided by implementation team. | Baseline wattages and HOU were provided by implementation team. WHF is from Ohio 2010 TRM, page 171. ISR is assumed to be 100%. | Simple savings formula is used. Calculations are based on the Ohio TRM. HOU and baseline wattages were provided by implementation team. | Baseline wattages were provided by implementation team. WHF is from Ohio 2010 TRM, page 171. CF is 0.732. ISR is assumed to be 100%. |
| Fluorescent T8 | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins based on review of 1000 bulbs data and CEE Qualified Products List used per Cadmus recommendation. | Actual lamp wattage is used, and baselines are based on lumen equivalence. WHF is from Ohio 2010 TRM, page 171. ISR is assumed to be 100%. | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins based on review of 1000 Bulbs data and CEE QPL data used per Cadmus recommendation. | Actual lamp wattage is used, and the baselines are based on lumen equivalence. WHF is from Ohio 2010 TRM, page 171. CF is 0.732. ISR is assumed to be 100%. |
| LED and Fluorescent T5 | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins based on review of 1000 bulbs data used per Cadmus recommendation. | Actual lamp wattage is used, and baselines are based on lumen equivalence. WHF is from Ohio 2010 TRM, page 171. ISR is assumed to be 100%. | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins based on review of 1000 bulbs data used per Cadmus recommendation. | Actual lamp wattage is used, and the baselines are based on lumen equivalence. WHF is from Ohio 2010 TRM, page 171. CF is 0.732. ISR is assumed to be 100%. |
| LED Fixtures | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins from 2016 PA TRM IMP used per Cadmus recommendation for majority of records. | Actual lamp wattage is used, and baseline wattages based on lumen equivalence for majority of records. WHF is from Ohio 2010 TRM, page 171. ISR is assumed to be 100%. | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins from 2016 PA TRM IMP used per Cadmus recommendation for majority of records. | Actual lamp wattage is used, and baseline wattages based on lumen equivalence for majority of records. WHF is from Ohio 2010 TRM, page 171. CF is 0.732. ISR is assumed to be 100%. |
| Occupancy Sensors | Deemed savings values from Commercial program. | Average kWh savings per sensor calculated from commercial program. | Deemed savings values from Commercial program. | Average kW savings per sensor calculated from commercial program. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| LED 4-Pin CFL Replacement | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins from the 2016 PA TRM IMP used per Cadmus recommendation for majority of records. | Actual lamp wattage is used, and baseline wattages based on lumen equivalence for majority of records. WHF is from Ohio 2010 TRM, page 171. ISR is assumed to be 100%. | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins from the 2016 PA TRM IMP used per Cadmus recommendation for majority of records. | Actual lamp wattage is used, and baseline wattages based on lumen equivalence for majority of records. WHF is from Ohio 2010 TRM, page 171. CF is 0.732. ISR is assumed to be 100%. |
| LED Exit Signs | Simple savings formula is used. Calculations are based on the Ohio 2010 TRM. | Calculations are based on the Ohio 2010 TRM, page 184. ISR is assumed to be 100%. | Simple savings formula is used. Calculations are based on the Ohio 2010 TRM. | Calculations are based on the Ohio 2010 TRM, page 184. ISR is assumed to be 100%. |
| LED Screw-In | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins from literature review of federal baselines used per Cadmus recommendation for majority of records. | Actual lamp wattage is used, and baselines are determined through lumen equivalence for majority of records. WHF is from Ohio 2010 TRM, page 171. ISR is assumed to be 100%. | Simple savings formula is used. HOU were provided by implementation team. Lumen equivalency bins from literature review of federal baselines used per Cadmus recommendation for majority of records. | Actual lamp wattage is used, and baseline wattages based on lumen equivalence for majority of records. WHF is from Ohio 2010 TRM, page 171. CF is 0.732. ISR is assumed to be 100%. |
| Chillers Air-cooled | Ohio 2010 TRM, pages 146-148. 2012 IECC baselines were used in place of Ohio 2010 TRM baselines for six units. | IPLV provided by the implementation team. EFLH from Ohio 2010 TRM. ISR assumed to be 100%. | Ohio 2010 TRM, pages 146-148. 2012 IECC baselines were used in place of Ohio 2010 TRM baselines for six units. | FL EER provided by the implementation team. ISR assumed to be 100%. |
| Mini-splits | Ohio 2010 TRM, pages 194-196 (air conditioners) and pages 197-200 (heat pumps), with DOE federal baselines for SEER and HSPF. | SEER and HSPF provided by the implementation team. EFLH from Ohio TRM. ISR assumed to be 100%. | Ohio 2010 TRM, pages 194-196 (air conditioners) and pages 197-200 (heat pumps) | EER provided by the implementation team. ISR assumed to be 100%. |
| Unitary AC | Ohio 2010 TRM, pages 194-196 | SEER provided by the implementation team. EFLH from Ohio TRM. ISR assumed to be 100%. | Ohio 2010 TRM, pages 194-196, with DOE federal baselines for EER and IEER for units <760,000 Btu/hr and 2012 IECC for EER and IEER for units >=760,000 Btu/hr | EER provided by the implementation team. ISR assumed to be 100%. |
| Unitary HP | Ohio 2010 TRM, pages 197-200, with DOE federal baseline efficiencies. | SEER, HSPF, EER, COP provided by the implementation team. EFLH from Ohio TRM. ISR assumed to be 100%. Units greater than 65,000 Btu/hr incorrectly use EER (instead of IEER) for kWh savings. | Ohio 2010 TRM, pages 197-200, with DOE federal baseline efficiencies. | EER provided by the implementation team. EFLH from Ohio TRM. ISR assumed to be 100%. |
| Variable Frequency Drive | Ohio 2010 TRM, 207-209 | Motor efficiencies provided by the implementation team. ESF and EFLH from Ohio TRM. ISR assumed to be 100% | Ohio 2010 TRM, 207-209 | Motor efficiencies provided by the implementation team. DSF and EFLH from Ohio TRM. ISR assumed to be 100% |
| **Nonresidential Custom** | | | | |
| Custom NC | Custom engineering calculation | A full impact analysis report is completed. Specific to each project, as-built building simulations are developed and used to determine electric kWh savings. | Custom engineering calculation | A full impact analysis report is completed. Specific to each project, as-built building simulations are developed and used to determine electric kW savings. |

| Measure | *Ex Ante* kWh Savings Documentation | Ex Ante kWh Savings Documentation Detail | Ex Ante kW Savings Documentation | Ex Ante kW Savings Documentation Detail |
|---|---|---|---|---|
| Custom NC-LPD | Custom engineering calculation | A full impact analysis report is completed. Specific to each project, lighting power density calculations are used to determine electric kWh savings. | Custom engineering calculation | A full impact analysis report is completed. Specific to each project, lighting power density calculations are used to determine electric kW savings. |
| Custom-HVAC | Custom engineering calculation | Depending on project size and scope, a full impact analysis report is completed. Specific to each project, the impact analysis may include pre- and post- metering, billing analysis, and custom engineering calculations. | Custom engineering calculation | Depending on project size and scope, a full impact analysis report is completed. Specific to each project, the impact analysis may include pre- and post- metering, billing analysis, and custom engineering calculations. |
| Custom-Lighting | Custom engineering calculation | Depending on project size and scope, a full impact analysis report is completed. Specific to each project, the impact analysis may include pre- and post- metering, billing analysis, and custom engineering calculations. | Custom engineering calculation | Depending on project size and scope, a full impact analysis report is completed. Specific to each project, the impact analysis may include pre- and post- metering, billing analysis, and custom engineering calculations. |
| Custom-Other | Custom engineering calculation | Depending on project size and scope, a full impact analysis report is completed. Specific to each project, the impact analysis may include pre- and post- metering, billing analysis, and custom engineering calculations. | Custom engineering calculation | Depending on project size and scope, a full impact analysis report is completed. Specific to each project, the impact analysis may include pre- and post- metering, billing analysis, and custom engineering calculations. |
| Custom-RCx | Custom engineering calculation | Depending on project size and scope, a full impact analysis report is completed. Specific to each project, the impact analysis may include pre- and post- metering, billing analysis, and custom engineering calculations. | Custom engineering calculation | Depending on project size and scope, a full impact analysis report is completed. Specific to each project, the impact analysis may include pre- and post- metering, billing analysis, and custom engineering calculations. |

# Appendix H. Residential Behavior Change Program Impact Evaluation Methodology

To evaluate the 2020 Behavior Change program, Cadmus conducted four tasks:

- Collected, reviewed, and prepared data
- Estimated energy savings
- Analyzed demand reduction
- Conducted energy efficiency program uplift analysis

This appendix describes our methodology and presents detailed findings for the billing and uplift analyses of the Behavior Change program.

## *Data Collection, Review, and Preparation*

Cadmus worked with DP&L and Uplight to acquire the data necessary to evaluate the Behavior Change program savings in 2020. Major data preparation steps included cleaning and compiling the program tracking data, billing consumption, and weather data and testing for significant differences in annual pre-treatment consumption between treatment and control customers.

### Program Tracking Data

Cadmus collected program tracking data directly from Uplight at the end of September 2020. Thisdata included treatment group customers, who received a combination of paper or electronic HERs or Marketplace promotional emails, and control group customers tracked since program inception. Because the Behavior Change program was implemented as a random control trial, we included all the possible customers in the evaluation, adopting a “once in, always in” policy for customers originally randomized into either the treatment or control group prior to the program launch.

### Billing Data

Cadmus collected customer billing data for each wave from DP&L directly. To clean that billing data, we followed three steps:

1. Dropped customers whose account went inactive before delivery of the first energy report. Cadmus used the last bill received for customers as their account inactive date.
2. Cleaned and calendarized bills, including dropping bills that covered more than 100 days. We dropped bills with no consumption and with non-zero durations if it was the first or last bill received for a customer. We also dropped bills earlier than one year prior to delivery of the first treatment and trued up bills with estimated reads.
3. Dropped customers with less than 11 months of pre-treatment bills.

Table 106 provides the attrition in the 2020 analysis sample from data cleaning steps. The final modeling sample included customers in the program tracking data who were not dropped during the cleaning process (and were therefore included in the billing analysis). As the table shows, very few customers were dropped in the cleaning process.

**Table 106. Billing Data Customer Attrition**

| Filtering Conditions | Experiment 1 | | | | | Experiment 2 | |
|---|---|---|---|---|---|---|---|
| | Email + Paper | Email + Paper + Marketplace | Email + Marketplace | Marketplace | Control | Paper | Control |
| Original randomly assigned homes | 14,081 | 28,160 | 53,945 | 14,106 | 14,104 | 33,224 | 28,449 |
| Included in billing data | 14,081 | 28,160 | 53,945 | 14,106 | 14,104 | 33,224 | 28,449 |
| After data cleaning | 14,073 | 28,149 | 53,917 | 14,094 | 14,094 | 33,224 | 28,449 |
| Active at program launch | 14,069 | 28,137 | 53,903 | 14,092 | 14,091 | 33,207 | 28,441 |
| At least 11 months of pre-treatment data | 14,009 | 28,018 | 53,705 | 14,038 | 14,036 | 33,113 | 28,374 |
| **Final Estimation Sample** | **14,009** | **28,018** | **53,705** | **14,038** | **14,036** | **33,113** | **28,374** |

Note: Total values in table are rounded for reporting purposes.

## Weather Data

Cadmus collected weather data from the weather station closest to each home and estimated the HDDs and CDDs for each customer billing cycle. After merging the weather and billing data, we allocated the billing cycle electricity consumption, HDDs, and CDDs to calendar months.

## Verification of Balanced Treatment and Control Groups

Cadmus verified that subjects in the randomized treatment and control groups were equivalent in pre-treatment monthly energy consumption. We conducted the random assignment of eligible customers to treatment or control groups in April 2018. We also verified the equivalency of waves using the cleaned billing data, comparing pre-treatment average annual consumption from before to after the program launch.

Table 107 provides the results of tests for significant differences between treatment and control group pretreatment consumption by pre-treatment month. All waves were balanced in all pre-treatment months: no statistically significant differences existed between the pretreatment consumption of treatment and control groups in any wave, as shown by the p-values (provided in parentheses) that are all much greater than 0.10.

**Table 107. Tests for Significant Differences in Annual Pretreatment Consumption**

| Pre-Treatment Month | Average Annual Change Electricity Consumption due to Random Treatment Assignment in kWh/yr (p-value) | | | | |
|---|---|---|---|---|---|
| | Email + Paper | Email + Paper + Marketplace | Email + Marketplace | Marketplace | Paper |
| January | -8.999 (0.3291) | -8.946 (0.2626) | -6.693 (0.3605) | -0.960 (0.9170) | -7.404 (0.3033) |
| February | -3.494 (0.7048) | -2.712 (0.7342) | -0.160 (0.9825) | 4.601 (0.6177) | -2.707 (0.7066) |
| March | -4.805 (0.6023) | -1.881 (0.8138) | 0.470 (0.9489) | 4.066 (0.6591) | -4.314 (0.5486) |
| April | -2.085 (0.8212) | 0.803 (0.9199) | 0.850 (0.9076) | 5.434 (0.5555) | 1.883 (0.7935) |
| May | -3.920 (0.6708) | 0.349 (0.9652) | -4.897 (0.5036) | 1.257 (0.8916) | 3.316 (0.6447) |
| June | -3.791 (0.6812) | -1.464 (0.8546) | -5.888 (0.4215) | -0.624 (0.9461) | 2.404 (0.7382) |
| July | -3.026 (0.7428) | -1.845 (0.8173) | -7.797 (0.2868) | -2.427 (0.7923) | 2.877 (0.6891) |
| August | -2.041 (0.8248) | -1.084 (0.8920) | -6.545 (0.3713) | -0.962 (0.9169) | 4.120 (0.5668) |
| September | -0.882 (0.9238) | -2.322 (0.7713) | -5.055 (0.4899) | 2.8640 (0.7560) | 3.991 (0.5789) |
| October | -6.683 (0.4687) | -3.257 (0.6834) | -3.736 (0.6098) | 5.224 (0.5709) | 1.735 (0.8093) |
| November | -6.990 (0.4485) | -2.917 (0.7149) | -2.308 (0.7526) | 6.219 (0.4998) | -0.902 (0.9002) |
| December | -10.721 (0.2450) | -9.803 (0.2196) | -8.479 (0.2468) | -0.953 (0.9176) | -10.745 (0.1351) |

## *Ex Post Verified Savings*

### Energy Savings Model Specification

Cadmus used regression analyses of monthly billing data from customers in the treatment and control groups to estimate energy savings from the Behavior Change program. The billing analysis conformed to IPMVP Option C, whole facility,[41] and the approach described in the UMP.[42]

41 Efficiency Valuation Organization. January 2012. *International Performance Measurement and Verification Protocol, Concepts and Options for Determining Energy and Water Savings, Volume 1*. p.25. EVO 10000 – 1:2012. http://www.evo-world.org/

42 National Renewable Energy Laboratory. April 2013. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* "Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol." Written by K. Agnew and M. Goldberg. NREL/SR-7A30-53827. http://www1.eere.energy.gov/office_eere/de_ump_protocols.html
National Renewable Energy Laboratory. August 2014. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. "Chapter 17: Residential Behavior Protocol." Written by J. Stewart and A. Todd. NREL/SR-7A40-62497. http://www1.eere.energy.gov/office_eere/de_ump_protocols.html

More specifically, we used a multivariate regression to analyze the energy use of customers who had been randomly assigned to treatment and control groups. We tested and compared two general model specifications to check the robustness of savings results:

- The ***post-only model*** regresses customer average daily consumption on a treatment indicator variable and includes regressors as customers' pretreatment energy use, month-by-year fixed effects, and weather.[43] The model is estimated only with post-treatment customer bills.
- The ***difference-in-differences (D-in-D) fixed-effects*** model regresses average daily consumption on a treatment indicator variable, month-by-year fixed effects, and weather. The model is estimated with pre-treatment and post-treatment customer bills.

The models both yielded savings estimates within the other model's confidence intervals, so their results were not statistically different. In 2020, Cadmus reported the results of the post-only model.

The error term $\varepsilon_{it}$ should be uncorrelated with program participation ($PART_i$) and other observable variables because of the random assignment of homes to treatment and control groups; therefore, ordinary least squares should result in an unbiased estimate of the average daily savings per customer. We clustered the standard errors on customers to account for arbitrary correlation in customer consumption over the analysis period.

### *Post-Only Model*

Cadmus specified the post-only model assuming the average daily consumption ($ADC_{it}$) of home electricity, as given by Equation 1:

**Equation 1**

$$ADC_{it} = \beta_1 PART_i * PY_t + \sum_{m=1}^{m=12} \beta_{2\mathrm{m}} Pre\text{–}Usage_{im} \times Month_t + W'\gamma + \tau_t + \varepsilon_{it}$$

Where, for home *i* in month *t*:

| | | |
|---|---|---|
| $\beta_1$ | = | Coefficient representing the conditional average treatment effect of the program on electricity use (kilowatt-hours per customer per day) |
| $PART_i$ | = | Indicator variable for program participation (equals 1 if customer *i* was in the treatment group and 0 otherwise) |
| $PY_t$ | = | Indicator variable for each program year (equals 1 if the month *t* was in the program year and 0 otherwise) |
| $\beta_{2m}$ | = | Coefficient representing the average effect of pre-treatment electricity consumption during month $m$ on post-treatment average daily consumption during month $m$ (kilowatt-hours per customer per day). |
| $Pre\text{–}Usage_{im}$ | = | Mean household energy consumption of customer *i* in pre-treatment month $m$ |

[43] Allcott, H., and T. Rogers. 2014. "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation." *American Economic Review*, no. 104 (10): 3003–3037.

| | | |
|---|---|---|
| $Month_t$ | = | Indicator variable for month of the year (equals 1 if the month *t* was in month *m* of the calendar year, *m = 1,…,12*, and 0 otherwise) |
| $\tau_t$ | = | Average energy use in month *t* reflecting unobservable factors specific to the month, controlled for with month-by-year fixed effects |
| $W$ | = | Vector using both HDD and CDD variables to control for weather impacts on energy use |
| $\gamma$ | = | Vector of coefficients representing the average impact of weather variables on energy use |
| $\varepsilon_{it}$ | = | Error term for customer *i* in month *t* |

### *Difference-in-Differences Fixed-Effects Model*

The D-in-D fixed-effects model was specified assuming the average daily consumption ($ADC_{it}$) of electricity as given by Equation 2:

**Equation 2**

$$ADC_{it} = \alpha_i + \tau_t + W'\gamma + \beta_1 PART_i \times POST_t + \epsilon_{it}$$

Where, for customer *i* in month *t*:

| | | |
|---|---|---|
| $\alpha_i$ | = | Average energy use of customer *i* reflecting unobservable, non-weather-sensitive, and time-invariant factors specific to the customer, controlled for with customer fixed effects |
| $\tau_t$ | = | Average energy use in month *t* reflecting unobservable factors specific to the month, controlled for with month-by-year fixed effects |
| $W$ | = | Vector using HDD and CDD variables to control for weather impacts on energy use |
| $\gamma$ | = | Vector of coefficients representing the average impact of weather variables on energy use |
| $\beta_1$ | = | Coefficient representing the program's conditional average treatment effect on electricity use (kilowatt-hours per customer per day) |
| $PART_i$ | = | Indicator variable for program participation (equals 1 if customer *i* was in the treatment group and 0 otherwise) |
| $POST_t$ | = | Indicator variable for whether month *t* is pre- or post-treatment (equals 1 if month *t* was in the treatment period and 0 otherwise) |
| $\epsilon_{it}$ | = | Error term for customer *i* in month *t* |

### *Regression Analysis Estimates*

Cadmus estimated separate treatment effects for each wave and program year. Table 108 shows both the D-in-D fixed-effects model and the post-only model estimates of average daily savings per customer, by wave and program year. All of the models were estimated by ordinary least squares and Huber-White robust standard errors were adjusted for correlation over time in a customer's consumption.

**Table 108. Treatment Effects for the Behavior Change Program by Model Specifications**

| Treatment Year | Email + Paper | | Email + Paper + Marketplace | | Email + Marketplace | | Marketplace | | Paper | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Post-Only | D-in-D | Post-Only | D-in-D | Post-Only | D-in-D | Post-Only | D-in-D | Post-Only | D-in-D |
| 2018[a] | -0.12<br>(0.091) | -0.118<br>(0.085) | -0.019<br>(0.079) | -0.042<br>(0.075) | 0.02<br>(0.072) | -0.011<br>(0.068) | 0.144<br>(0.093) | 0.14<br>(0.087) | -0.285 [b]<br>(0.086) | -0.289 [b]<br>(0.076) |
| 2019 | -0.281 [b]<br>(0.092) | -0.255 [b]<br>(0.092) | -0.174 [c]<br>(0.079) | -0.147 [d]<br>(0.08) | -0.06<br>(0.072) | -0.051<br>(0.073) | 0.044<br>(0.093) | 0.019<br>(0.094) | -0.365 [b]<br>(0.082) | -0.346 [b]<br>(0.08) |
| 2020 | -0.372 [b]<br>(0.118) | -0.321 [b]<br>(0.124) | -0.235 [c]<br>(0.101) | -0.225 [c]<br>(0.106) | -0.067<br>(0.093) | -0.108<br>(0.097) | 0.059<br>(0.121) | -0.053<br>(0.125) | -0.374 [b]<br>(0.101) | -0.353 [b]<br>(0.106) |

[a] In 2018, treatment customers in the Mail + Paper + Marketplace, Email + Marketplace, and Marketplace waves were treated between June and December 2018. Treatment customers in the Email + Paper and Paper waves were treated between August and December 2018.

[b] This value is significant at the 1% significance level.

[c] This value is significant at the 5% significance level.

[d] This value is significant at the 10% significance level.

The 2020 savings estimates from the D-in-D fixed effects and post-only models were statistically indistinguishable, suggesting that the estimated treatment effects do not depend on the modeling approach. Cadmus reported savings based on the post-only models for all waves because of the increased precision achieved with these models, as shown by the smaller standard errors of post-only estimates compared to D-in-D fixed effects estimates.

Post-only treatment effects were significant in the Email + Paper, Email + Paper + Marketplace, and Paper treatment waves, but there were no significant savings for the two remaining waves in Experiment 1. A p-value less than 0.10 suggests that the estimate is not statistically different from 0.0 kWh per day, which may either mean that customers in this wave did not truly reduce their consumption compared to the control group or that savings in these periods were too small to identify with the available sample size.

## Annual Program Energy Savings

Cadmus estimated program savings in 2020 for each wave's population of treated customers as the product of average daily savings per participant and the number of days these customers were treated in 2020, shown in Equation 3.

**Equation 3**

$$Savings_h = \beta_{1h} \times \sum_{i=1}^{N} Treatment\ Days_{i,h}$$

Where:

$\beta_{1h}$ = Average daily savings in kilowatt-hours per treatment group customer in wave *h*, estimated from Equation 1

$Treatment\ Days_{i,h}$ = The number of days customer *i* in wave *h* was treated in 2020

We estimated realization rates for each wave as the ratio of *ex post* to *ex ante* program savings.

## *Uplift Analysis*

Savings from the Behavior Change program reflected both behavioral changes, such as turning off lights in unoccupied rooms and adjusting thermostat settings, and investments in energy-efficient products, such as high-efficiency furnaces and LEDs. In 2020, some customers who installed efficiency products because of home energy reports or Marketplace promotional emails may have received rebates from DP&L through their other residential energy efficiency programs.

To avoid double-counting cross-program savings caused by the HER program, Cadmus subtracted cross-participation savings from the residential portfolio savings by conducting an uplift analysis to estimate the impacts of the Behavior Change program on participation in PPL Electric Utilities' residential and low-income efficiency programs (and the energy savings from that participation). Any difference in the rate of participation is *participation uplift* and any difference in the rate of savings is *savings uplift*.

Behavior Change program treatment and control customers participated in six residential downstream DP&L rebate programs in 2020: Appliance Recycling, Efficient Products, Energy Savings Kits, Heating and Cooling Rebates, Income Eligible Efficiency (OPAE and PWC), and Smart Thermostats. The following sections provide details of the uplift analyzes' results.

### Participation Uplift

After matching tracking data to Behavior Change program customers, Cadmus calculated participation uplift in downstream programs, defined as the difference in the percentage of treatment group customers participating in at least one rebate program and the percentage of control group customers participating in at least one rebate program. The control group's participation rate captured the business-as-usual effect of marketing and word-of-mouth impacts on customers' participation in other DP&L energy efficiency programs. This baseline participation rate is defined as the number of control group customers who participated in at least one other DP&L energy efficiency program in 2020 divided by the total number of control group customers. The home energy reports had an additive effect on participation in the other programs if the cross-program participation rate was greater for treatment customers than it was for control customers.

Table 109 shows the 2020 participation rate uplift results for each wave of the Behavior Change program, broken out by the other programs of customer participation. Negative participation uplift indicates that more control customers participated in the energy efficiency program, on average, than treatment customers. Smart Thermostats and Efficient Products experienced that largest participation uplift of DP&L's other energy efficiency programs, particularly for the waves in Experiment 1. Smart Thermostats were purchased frequently by treatment customers through the online Marketplace. Free energy savings kits, which were promoted in the HERs during the 2020 program year, were most often purchased by control customers in the 2020 program year, as evidenced by the large negative uplift participation rates.

**Table 109. 2020 Residential Behavior Change Program Uplift Participation by Program**

| Program | Email + Paper | Email + Paper + Marketplace | Email + Marketplace | Marketplace | Paper |
|---|---|---|---|---|---|
| Appliance Recycling | 0.93 | 0.93 | 0.67 | 0.77 | 0.49 |
| Efficient Products | 1.10 | 11.15 | 10.32 | 15.22 | -0.22 |
| Energy Savings Kits | -25.23 | -19.71 | -17.35 | -12.83 | -8.27 |
| Heating and Cooling Rebates | 0.19 | 0.64 | 0.39 | -1.48 | 2.76 |
| Income Eligible Efficiency (OPAE) | 0.34 | 0.21 | 0.43 | 0.42 | 0.15 |
| Income Eligible Efficiency (PWC) | -0.08 | -0.08 | -0.19 | 0.00 | 0.05 |
| Smart Thermostats | 2.66 | 8.16 | 8.46 | 13.95 | 0.96 |

## Savings Uplift

For the savings uplift analysis from downstream programs, Cadmus followed a simple-differences approach:

- Matched the program tracking data for each program year to the treatment and control customers by a unique identifier
- Assigned each transaction to a month based on the participation date field in the tracking data
- Included only installations with first-year savings occurring during 2020 program months
- Calculated the average monthly electricity savings of each efficient product installed by a Behavior Change program customer, proportioned across months by the accrued HDDs and CDDs in each month for weather-sensitive products (we proportioned annual savings across months equally for products that are not weather sensitive), then used the *ex post* gross savings for each product in DP&L's evaluation
- Summed the monthly average savings, by customer, for all products installed prior to a given month through the end of 2020 or the end of the measure's first year (whichever came first), incorporating customer inactive dates and product measure lives to aggregate monthly savings
- Calculated the average annual savings accrued per customer for the treatment and control groups during 2020
- Calculated the incremental average daily savings per customer from other programs by taking the difference in daily per-customer savings for the treatment and control groups

Multiplying the incremental average daily savings per customer by the number of days customers were treated in 2020 yielded the estimate of total Behavior Change program savings from participation in other DP&L energy efficiency programs and already counted by those other efficiency programs.

Table 110 provides results of the savings uplift analysis by program.

**Table 110. 2020 Residential Behavior Change Program Uplift Savings (kWh) by Program**

| Program | Email + Paper | | Email + Paper + Marketplace | | Email + Marketplace | | Marketplace | | Paper | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Per Home | Total | Per Home | Total | Per Home | Total | Per Home | Total | Per Home | Total |
| Appliance Recycling | 1.59 | 19,001 | 0.78 | 18,643 | 0.44 | 20,140 | 1.02 | 12,114 | -0.43 | -12,967 |
| Efficient Products | 0.54 | 6,471 | 4.05 | 96,526 | 3.72 | 169,119 | 4.97 | 59,200 | 0.06 | 1,710 |
| Energy Savings Kits | -1.65 | -19,653 | -1.34 | -31,877 | -0.88 | -40,160 | -1.91 | -22,704 | -0.54 | -16,486 |
| Heating and Cooling Rebates | -0.97 | -11,618 | 0.06 | 1,492 | -0.75 | -34,110 | -3.42 | -40,656 | 3.45 | 104,877 |
| Income Eligible Efficiency (OPAE) | -0.52 | -6,209 | 0.13 | 3,058 | 0.04 | 1,661 | 0.29 | 3,498 | 0.39 | 11,959 |
| Income Eligible Efficiency (PWC) | -0.10 | -1,135 | 0.11 | 2,529 | -0.01 | -459 | -0.17 | -1,981 | -0.05 | -1,562 |
| Smart Thermostats | 1.42 | 16,896 | 6.57 | 156,726 | 5.69 | 258,920 | 6.98 | 83,098 | 0.42 | 12,694 |