BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of The Dayton Power and Light Company's Portfolio Status Report	))	Case No. 16-851-EL-POR

THE DAYTON POWER AND LIGHT COMPANY'S COMBINED NOTICE OF FILING PORTFOLIO STATUS REPORT AND APPLICATION TO ADJUST BASELINES

The Dayton Power and Light Company ("DP&L" or "the Company") hereby submits its annual Portfolio Status Report pursuant to Section 4901:1-39-05(C) 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 2015. As shown in the attached Portfolio Status 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. §4901:1-39-05(B) to adjust its sales and demand baselines to normalize for weather. As described in the 2015 Benchmark Report, included within the Portfolio Status Report as Appendix A, the changes requiring adjustments to the baselines were outside of DP&L's reasonable control. Appendix A 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. §4901:1-39-05(B).

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 is 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. Thereafter, the annual savings requirements shall be, for years 2017, 2018, 2019, and

2020, one per cent of the baseline, and two per cent each year thereafter, achieving cumulative energy savings in excess of twenty-two per cent by the end of 2027."

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 2015 Benchmark Report, included with the Portfolio Status Report as Appendix A, DP&L applies to make adjustments to its baseline to normalize for weather changes and mercantile customers.

6. As more fully explained in the 2015 Benchmark Report, and supported by Schedule 1 and the corresponding Workpapers A, C, D, and E, DP&L's 2015 normalized energy efficiency baseline is 13,806,336 MWh and DP&L's 2015 incremental normalized energy efficiency reduction benchmark is 138,063 MWh. DP&L's cumulative energy efficiency reduction benchmark is 726,247 MWh.

7. DP&L's 2015 normalized peak demand reduction baseline, as fully explained in its 2015 Benchmark Report, and supported by Schedule 2 and the corresponding Workpapers B, C, D, and E is 2,835 MW and DP&L's 2015 normalized peak demand reduction benchmark is 155.9 MW.

8. DP&L's current energy efficiency and demand reduction programs, designed to achieve the required energy savings and demand reductions from 2013 through 2015, were filed as part of a comprehensive energy efficiency and peak-demand reduction program portfolio. A Stipulation and Recommendation in Case No. 13-0833-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 2013 through 2015* was approved by a Commission Order dated December 4, 2013.

9. Senate Bill ("S.B.") 310, signed in September 2015, gave Ohio Electric Distribution Utilities ("EDU") the option of freezing their energy efficiency programs or automatically extending their currently approved Portfolio Program Plan through 2016. DP&L opted to extend its currently approved Portfolio Program Plan approved in Case No. 13-833-EL-POR.

10. O.A.C. §4901:1-39-05(C) provides: "by March fifteenth of each year, each electric utility shall file a portfolio status report addressing the performance of all

approved energy efficiency and peak-demand reduction programs in its program portfolio plan over the previous calendar year. . ." DP&L sought, and was granted a waiver of O.A.C. § 4901:1-39-05(C) to permit DP&L to file its Annual Portfolio Status Report on or before May 15, 2014.[1]

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

(1) A Compliance Demonstration which includes: (a) an update to DP&L's initial benchmark report (Report, Compliance Demonstration); (b) a comparison of the applicable benchmarks to the actual energy savings and peak demand reductions achieved (Report, Compliance Demonstration); and (c) an affidavit regarding compliance with the statutory benchmarks (Exhibit 3).

(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, Education, Awareness Building & Market Transformation); (b) an evaluation, measurement, and verification report by The Cadmus Group, Inc. ("Cadmus Report", Exhibit 1); (c) an evaluation report on the notched v-belt pilot program by Navigant Consulting, Inc. ("Navigant Report", Exhibit 2); and (d) a recommendation with respect to continuation, modification or elimination of each program (Report, Recommendations).

12. As described in the Report, and as attested to in the attached Affidavit of the President and Chief Executive of DP&L, DP&L has met its 2015 statutory benchmarks for energy efficiency and peak demand reduction.

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[1] Entry dated December 4, 2013 in, *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 2013 through 2015*, Case Nos. 13-833-EL-POR, 13-837-EL-WVR; *see also*, Senate Bill 310, Section 6(D).

WHEREFORE, DP&L respectfully requests that the Commission issue an order finding that DP&L has complied with its 2015 statutory energy efficiency and peak demand reduction benchmark requirements, and acknowledging DP&L's compliance with the Program Portfolio Status Report requirements found in O.A.C. § 4901:1-39-05(C).

Respectfully submitted,

Jeremy M. Grayem (0072402)
ICE MILLER LLP
250 West Street
Columbus, Ohio 43215
Telephone: (614) 462-2284
Facsimile: (614) 222-2440
Email: jeremy.grayem@icemiller.com

Counsel for The Dayton Power & Light Company

Dayton Power and Light

May 15

2016

2015 Energy Efficiency and Demand Reduction/Response Portfolio Status Report

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EXECUTIVE SUMMARY

OVERVIEW

In April 2013,The Dayton Power and Light Company (DP&L) filed a three-year Energy Efficiency and Demand Response Portfolio Plan in Case No. 13-0833-EL-POR and 13-0837-EL-WVR. A settlement agreement was reached with all of the intervening stakeholder groups, and the plan was approved by the Commission on December 4, 2013. The plan covers the years 2013 through 2015.

The approved plan continues DP&L's portfolio of business and residential programs that provide customers with a variety of energy efficiency choices. Specifically, DP&L is offering customers five residential programs, four business programs, two residential pilot programs and two business pilot programs. Through the process, DP&L has kept the energy efficiency collaborative informed of its progress and is working directly with several collaborative members to either implement programs or market them to various customer groups.

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.

SAVINGS CALCULATIONS

The energy and demand savings calculations were 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 were 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 2014, DP&L reported cumulative energy efficiency program savings of 1,006,413 MWh and mercantile program savings of 40,526 MWh. The 2015 energy efficiency programs generated 169,030 MWh and mercantile programs generated 3,736 MWh. Therefore, cumulative annualized energy savings for 2009 through 2015 are 1,219,705 MWh.

From 2009 through 2014, DP&L reported cumulative demand savings from energy efficiency programs of 158.6 MW and 14.5 MW of cumulative demand savings from mercantile commitments. The 2015 energy efficiency programs generated 24.7 MW and mercantile programs generated 0.58 MW of energy efficiency demand for integration with DP&L's program portfolio. Therefore, total 2015 cumulative demand savings are 198.4 MW.

Based on this performance, DP&L surpassed its 2015 cumulative benchmark targets of 726,247 MWh and 155.9 MW. A more detailed analysis is provided in the Compliance Demonstration portion of this report.

	MWh	**MW**
Cumulative 2009 – 2014 Total Savings	1,046,939	173.1
2015 Energy Efficiency Actuals	169,030	24.7
2015 Mercantile Commitments	3,736	0.58
Cumulative 2009 – 2015 Total Savings	1,219,705	198.4
Cumulative 2015 Benchmarks	726,247	155.9

2015 PROGRAM SUMMARY

2015 Annualized Program Results

Program	***2015 Energy (MWh)***	***2015 Demand (MW)***
Residential Lighting	50,865	6.09
Residential HVAC Rebates	9,603	1.66
Residential Appliance Recycling	5,232	0.82
Residential School Education[(1)]	4,204	0.29
Residential Low Income Affordability	1,536	0.19
Non-Residential Prescriptive Rebates	78,556	13.04
Non-Residential Custom Rebates	16,484	2.12
Mercantile Customer Commitments	3,736	0.58
Non-Residential PJM Demand Response	0	0
Pilot Programs	2,550	0.52
T&D Infrastructure Improvements	0	0
Total	172,766	25.3

[(1)] 2015 savings are savings from the 2014/2015 school year.

BANKED ENERGY SAVINGS

DP&L plans to bank the excess energy savings achieved cumulatively through 2015 and apply the excess toward future benchmarks. The total amount of banked energy savings is 493,458 MWh and is calculated as follows:

2015 Actual Cumulative Energy Savings – 2015 Cumulative Benchmark = Banked Energy Savings

1,219,705 MWh – 726,247 MWh = 493,458 MWh

EVALUATION, COST EFFECTIVENESS

Attached to this report, as Exhibit 1, is the 2015 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	1.78	3.51	0.49	4.04	2.54

2015 PROGRAM COST SUMMARY

PROGRAM	2015 Filed	2015 Actual
Residential Lighting		
Incentive Costs	$2,016,965	$2,363,573
Marketing & Administration	$1,055,824	$946,954
Program Total	$3,072,789	$3,310,527
Residential HVAC Rebates		
Incentive Costs	$1,808,012	$1,629,370
Marketing & Administration	$976,234	$703,978
Program Total	$2,784,246	$2,333,348
Residential Appliance Recycling		
Incentive Costs	$225,000	$217,651
Marketing & Administration	$564,656	$564,616
Program Total	$789,656	$782,267
Residential Low Income Affordability		
Incentive Costs	$997,892	$927,486
Marketing & Administration	$251,834	$227,696
Program Total	$1,249,726	$1,155,182
Residential School Education		
Incentive Costs	$98,103	$114,687
Marketing & Administration	$237,270	$164,132
Program Total	$335,373	$278,819
Non-Residential Prescriptive Rebates		
Incentive Costs	$5,469,919	$4,636,068
Marketing & Administration	$1,661,467	$1,686,051
Program Total	$7,131,386	$6,322,119
Non-Residential Custom Rebates		
Incentive Costs	$2,318,812	$1,660,322
Marketing & Administration	$1,108,240	$982,350
Program Total	$3,427,052	$2,642,672
Non-Residential Mercantile Program		
Incentive Costs	$637,479	$276,236
Marketing & Administration	$194,040	$144,645
Program Total	$831,519	$420,881

2015 PROGRAM COST SUMMARY CONTINUED

PROGRAM	2015 Filed	2015 Actual
PJM Demand Response		
Incentive Costs	$26,807	$0
Marketing & Administration	$7,200	$0
Program Total	$34,007	$0
Education		
General Energy Efficiency Education & Outreach	$886,745	$537,356
Marketing & Administration	$15,748	$58,737
Program Total	$902,493	$596,093
Pilot Programs		
Incentive Costs	$747,828	$487,035
Marketing & Administration	$320,498	$468,961
Program Total	$1,068,326	$955,996
Evaluations, Measurement & Verification	$808,272	$887,916
Total Program Costs	**$22,434,845**	**$19,685,819**

COMPLIANCE DEMONSTRATION

BENCHMARK REPORT UPDATE

In accordance with O.A.C. Section 4901:1-39-05(C)(1)(a) DP&L is filing its 2015 Benchmark Report, included in this filing as Appendix A.

DP&L's 2015 cumulative energy and peak demand reduction benchmark targets are as follows:

Normalized Energy Reduction Benchmark (MWh)	726,247
Normalized Peak Demand Reduction Benchmark (MW)	155.9

For informational purposes, included below are Schedules 1 and 2 from DP&L's 2015 Benchmark Report.

Schedule 1

THE DAYTON POWER & LIGHT COMPANY
2015 Benchmark Report
Energy Efficiency Baseline and Benchmark Calculation

		2012	2013	2014	2015
1	**Baseline Calculation Components**				
2	Retail MWh Sales [1]	13,936,670	13,829,968	14,024,297	
3					
4	**Normalizing Adjustments**				
5	Mercantile Customer Adjustment [2]	34,588	38,938	43,111	
6	Total Adjusted Retail Sales (2)+(5)	13,971,258	13,868,906	14,067,408	
7	Weather Normalization Factor [3]	0.99308	0.98849	0.98349	
8	Normalized Retail Energy Sales (6)*(7)	13,874,577	13,709,275	13,835,155	
9					
10	**2015 Normalized Energy Efficiency Baseline**				
11	3 Year Normalized Average (MWh)				13,806,336
12					
13	**Calculation of 2015 Energy Efficiency Reduction Benchmark**				
14	Normalized Preceding 3 Year Average Sales (11)				13,806,336
15	2015 Incremental Energy Efficiency Reduction Benchmark % [4]				1.00%
16	2015 Incremental Energy Efficiency Reduction Benchmark (14)*(15)				138,063
17	2014 Energy Efficiency Reduction Benchmark [5]				588,184
18	**2015 Cumulative Energy Efficiency Reduction Benchmark (16)+(17)**				**726,247**

[1] Retail sales for the period 2012-2014 are reported in PUCO Form FE-D1 (Case No. 16-724-EL-FOR). See Workpaper A, Column (6).

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

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

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

[5] 2014 Cumulative Energy Efficiency Reduction Benchmark as established in Case No. 15-777-EL-POR, Schedule 1, line 21.

THE DAYTON POWER & LIGHT COMPANY

2015 Benchmark Report

Peak Demand Baseline and Benchmark Calculation

		2012	2013	2014	2015
1	**Baseline Calculation Components**				
2	Peak MW Demand [1]	3,046	2,937	2,756	
3					
4	**Normalizing Adjustments**				
5	Mercantile Customer Adjustment [2]	13	15	15	
6	Total Adjusted Peak Demand (2)+(5)	3,059	2,952	2,771	
7	Weather Normalization Factor [3]	0.94288	0.96084	1.00544	
8	Normalized Peak Demand (6)*(7)	2,884	2,836	2,786	
9					
10	**2015 Normalized Peak Demand Reduction Baseline**				
11	3 Year Normalized Average (MW)				2,835
12					
13	**Calculation of Normalized 2015 Peak Demand Reduction Benchmark**				
14	Normalized Preceding 3 Year Average Peak Demand (11)				2,835
15	2015 Peak Demand Reduction Benchmark % [4]				5.50%
16	**2015 Peak Demand Reduction Benchmark (14)*(15)**				**155.9**

[1] Peak demand for the period 2012-2014 is reported in PUCO Form FE-D3. See Workpaper B.

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

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

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

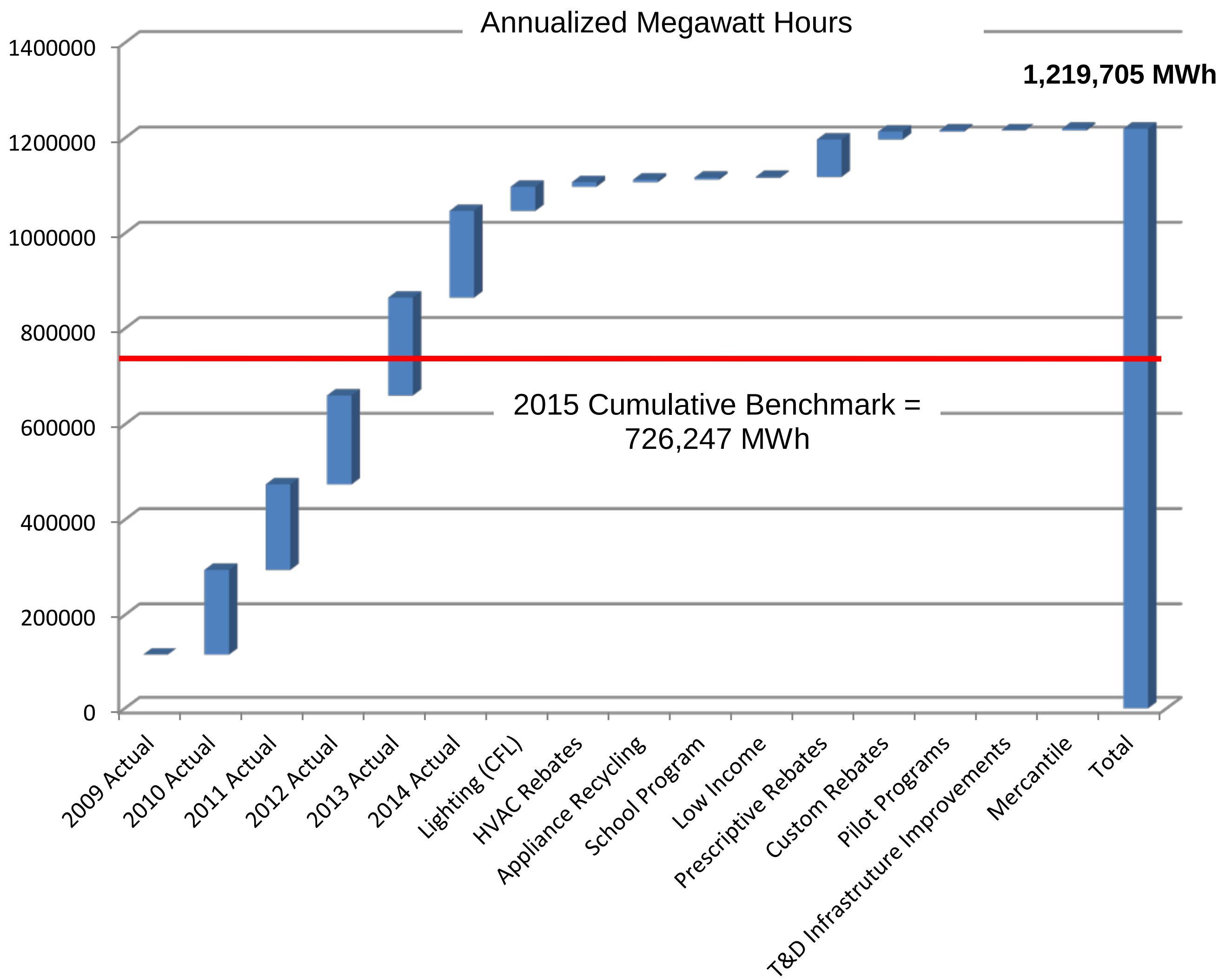
2015 FILED VERSUS ACTUAL ENERGY SAVINGS

Below, in tabular and graph form, are the programs' energy and demand savings as filed, as well as the corresponding energy and demand actual 2015 program performance. The actual performance is then compared to the 2015 energy and peak demand reduction benchmarks to demonstrate DP&L's compliance.

PROGRAM	2015 Filed (MWh)	Annualized 2015 Actual (MWh)	Variance (MWh)
Residential Lighting	50,573	50,865	292
Residential HVAC Rebates	8,814	9,603	789
Residential Appliance Recycling	4,274	5,232	958
Residential School Education	2,377	4,204	1,827
Residential Low Income Affordability	1,083	1,536	453
Non-Residential Prescriptive Rebates	54,446	78,556	24,110
Non-Residential Custom Rebates	28,144	16,484	-11,660
Non-Residential Mercantile Commitments [(1)]	8,822	3,736	-5,086
Non-Residential PJM Demand Response	0	0	0
Pilot Programs	0	2,550	2,550
Transmission & Distribution Infrastructure Improvements	0	0	0
Total	**158,533**	**172,766**	**14,233**

[(1)] Mercantile Customer Commitments for energy represent those mercantile applications paid in 2015.

2015 ENERGY ACTUALS COMPARED TO CUMULATIVE BENCHMARKS



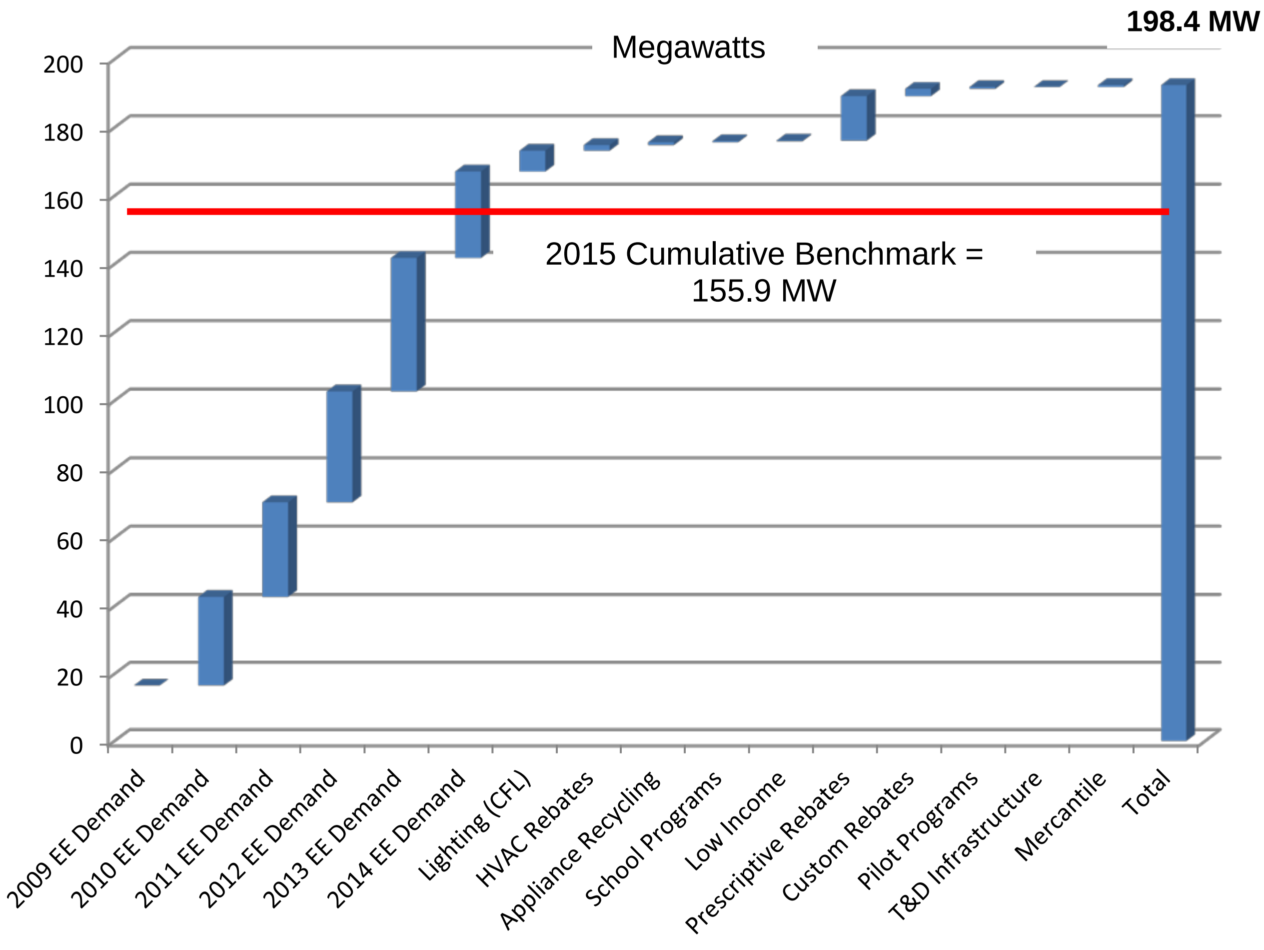
	MWh
Cumulative 2009 – 2014 Total Savings	1,046,939
2015 Energy Efficiency Actuals	169,030
2015 Mercantile Commitments	3,736
Cumulative 2009-2015 Total Savings	1,219,705
Cumulative 2015 Benchmark	726,247

2015 FILED VERSUS ACTUAL DEMAND SAVINGS

PROGRAM	2015 Filed (MW)	Annualized 2015 Actual (MW)	Variance (MW)
Residential Lighting	6.04	6.09	0.05
Residential HVAC Rebates	2.71	1.66	-1.05
Residential Appliance Recycling	0.76	0.82	0.06
Residential School Education	0.02	0.29	0.27
Residential Low Income Affordability	0.16	0.19	0.03
Non-Residential Prescriptive Rebates	9.64	13.04	3.40
Non-Residential Custom Rebates	5.16	2.12	-3.04
Non-Residential Mercantile Commitments (1)	4.12	0.58	-3.54
Non-Residential PJM Demand Response	6.00	0.00	-6.00
Pilot Programs	0.00	0.52	0.52
Transmission & Distribution Infrastructure Improvements	0.00	0.00	0.00
Total	**34.61**	**25.31**	**-9.30**

(1) Mercantile Customer Commitments for energy represent those mercantile applications paid in 2015.

2015 DEMAND ACTUALS COMPARED TO CUMULATIVE BENCHMARKS



	MW
Cumulative 2009 – 2014 Total Savings	173.1
2015 Energy Efficiency Actuals	24.7
2015 Mercantile Commitments	0.58
Cumulative 2009-2015 Total Savings	198.4
Cumulative 2015 Benchmark	155.9

RESIDENTIAL PROGRAMS

RESIDENTIAL LIGHTING

PROGRAM DESCRIPTION
The Residential Lighting Program is an upstream, manufacturer buy-down of compact fluorescent light bulbs (CFL) and light-emitting diode bulbs (LED) 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.

The objective of the program is to increase the number of long-life, Energy Star qualified CFLs and LEDs sold to DP&L customers by providing incentives to decrease consumer costs. The program increases consumer awareness and acceptance of energy-efficient lighting technology and also has an educational component to promote use, and proper disposal of, CFL bulbs.

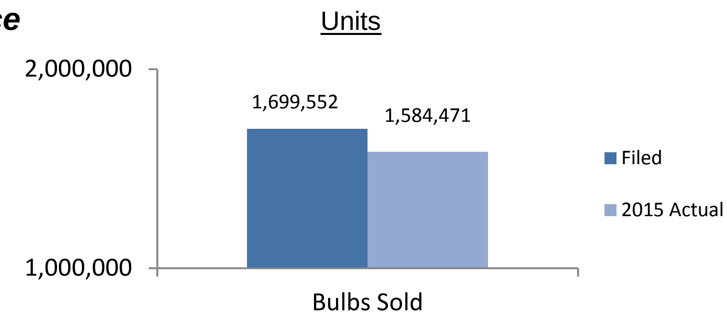
The Residential Lighting Program is designed for all DP&L residential customers who purchase bulbs through retail channels. All customers taking delivery service from DP&L are eligible for this program regardless of their choice of generation supplier.

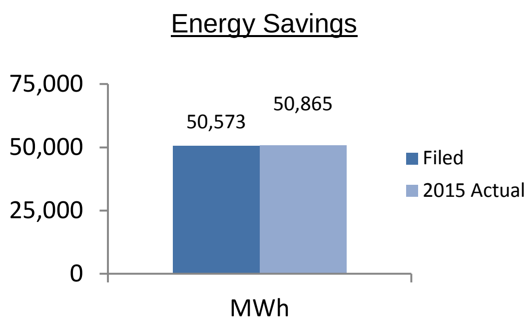
This program started in February 2009 and continued through 2015.

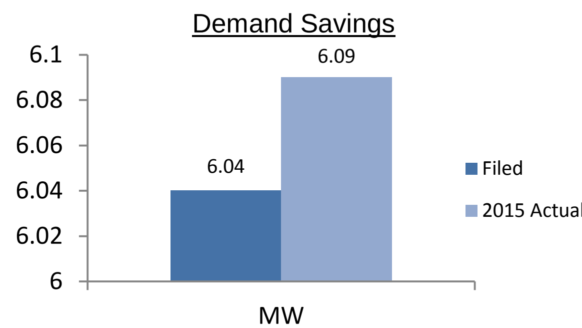
PERFORMANCE SUMMARY
During 2015, a total of 1,584,471 bulbs were sold throughout the DP&L service territory, resulting in gross annualized energy savings of 50,865 MWh and peak demand savings of 6.09 MW. Keys to the program's success include offering customers a wide variety of lighting choices with attractive discounts as well as a broad, and convenient, retail distribution network.

Program evaluations and national trends suggest that five percent of discounted CFLs were purchased by non-residential customers. As a result, five percent of savings and costs from the Residential Lighting Program have been reallocated to the Non-Residential Prescriptive Rebates Program. The metrics in this section reflect the 5% reallocation.

2015 Performance

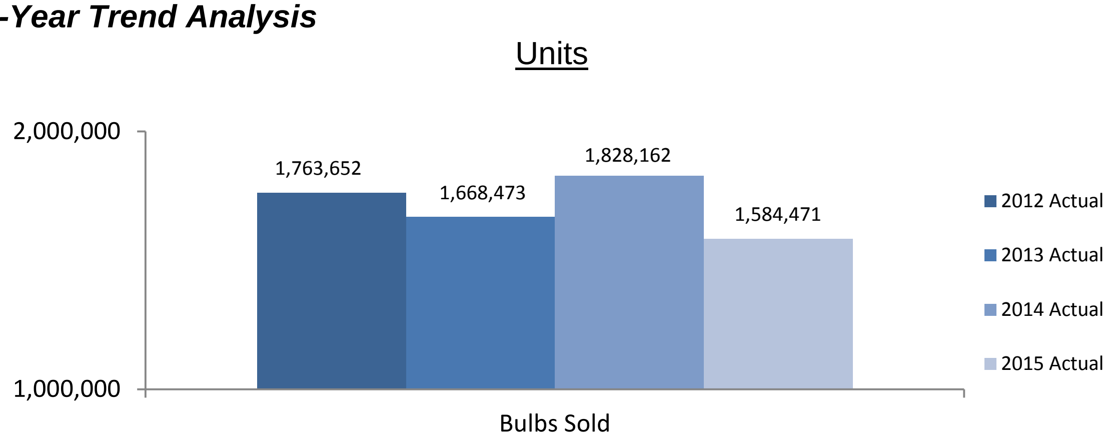


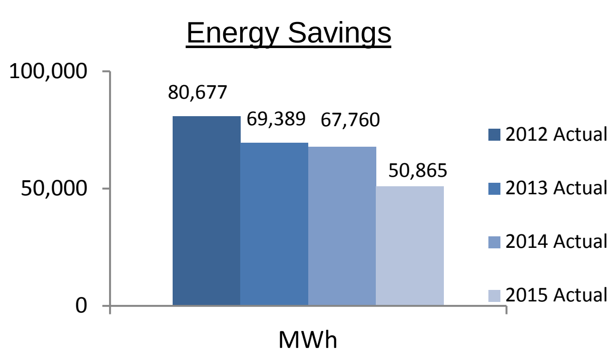


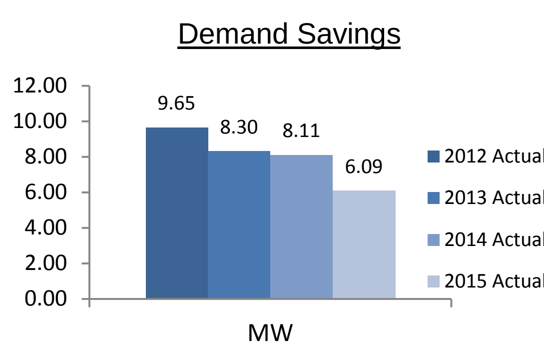


All "filed" numbers are taken from DP&L's program portfolio filing; Case No. 13-0833-EL-POR

Four-Year Trend Analysis







Budget, Cost Summary

Budget Category	Filed 2015	Actual 2015
Incentive Costs	$2,016,965	$2,363,573
Marketing & Admin	$1,005,824	$946,954
Total Costs	$3,072,789	$3,310,527

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.

Targeted Products

DP&L's Residential Lighting Program was designed to provide customers with an extensive choice of products, so customers can select the types of bulbs that best meet their needs. In total, the 2015 DP&L program offered customers a choice of 352 different products. CFL and LED technologies were both available to customers in 2015. The most popular products by type included: 13-watt CFLs (standard CFLs), 8-watt A19 LEDs (standard LEDs), and 10-watt BR30 LEDs (specialty LEDs). Overall, DP&L offers soft white, bright white and daylight colored bulbs. Customers could choose between CFL spirals as well as the following LED bulb types: 3-way, dimmable, globe, A-line, reflector, candelabra, and retrofit kits. Available wattages ranged from 4-watts to 42-watts. For CFLs, the average discount was $1.25 per bulb with discounts ranging from $1.00 to $1.75. For LEDs, the average discount offered was $3.74 per bulb with discounts ranging from $1.33 to $7.00, depending on the type of bulb.

Products Types Offered

Product Name	Product Wattage	Product Name	Product Wattage
CFL Spiral	9	LED BR30	10
CFL Spiral	10	LED BR30	11
CFL Spiral	11	LED BR30	12
CFL Spiral	13	LED BR30	13
CFL Spiral	14	LED BR30	18
CFL Spiral	15	LED BR40	12
CFL Spiral	18	LED BR40	13
CFL Spiral	19	LED BR40	15
CFL Spiral	20	LED BR40	17
CFL Spiral	23	LED Candelabra	4
CFL Spiral	26	LED Globe	4
CFL Spiral	27	LED Globe	5
CFL Spiral	42	LED Globe	6
LED A-Line	6	LED Globe	8
LED A-Line	7	LED PAR20	7
LED A-Line	8	LED PAR20	8
LED A-Line	9	LED PAR30	12
LED A-Line	10	LED PAR30	14
LED A-Line	11	LED PAR38	12
LED A-Line	12	LED PAR38	17
LED A-Line	13	LED PAR38	18
LED A-Line	15	LED PAR38	19
LED A-Line	16	LED R20	7
LED A-Line	17	LED R20	8
LED A-Line	18	LED R20	10
LED A-Line	22	LED R30	10
CFL High Lumen Spiral	40	LED R30	12
CFL High Lumen Spiral	42	LED R40	17
LED 3-WAY	18	LED Retrofit Kit	9
LED BR20	7	LED Retrofit Kit	10
LED BR30	8	LED Retrofit Kit	11
LED BR30	9	LED Retrofit Kit	12

Targeted Retailers, Locations
To make the 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. The big box retailers were the first selected to participate, given their previous experience with implementing similar buy-down programs in other regions and their ability to get the programs up and running quickly. Further, big box retailers sell significant volume, allowing the program to reach the largest number of DP&L customers as quickly as possible.

The first participating retail outlets selected were concentrated in the Dayton metropolitan area to match the location of the highest volume of DP&L residential customers. DP&L then expanded the program to outlying areas, giving all residential customers the opportunity to participate. In addition, an online retailer 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.

Participating Retailers

Retailer	# of Locations	Retailer	# of Locations
Ace	14	Meijer	6
Batteries Plus	3	Menards	4
Costco	1	Online	1
Dickman Supply	14	Sam's Club	3
Dollar Tree	19	Target	4
Home Depot	7	True Value	8
Kroger	27	Walmart	17
Lowes	12	**Total**	**140**

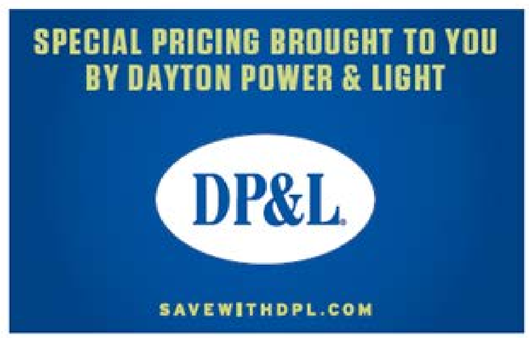
Staffing
Three CLEAResult staff members managed the program from the main office in Springfield, MA and served as DP&L's direct points-of-contact. These experienced managers supported three local field staff members. The local field staff was responsible for visiting participating retail outlets to ensure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

Marketing
In order to promote CFLs, LEDs, and the lighting program discounts to its customers, DP&L employed a breadth of marketing methods. Starting with the assumption that approximately 70 percent of 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 CFLs. 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.

Point-of-Purchase Material Samples:

Vertical Beam Sign

Shelf Sticker

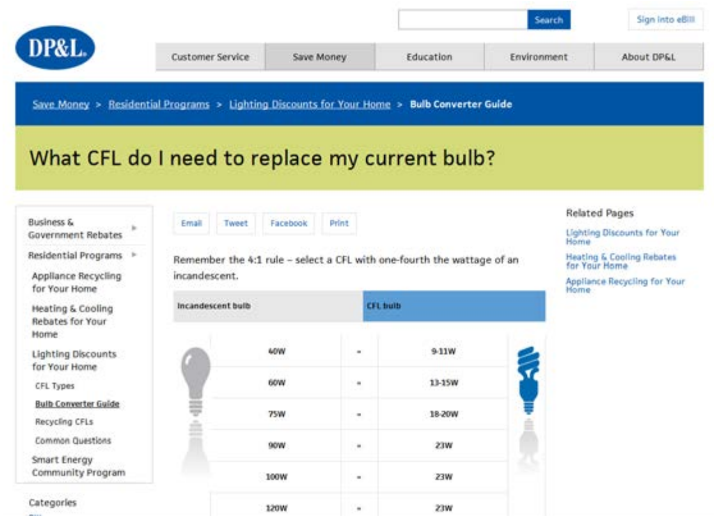


8x10 Shelf Sign

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

The CFL program's web pages on the DP&L company web site provide a description of CFL bulb types and their applications, conversions of wattages from incandescent to CFL, and answers to frequently asked questions. A page of the web site is devoted to CFL recycling, educating customers about the small amount of mercury in CFLs, and how to properly dispose of a CFL (if broken), and where to recycle (if unbroken).

Customers can also access an online retailer to place an order of discounted bulbs.



Web Site
The CFL program landing page gives a description of the residential lighting program and allows customers to navigate to other pages for more information.

YouTube Video
The YouTube video, produced by DP&L and posted on the CFL program landing page, educates customers about the benefits of switching to CFLs.

DP&L

SCORE BIG TIME WITH INSTANT, IN-STORE DISCOUNTS ON EFFICIENT LIGHTING

The average home has 40 light bulbs on its roster. With DP&L's residential lighting discounts, you can make that roster much more energy efficient.

- Save at the register at participating area retailers
- Save with ENERGY STAR™ certified CFLs and LEDs, which use 75% and 85% less energy than incandescent bulbs, respectively

No applications. No paperwork. Just savings.

LEARN MORE AT energystar.gov

Be a savings champion. Call **866-668-9581** or visit **SAVEWITHDPL.COM** to learn more.

EE-03-15-R

Bill Insert
Bill inserts were mailed to 450,000 residential customers in February, March, and April.

Community Outreach Events
The CLEAResult local field staff attended 10 local community events and 32 in-store events to discuss the residential lighting program, CFLs and LEDs, and their benefits.

Education, General Awareness

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

Community Partnerships

DP&L was able to utilize promotional benefits provided via existing corporate sponsorships of local organizations, like the minor league Dayton Dragons baseball team.

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 Lighting 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 CFLs and 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 Residential 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 2,600 store visits in 2015. In addition, the local field staff was in direct contact with customers at 10 local community events and 32 in-store events in 2015, answering questions and helping to educate customers about the program.

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.

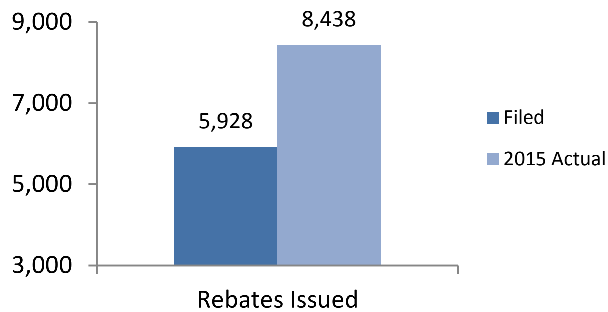
This program is designed for any homeowner or landlord purchasing a new or replacement HVAC unit that will be installed at a residence within the DP&L service territory. All customers taking delivery service from DP&L are eligible for this program regardless of their choice of generation supplier.

The program started in June 2009 with a core group of 23 participating contractors and has increased to 169 participating contractors by the end of 2015.

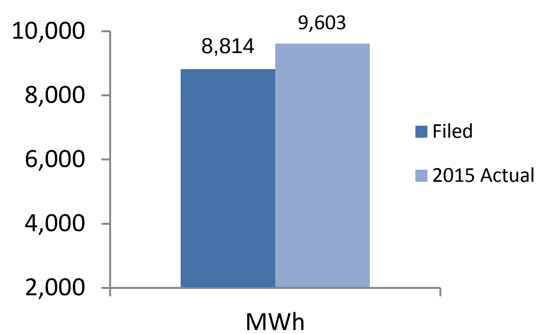
PERFORMANCE SUMMARY
During 2015, a total of 8,438 HVAC rebates were issued throughout the DP&L service territory, resulting in gross annualized energy savings of 9,603 MWh and peak demand savings of 1.66 MW. Keys to the program’s success include offering customer rebates on a wide variety of HVAC products through a widespread contractor network.

2015 Performance

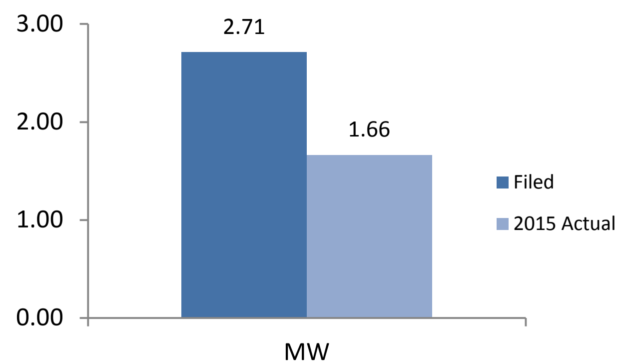
Units



Energy Savings



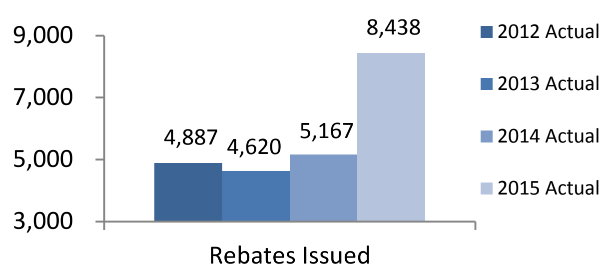
Demand Savings



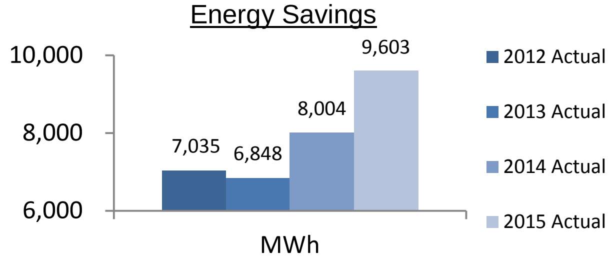
All “filed” numbers are taken from DP&L’s program portfolio filing; Case No. 13-0833-EL-POR.

Four-Year Trend Analysis

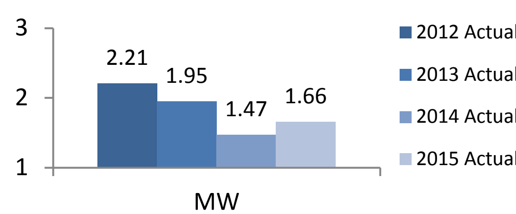
Units



Energy Savings



Demand Savings



Budget, Cost Summary

Budget Category	Filed 2015	Actual 2015
Incentive Costs	$1,808,012	$1,629,370
Marketing & Admin	$976,234	$703,978
Total Costs	$2,784,246	$2,333,348

IMPLEMENTATION REVIEW

Implementation Strategy

With a Residential HVAC Rebate Program, it is of great value 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 RFP process, Conservation Services Group (CSG) was chosen as DP&L's implementation partner. CSG, based in Westborough, Massachusetts is a non-profit organization with a 25-year history of delivering energy efficiency programs. CSG's track record includes running successful programs for utilities such as Southern California Edison, San Diego Gas and Electric, NSTAR, Columbia Gas of Ohio, and National Grid. In 2015, CLEAResult acquired CSG, and continued with seamless implementation of DP&L's Residential HVAC Program.

Targeted Products

DP&L offered rebates for central HVAC systems in three categories: New Construction; Replacement; and Early Retirement, 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 2015, the most popular central system rebate was for early retirement air conditioners at SEER 14/15, followed by early retirement air conditioners at SEER 16+. DP&L also issued 2,229 rebates for ECMs. In 2015, two new measures were added to the program: Programmable Thermostats and Heat Pump Water Heaters.

Rebates Offered

For Central Air Conditioning

SEER Efficiency Rating	New Construction	Replacement	Early Retirement
14-15	$100	$100	$200
16+	$150	$150	$300

For Air-Source Heat Pumps and Ductless Mini-Splits*

SEER Efficiency Ratio	New Construction	Replacement	Early Retirement
14-15	$200	$200	$400
16+	$300	$300	$600

*Mini-splits are not eligible for early retirement rebates.

For Ground-Source Heat Pumps

EER Efficiency Ratio	New Construction	Replacement	Early Retirement
16-18	$800	$800	$1,200
19+	$1,200	$1,200	$1,600

For Electronically Commutated Motors

AFUE	New Construction	Replacement	Early Retirement
95%+	$100	$100	$100

Programmable Thermostat

Cooling Type	Air Conditioner	Heat Pump	
	$20	$50	

Heat Pump Water Heater

Heating Type	***Gas Furnace***	Heat Pump	
	$800	$800	

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.
Early Retirement – High-efficiency, new equipment installed as a replacement for existing equipment that meets the following requirements:

Existing equipment is in working order, regardless of age OR
Existing equipment is less than or equal to 20 years old and is repairable for less than $1000.

Rebates Issued

Product	Rebates Issued 2015
Replacement or New Construction Air Conditioner SEER 14/15	101
Replacement or New Construction Air Conditioner SEER 16+	63
Replacement or New Construction Air Source Heat Pump SEER 14/15	79
Replacement or New Construction Air Source Heat Pump SEER 16+	49
Replacement or New Construction Ductless Mini-Split SEER 14/15	3
Replacement or New Construction Ductless Mini-Split SEER 16+	150
Replacement or New Construction Ground Source Heat Pump EER 16-18	35
Replacement or New Construction Ground Source Heat Pump EER 19+	29
Early Retirement Air Conditioner SEER 14/15	1,118
Early Retirement Air Conditioner SEER 16+	962
Early Retirement Air Source Heat Pump SEER 14/15	545
Early Retirement Air Source Heat Pump SEER 16+	490
Early Retirement Ground Source Heat Pump EER 16-18	67
Early Retirement Ground Source Heat Pump EER 19+	89
ECM	2,230
Thermostat	2,424
Heat Pump Water Heater	4

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 2015, the program had 169 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 any DP&L certified contractor of their choice. If a customer's existing contractor is not already a certified contractor, CLEAResult will work to recruit the contractor into the program so that 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 personal 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 that 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.

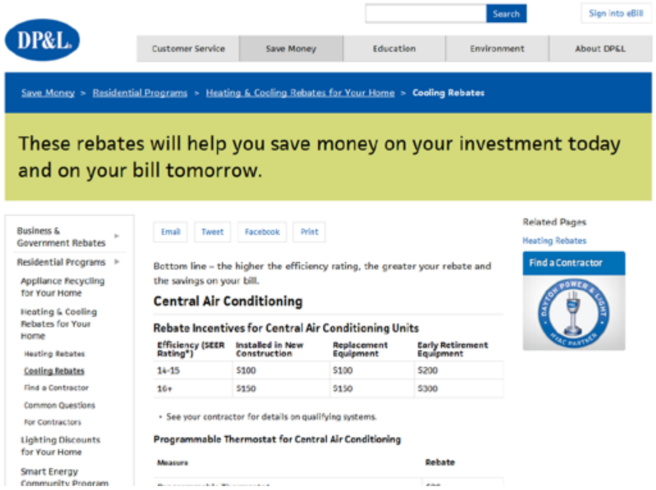
CLEAResult closely monitors rebate applications for accuracy of rebate values and eligibility of equipment. CLEAResult also performs quality control checks on a portion of all system installations and accompanying paperwork to ensure that contractors adhere to the program guidelines. Contractors who 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

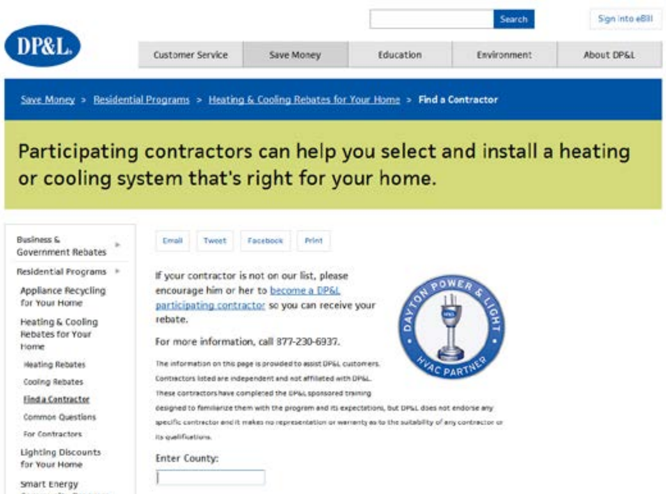
The program is designed to be marketed largely through participating HVAC contractors. Since contractors work directly with DP&L customers, they are able to offer rebates at the point-of-sale. Participating contractors are motivated to offer the rebates as a sales tool, providing a discount that non-participating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

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 present contractor.

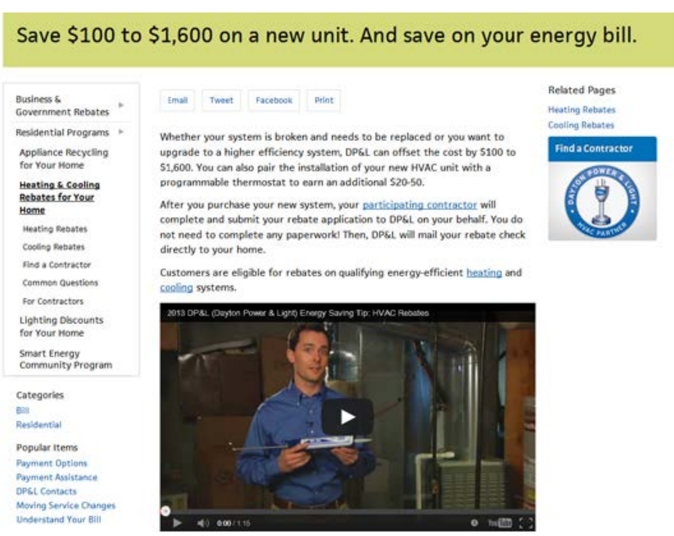
The web portal contains a special log-in section for participating contractors. The portal displays program news and answers to frequently asked questions.



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.



YouTube Video
The YouTube video, produced by DP&L and posted on the HVAC rebates program landing page, educates customers about the benefits of upgrading to a high efficiency HVAC system.

Bill Insert

Bill inserts were mailed to 450,000 customers in May, June, July, and August.

Flyer

Program fliers were distributed to customers at community outreach events attended by the residential lighting program field staff, creating promotional efficiencies among programs.

Education, 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 and five percent of pre-installations for early retirement systems. Equipment is reviewed along with the accompanying paperwork to ensure that contractors adhere to the program guidelines. CLEAResult's oversight ensures that the program's integrity is maintained and that customers are treated properly and fairly. Contractors who exhibit a track record of poor quality work or customer complaints are removed from the program.

Participating Contractors

A C Service Co., Inc.	Barga Heating, A/C & Refrig., Inc.
AAA Professional Heating & Cooling	Barker Heating and Air Conditioning Co.
A-Abel Heating & Air Conditioning Inc.	Barnard HVAC, LLC
Accurate Heating & Cooling	Beck Heating & Air Conditioning, LLC
Advanced Mechanical Services	Bolyard Heating & Cooling Inc.
Air Comfort Heating and Cooling	Burns Heating and Cooling LLC
Air Conditioning & Refrigeration Ser. Co. Inc.	Buschur's Refrigeration Inc.
Aireawide Heating & Air Inc.	Butler Heating and Air Conditioning Co.
Airtron Heating & Air Conditioning	Childers H.V.A.C. Systems Inc.
AJ Mechanical Services, Inc.	ChillTex, LLC
All Home Improvement Heating & Cooling	Choice Comfort Services
Allied Services, Inc.	CJS Heating & Air
Alternative Heating and Cooling	Climate Control Specialist
Anderson Mechanical Associates, LLC	Climate Zone Heating & Air LLC
Apex Mechanical Systems	Cloverleaf Mechanical
Area Energy & Electric	Comfort Control Heating & Cooling, Inc.
Area Heating & Air Conditioning, LLC	Comfort Solutions Heating & Air Conditioning LLC
Arronco Comfort Air, Inc.	Comfort Solutions, Inc.
Arrow Mechanical Services	Comfort Xpress, LLC
Ayers Service Group DBA CW Service	Commercial Refrigeration Specialists
B & B Plumbing and Heating Co.	Consolidated Hunter Heating & Plumbing, Inc.
B & K Heating & A/C Inc.	Cool Solutions
Baker Enterprises Heating & Air Conditioning	Cowboys Heating & Air LLC

Participating Contractors (Continued)

Crabtree Heating & Air Conditioning	Home Heating & AC, Inc.
Crane Heating & Air	Howard Heating & A/C LLC
Crawford & Son Htg and Clg Inc.	Howell Heating & Cooling
Damon Whorton	J & M Heating & Cooling
Danco Enterprises Inc.	Jent Mechanical
Dave's Services	John Boyd Heating & Cooling
Davis Refrigeration Inc.	John P. Timmerman Co., LLC
Dawson Services	Johnson Mechanical, Inc.
Dayton AC & Heating Co., Inc.	K C Services, LLC
Deer Heating & Cooling Inc.	Kenny Adams Heating & Cooling LLC
Del's Heating & Air Conditioning Co.	Kettering Heating and Air
Dependable Heating & Air	Kirkwood Heating & Cooling
Design Heating & Cooling LLC	Kogge Plumbing, Heating & A/C, Inc.
Detmer and Sons, Inc.	Kool-Ease, Inc.
Drake Heating & Air	Korrect Plumbing Co.
EcoEnvironments	Korte Eectric Inc.
Edington Heating & Cooling	Lifestyle Comfort Solutions
Ed's HVAC, Plumbing, Electric	Lochard Inc.
Eisert Plumbing & Heating, Inc.	Logan Master Appliance
Environmental Doctor	Logan Services
Excel Heating & Cooling LLC	Lowman Metal Shop
Extreme's One Hour Heating & Air Conditioning	M. Bruns Plbg. HVAC & Elect
Faller Mechanical, LLC	MAB Mechanical Inc.
Favret Heating & Cooling	Mark Sweitzer Htg. Clg. & Ref. Inc.
Fetz Plumbing, Heating & Air Conditioning	Masters Heating & Cooling, Inc.
Franck Plumbing & Heating Co., Inc.	MC Heating & Cooling
Future Air	Mike Logan Refrigeration/Appliance
Gagel Plumbing & Heating, Inc.	Minkner Services Corp
Gallion Heating & Cooling Inc.	Morland Heating & Air Conditioning
Greenergy Professional Services LLC	Morris Heating Cooling and Electrical Services Inc.
Grilliot's Heating & Cooling Inc.	Nash Heating & Air
Gruter Heating & A/C Co. Inc.	Nelson Comfort
H & M Heating & Cooling, Inc.	New Comfort Heating & Cooling
Haines Heating & Cooling LLC	North Star Plbg. Htg. & Clg.
Hart Mechanical Services	Outstanding Heating & Air, LLC

Participating Contractors (Continued)

Hauck Bros., Inc.	Peck Heating Air Conditioning
Perry's Heating & Air Conditioning	Southtown Heating, Cooling, Plumbing & Electrical
Quality Heating & Cooling Inc.	Southwestern Ohio Heating and Air Conditioning, Inc.
Quality Mechanical Services, Inc.	Stanley Construction Services, LLC
R & R Service Plumbing	Steven Brackman Htg & Cooling
R & W Heating, Inc.	Stevenson's Service Experts Heating & Air Conditioning LLC
R. E. Becker Builders, Inc.	Summers of Dayton
Raiff Heating & Cooling LLC	Tanner Heating and Air Conditioning
Ray's Refrigeration, Inc.	Taylor Heating & A/C LLC
Refrigeration Control	Temp-Co Heating & A/C
Reliant Mechanical Inc.	The Problem Solvers LLC
Richard Sharp Heating & Air Conditioning	The Wright Company
Riesen Plumbing & Heating	Townsend Heating & Air Conditioning
RK Plumbing and Home Services LLC	Townsend's Heating & Cooling, Inc.
Roberts Brothers, Inc.	Trame Mechanical
Roessner Energy Products Inc.	Trenton Heating & Air Conditioning
Rose Heating & Cooling	Troy Plumbing, Heating & Air Conditioning Services, Inc.
Schmidt's Heating, Cooling & Refrigeration	Universal Heating & Cooling LLC
Scott's Heating & Air Conditioning, Inc.	Wallace Heating & Air
Seiter Services LLC	Watkins Heating & Cooling
Sentry Heating & Air	West Jefferson
Shafer Heating & Cooling LLC	Westfall Plumbing and Heating
Shawnee Heating & Air, LLC	Wind Bender & Associates
Snyder's Heating & Cooling	Wm. Brockman & Sons
Solar Flare Heating & Air	Wyatt's Heating & Cooling
South Home Air, Inc.	Yutzy Heating & Cooling Inc.
	Zimmer Heating & Cooling

RESIDENTIAL APPLIANCE RECYCLING

PROGRAM DESCRIPTION

The Residential Appliance Recycling Program allowed for the collection of working refrigerators and freezers. The appliances were picked up directly from customers' homes, at no cost, and were transported to a facility in Columbus, Ohio to be deconstructed and recycled according to the Environmental Protection Agency's (EPA) best practices. Customers participating in the program in 2015 received a $50 rebate check for each unit 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.

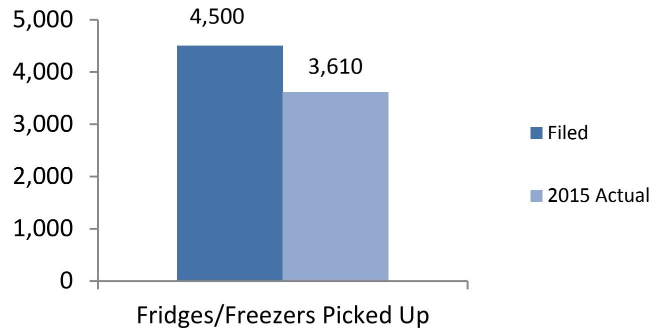
This program started in May 2009 and continued through November 2015. In late November, our third party vendor informed us they were ceasing business operations effective immediately. As a result, the program was suspended for the remainder of the year.

PERFORMANCE SUMMARY

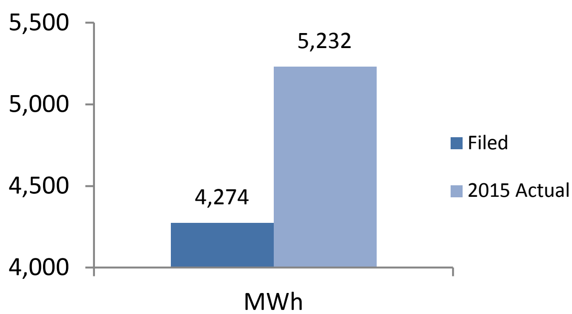
During 2015, 3,610 appliances were collected throughout the DP&L service territory, resulting in annualized energy savings of 4,874 MWh and peak demand savings of 0.78 MW. Additionally, DP&L continued distributing energy savings kits to customers when picking up their appliance to be recycled. Energy kit savings resulted in annualized energy savings of 358 MWh and peak demand savings of 0.04 MW. Therefore, the total gross annualized energy savings for the Residential Appliance Recycling Program was 5,232 MWh and peak demand savings of 0.82 MW.

2015 Performance

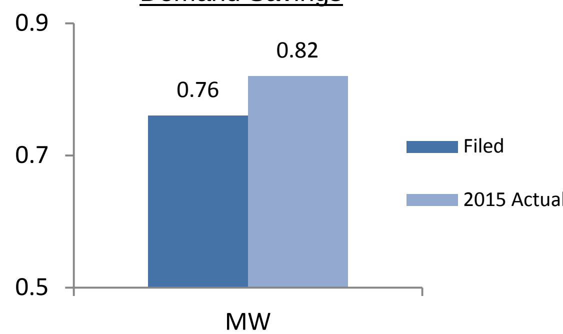
Units



Energy Savings



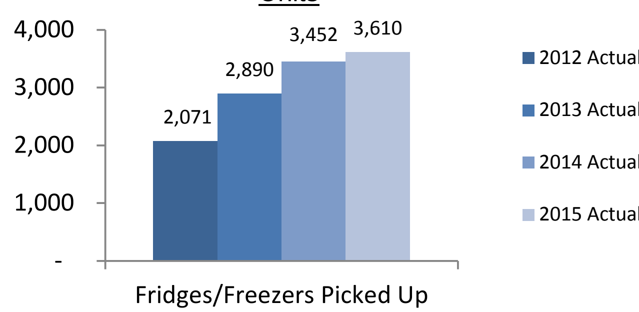
Demand Savings



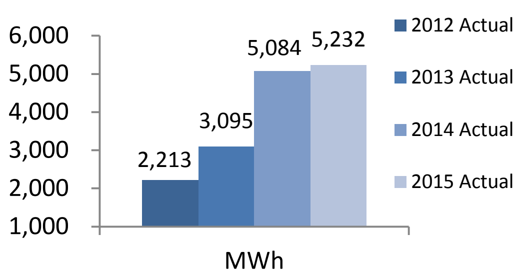
All “filed” numbers are taken from DP&L’s program portfolio filing; Case No. 13-0833-EL-POR.

Four-Year Trend Analysis

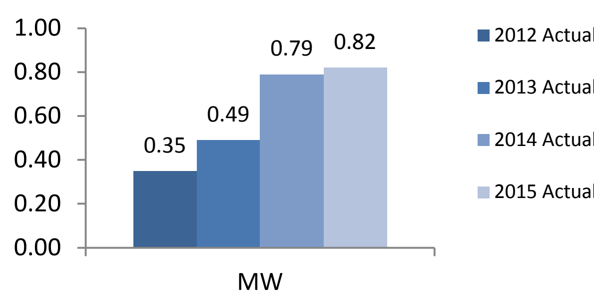
Units



Energy Savings



Demand Savings



Budget, Cost Summary

Budget Category	Filed 2015	Actual 2015
Incentive Costs	$225,000	$217,651
Marketing & Admin	$564,656	$564,616
Total Costs	$789,656	$782,267

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 that a third party implementation partner, specializing in this area, provided the best means of effectively managing the program.

At the conclusion of a RFP process, DP&L selected JACO Environmental as its implementation partner. In its proposal, JACO demonstrated a sound process for efficiently and properly collecting and deconstructing appliances, as well as the recycling and disposal of appliance components. JACO has experience running similar programs for more than 40 clients including PG&E, Southern California Edison, SMUD (California), PacifiCorp, and NJ Clean Energy.

In late November 2015, JACO informed DP&L they were ceasing business operations effective immediately. As a result, the program was suspended for the remainder of the year and DP&L's relationship with JACO ended.

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.

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

Rebates Issued by Order Date 2015

Month	Refrigerators	Freezers
January	117	17
February	157	25
March	199	49
April	277	68
May	224	52
June	330	92
July	337	84
August	431	103
September	335	92
October	375	100
November	123	23
December	0	0
Total	**2,905**	**705**

Of the 3,610 units collected in 2015, the average year the appliances were made was 1992.

The rebate amount was $50 per unit collected. Customers were paid via check mailed directly to their homes.

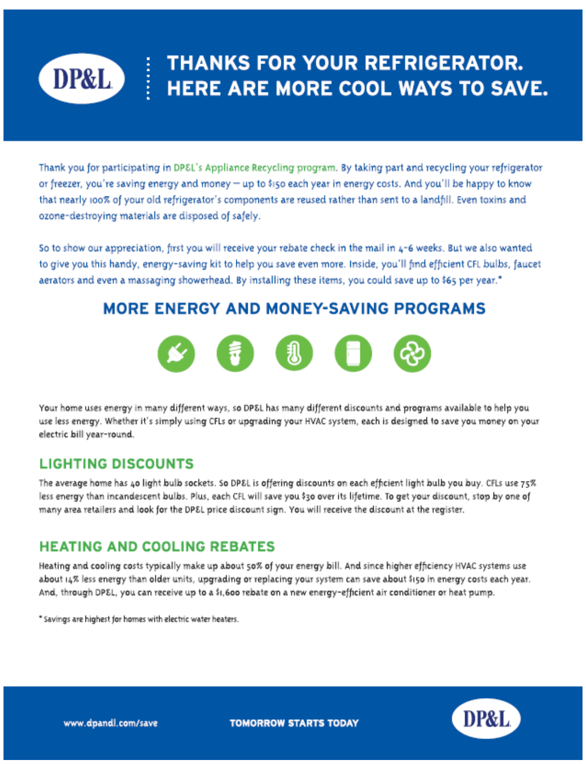
Home Energy Savings Kits
In 2015, DP&L continued distributing energy savings kits to customers when picking up their appliance to be recycled. This customer service element enabled customers to save more energy at home and increased program savings.

Energy savings kits included:
- 2 13W CFLs
- 1 Earth Massage Showerhead
- 1 Kitchen Faucet Aerator
- 1 Bathroom Faucet Aerator
- 1 Roll of TeflonTape for Aerator Installation
- 1 Flyer with Installation Instructions and Promotional Information about Other DP&L Energy Efficiency Programs

Each participating customer was offered an energy savings kits, but customers could choose whether to accept it. In 2015, 2,193 energy savings kits were distributed.

Energy Savings Kits Distributed to Appliance Recycling Program Participants

Flyer Included in Energy Savings Kits
Installation Instructions and Promotion of Other DP&L Energy Efficiency Programs



DP&L

THANKS FOR YOUR REFRIGERATOR.
HERE ARE MORE COOL WAYS TO SAVE.

Thank you for participating in DP&L's Appliance Recycling program. By taking part and recycling your refrigerator or freezer, you're saving energy and money — up to $150 each year in energy costs. And you'll be happy to know that nearly 100% of your old refrigerator's components are reused rather than sent to a landfill. Even toxins and ozone-destroying materials are disposed of safely.

So to show our appreciation, first you will receive your rebate check in the mail in 4-6 weeks. But we also wanted to give you this handy, energy-saving kit to help you save even more. Inside, you'll find efficient CFL bulbs, faucet aerators and even a massaging showerhead. By installing these items, you could save up to $65 per year.*

MORE ENERGY AND MONEY-SAVING PROGRAMS

Your home uses energy in many different ways, so DP&L has many different discounts and programs available to help you use less energy. Whether it's simply using CFLs or upgrading your HVAC system, each is designed to save you money on your electric bill year-round.

LIGHTING DISCOUNTS

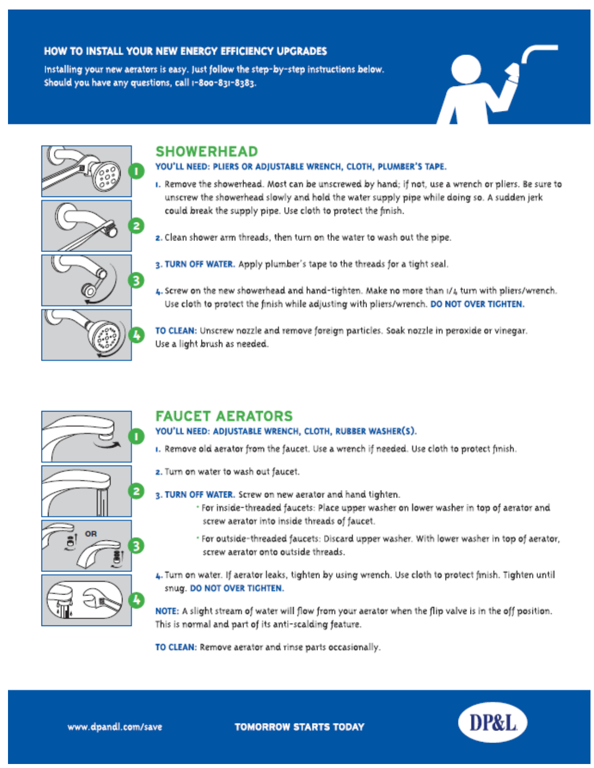
The average home has 40 light bulb sockets. So DP&L is offering discounts on each efficient light bulb you buy. CFLs use 75% less energy than incandescent bulbs. Plus, each CFL will save you $30 over its lifetime. To get your discount, stop by one of many area retailers and look for the DP&L price discount sign. You will receive the discount at the register.

HEATING AND COOLING REBATES

Heating and cooling costs typically make up about 50% of your energy bill. And since higher efficiency HVAC systems use about 14% less energy than older units, upgrading or replacing your system can save about $150 in energy costs each year. And, through DP&L, you can receive up to a $1,600 rebate on a new energy-efficient air conditioner or heat pump.

* Savings are highest for homes with electric water heaters.

www.dpandl.com/save TOMORROW STARTS TODAY DP&L



HOW TO INSTALL YOUR NEW ENERGY EFFICIENCY UPGRADES

Installing your new aerators is easy. Just follow the step-by-step instructions below. Should you have any questions, call 1-800-831-8383.

SHOWERHEAD

YOU'LL NEED: PLIERS OR ADJUSTABLE WRENCH, CLOTH, PLUMBER'S TAPE.

1. Remove the showerhead. Most can be unscrewed by hand; if not, use a wrench or pliers. Be sure to unscrew the showerhead slowly and hold the water supply pipe while doing so. A sudden jerk could break the supply pipe. Use cloth to protect the finish.
2. Clean shower arm threads, then turn on the water to wash out the pipe.
3. **TURN OFF WATER.** Apply plumber's tape to the threads for a tight seal.
4. Screw on the new showerhead and hand-tighten. Make no more than 1/4 turn with pliers/wrench. Use cloth to protect the finish while adjusting with pliers/wrench. **DO NOT OVER TIGHTEN.**

TO CLEAN: Unscrew nozzle and remove foreign particles. Soak nozzle in peroxide or vinegar. Use a light brush as needed.

FAUCET AERATORS

YOU'LL NEED: ADJUSTABLE WRENCH, CLOTH, RUBBER WASHER(S).

1. Remove old aerator from the faucet. Use a wrench if needed. Use cloth to protect finish.
2. Turn on water to wash out faucet.
3. **TURN OFF WATER.** Screw on new aerator and hand tighten.
   - For inside-threaded faucets: Place upper washer on lower washer in top of aerator and screw aerator into inside threads of faucet.
   - For outside-threaded faucets: Discard upper washer. With lower washer in top of aerator, screw aerator onto outside threads.
4. Turn on water. If aerator leaks, tighten by using wrench. Use cloth to protect finish. Tighten until snug. **DO NOT OVER TIGHTEN.**

NOTE: A slight stream of water will flow from your aerator when the flip valve is in the off position. This is normal and part of its anti-scalding feature.

TO CLEAN: Remove aerator and rinse parts occasionally.

www.dpandl.com/save TOMORROW STARTS TODAY DP&L

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

Staffing
JACO managed this program with staff located in the Portland, Oregon main office and at the recycling facility in Columbus, Ohio. A senior program manager served as the DP&L point-of-contact. The JACO program manager regularly communicated with the DP&L program manager to ensure that the program was on track to meet targets. The JACO program manager also coordinated all the project's tasks and served as the hub of communication to JACO support staff in technical support, customer service, check processing, and operations.

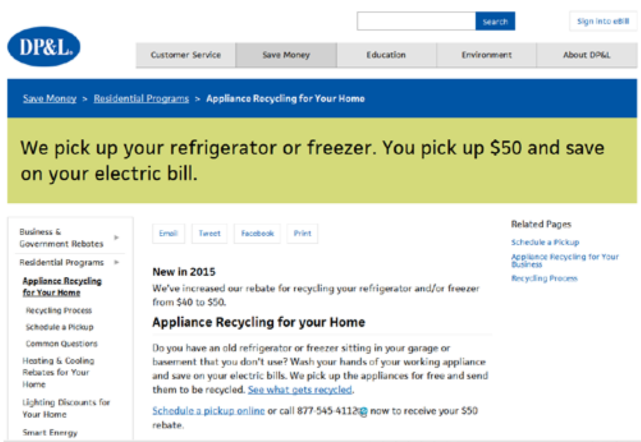
The recycling facility in Columbus, Ohio was managed by an on-site facility manager who planned the crew's pick-up routes and managed the deconstruction and recycling processes. Crews of two were dispatched each day from the facility to the pick-up routes while additional staff members worked in the facility, deconstructing the appliances. JACO 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), JACO 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 that all material handling processes complied with the best practices of the EPA.

Marketing
DP&L utilized a variety of marketing methods to promote the appliance recycling program to customers, including bill inserts, web pages, truck signs, and print advertisements. The marketing collateral emphasized the cost of operating a second refrigerator or freezer and the rebate offered to program participants.

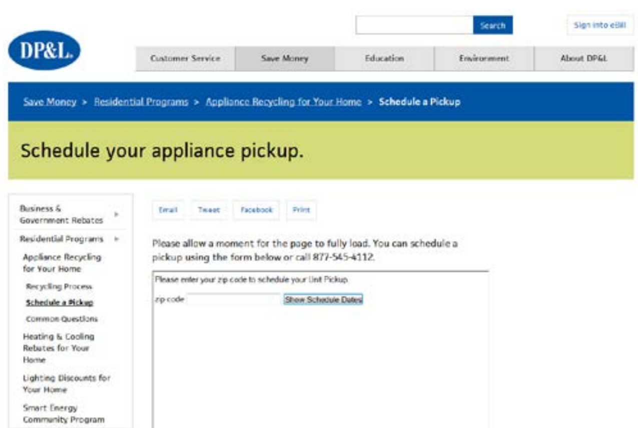
The customer web pages on the DP&L web site informed customers of program eligibility requirements, answers to frequently asked questions, and an overview of the recycling process. In addition, customers were able to register and schedule a pick-up via a web interface.

Sears Partnership
In 2015, DP&L continued its partnership with Sears retailers. Sears is a leading retailer of new refrigerators and freezers, and offers a home delivery service of customer's new appliances. JACO teamed up with Sears outlets across the country to offer a joint delivery of a new appliance along with a pick-up of an old appliance.

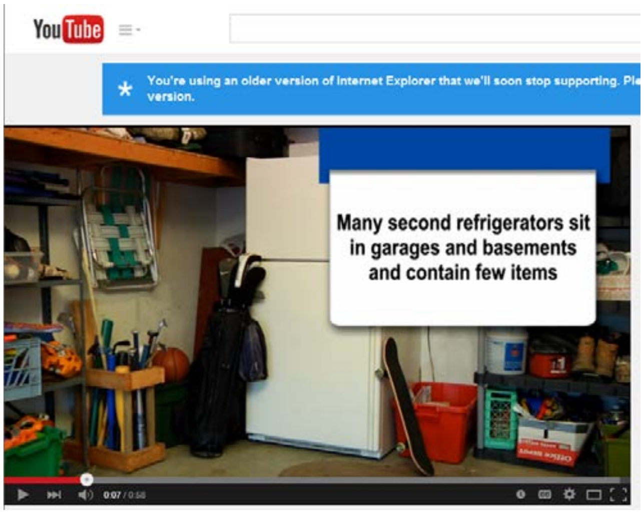
When a customer purchased a new refrigerator or freezer and was looking to get rid of an old appliance, the Sears sales representative helped him/her to register for participation in the DP&L appliance recycling program via an in-store computer kiosk. When the Sears crew member delivered the new appliance, he confirmed that the old appliance was working and meets the requirements of the DP&L program. The appliance was then transported to a warehouse where it was stored until JACO could perform a mass collection of appliances from the warehouse. This partnership offered an added convenience for customer participation. This service was marketed through signage on new appliances for sale in the Sears stores and mainly through Sears sales representatives. In 2015, 478 units were picked up through the Sears partnership.



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.



YouTube Video
The YouTube video, produced by DP&L and posted on the appliance recycling program landing page, educated customers about the savings opportunity from recycling an old fridge.

Bill Insert
Bill inserts were mailed to 450,000 customers in February, March, April, May, June, and September.

Flyer
Program fliers were distributed to customers at community outreach events attended by the residential lighting program field staff, creating promotional efficiencies among programs.

Truck Sign
This sign, 253' x 90', was displayed on the sides of several JACO trucks which performed pick-ups in DP&L neighborhoods. The wrap was updated in 2015 and the cost was shared with AEP Ohio.

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

Point-of-Purchase Materials
Promotional signage was displayed on appliances in Sears outlets throughout the year.

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 JACO crew would be working in their area and select the date of their choice for a pick-up. In 2015, 33 percent of appointments were scheduled via the online registration tool.

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 JACO employees. The staff was trained to answer detailed questions about the Residential Appliance Recycling Program and to assist customers in scheduling appointments. Sixty-seven percent of appointments were scheduled via the phone.

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, JACO 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, JACO crews called the customer 30 minutes prior to the expected arrival time.

JACO 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 check mailed directly to their homes. Check processing was managed by JACO.

The continuation of the partnership with Sears was an added customer service, increasing the convenience of customer participation. The Sears partnership is discussed in detail in the Marketing section. Three percent of appointments were scheduled via the Sears partnership.

In 2015, DP&L continued distributing energy savings kits 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 an energy savings kit, but customers could choose whether to accept it. In 2015, 2,193 energy savings kits were distributed.

In late November, our JACO unexpectedly informed DP&L they were ceasing business operations effective immediately. As a result, the program was suspended for the remainder of the year and DP&L's relationship with JACO ended. DP&L worked as quickly as possible to resolve all customer service issues, ensure that all participating customers received payment, and minimize the negative impact on customers. The majority of customers received payment and their issues were resolved in 2015. The remainder of customers received payment and their issues were resolved in early 2016.

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 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 school districts in the DP&L service territory.

This portfolio status report discusses and reports savings for the 2014-15 school year only. Results for the 2015-16 school year will be presented in the 2016 annual portfolio status report.

PERFORMANCE SUMMARY

During the 2014-15 school year, 9,298 energy savings kits were distributed to teachers and taken home by students. Savings garnered via the installation of compact fluorescent bulbs, LED night lights, faucet aerators and energy efficient showerheads provided in students' take-home kits were gross annualized energy savings of 4,204 MWh and peak demand savings of 0.29 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. OEP conducted surveys of participating teachers. Survey results are as follows:

- Students' energy knowledge before and after the training showed an 83 percent average improvement in test scores.
- Teachers rated the overall quality of the program a 9.3 out of 10.
- Teachers rating of the unit's ability to positively affect attitudes and awareness about energy issues: 8.4 out of 10.

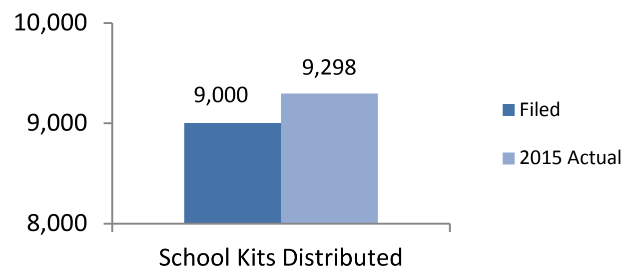
These are a few comments from participating teachers regarding the program:

- The kids have a better understanding of WHY it is important to save energy and in turn, save their families money.

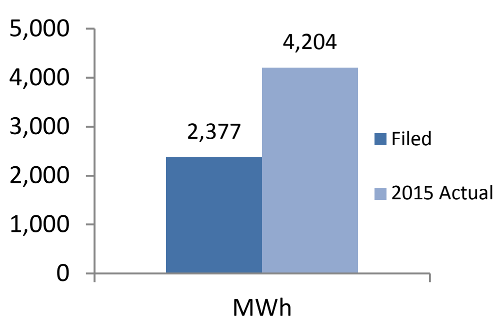
- This is a great resource for helping kids understand conservation. I continue to be impressed with the lessons and materials available to us. Thank you!
- This is some of the best professional development I have had in 25 years of teaching. Thank you for making this available.
- A lot of students enjoy sharing the ways their family put their kits to use and are always excited to hear how much of a difference they're making.
- Kids were shocked at just how much energy we use in a variety of ways. it really gets them thinking about how today's actions will have long term consequences.

2015 Performance

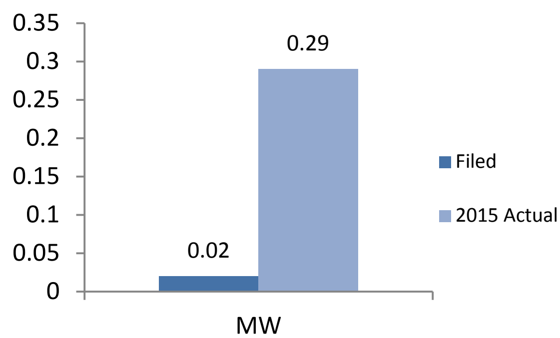
Units



Energy Savings



Demand Savings



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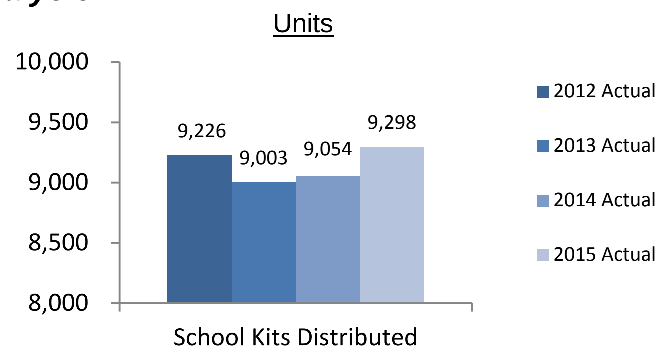
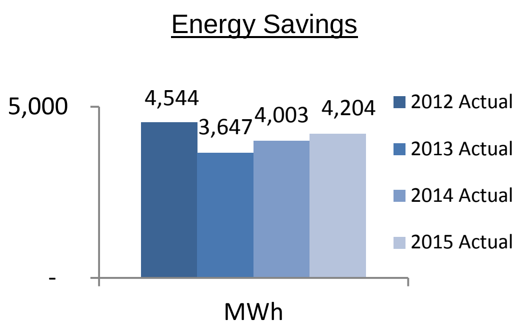
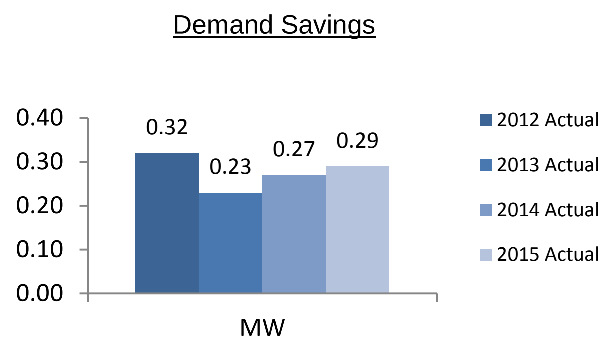
Four-Year Trend Analysis







Budget, Cost Summary

Budget Category	Filed 2015	Actual 2015
Incentive Costs	$98,103	$114,687
Marketing & Admin	$237,270	$164,132
Total Costs	$335,373	$278,819

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 that a third party implementation partner, specializing in this area, provided the best means of effectively managing the program.

DP&L selected Ohio Energy Project (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.
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, CFL versus incandescent cost comparisons, home temperature measurement exercises, and weatherization information.

In addition, teachers were given materials needed to complete experiments and activities, such as five Kill-A-Watt Meters, two radiometers, one canister of coal, six glow sticks, three “Blaster Balls”, and two circuit balls.

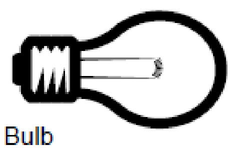
Take-Home Kit Contents

Item	*Description*
4 13W Soft White CFL	Long-life light bulb with up to 75% energy savings. Lasts 10 times longer than an incandescent bulb. Yellowish color tone.
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	Handout describing DP&L’s energy efficiency programs

Efficiency Programs Flier	which can help save energy and money.
CFL Recycling Brochure	Brochure explaining the small amount of mercury in CFLs and proper disposal methods.

Sample In-Class Activity

LET'S COMPARE ! (KEY)
12,000 Hours of Light

CFL	IL
 Compact Fluorescent Light Bulb	 Incandescent Light Bulb
Amount of light = __900__ lumens	Amount of light = __825__ lumens
Power in watts = __13___ watts	Power in watts = __60___ watts
Lifespan = __12,000___ hours	Lifespan = ____1000____ hours
Bulbs needed for 12,000 hours? __1__	Bulbs needed for 12,000 hours? _12__
Cost per bulb = $__2.00___	Cost per bulb = $_0.20_____
Total bulb cost for 12,000 hrs? $__2.00____	Total bulb cost for 12,000 hrs? $___2.40___
__13___ watts X 12,000 hours = ___156,000____ watt-hours	__60__ watts X 12,000 hours = ___720,000__ watt-hours
Kilowatt-hours (kWh)? __156___	Kilowatt-hours (kWh)? __720__
Cost per kWh = $ _0.11___	Cost per kWh = $ __0.11__
_156_ kwh x $_0.11_/kwh = $___17.16__	_720_ kwh x $_0.11_/kwh = $___79.20___
Cost of electricity for 12,000 hours $17.16	Cost of electricity for 12,000 hours $79.20
Total cost for 12,000 hours = $_2.00_ + $_17.16_ = $19.16	Total cost for 12,000 hours = $_2.40_ + $_79.20_ = $81.60

SAVINGS = $81.60- $19.16 = $62.44 !

This Energy Efficiency Education Curriculum written by OHIO ENERGY PROJECT with materials from NEED

Activating and Energizing Girls in Science

In addition to in-class activities, DP&L offers special events throughout the year. One such event is Activating and Energizing Girls in Science (AEGIS). Five middle schools were selected to participate in the summer program. The program allows students to build their own energy bike that generates electric energy to illuminate light bulbs by pedaling. Studies show that girls and boys are equally interested in science and math in elementary school. But by middle school, stereotypes and lack of role models start turning girls off when it comes to science, engineering, and technical careers. However, if girls get the opportunity to learn and experiment, they get excited about pursuing careers in those fields.

The 20 students in grades 7-9, along with their teachers and chaperones, spent three days working on the energy bike project. They also toured DP&L's operations headquarters to hear from women who work in science-related jobs at DP&L. After the project, the students transport their completed energy bike back to their schools where, as leaders, they can use it to help other students as well as members of their communities learn about energy.

Targeted Locations

The program was offered to school districts across DP&L's service territory, grades 5-12. One hundred and thirty four teachers participated from 87 schools in 50 school districts. Participating school districts were located in 14 counties in DP&L's service territory.

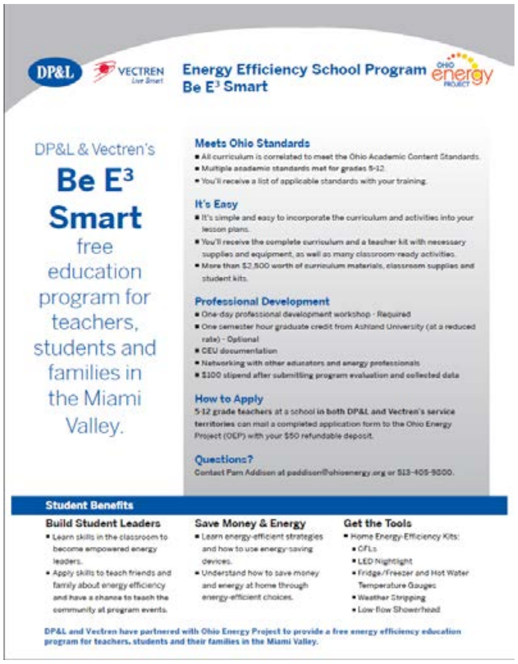
Staffing

The program is implemented by Ohio Energy Project. OEP maintains offices in Columbus and Cincinnati. One program manager, based in the Cincinnati office, served as DP&L's primary point-of-contact and program coordinator. The OEP program manager regularly communicated with the DP&L program manager to coordinate logistics and ensure that 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 that school districts could tell their specific educational story to their local newspaper.



Energy Efficiency School Program
Be E³ Smart

DP&L & Vectren's
Be E³ Smart
free education program for teachers, students and families in the Miami Valley.

Meets Ohio Standards
- All curriculum is correlated to meet the Ohio Academic Content Standards.
- Multiple academic standards met for grades 5-12.
- You'll receive a list of applicable standards with your training.

It's Easy
- It's simple and easy to incorporate the curriculum and activities into your lesson plans.
- You'll receive the complete curriculum and a teacher kit with necessary supplies and equipment, as well as many classroom-ready activities.
- More than $2,500 worth of curriculum materials, classroom supplies and student kits.

Professional Development
- One-day professional development workshop - Required
- One semester hour graduate credit from Ashland University (at a reduced rate) - Optional
- CEU documentation
- Networking with other educators and energy professionals
- $100 stipend after submitting program evaluation and collected data

How to Apply
5-12 grade teachers at a school in both DP&L and Vectren's service territories can mail a completed application form to the Ohio Energy Project (OEP) with your $50 refundable deposit.

Questions?
Contact Pam Addison at paddison@ohioenergy.org or 513-405-9800.

Student Benefits

Build Student Leaders
- Learn skills in the classroom to become empowered energy leaders.
- Apply skills to teach friends and family about energy efficiency and have a chance to teach the community at program events.

Save Money & Energy
- Learn energy-efficient strategies and how to use energy-saving devices.
- Understand how to save money and energy at home through energy-efficient choices.

Get the Tools
- Home Energy-Efficiency Kits:
  - CFLs
  - LED Nightlight
  - Fridge/Freezer and Hot Water Temperature Gauges
  - Weather Stripping
  - Low flow Showerhead

DP&L and Vectren have partnered with Ohio Energy Project to provide a free energy efficiency education program for teachers, students and their families in the Miami Valley.

Program Flyer/Application
OEP distributed program flyers and applications to school administrators, curriculum coordinators, and teachers.

Television Stories
Local media regularly responded to DP&L's invitations to attend school program events.

DP&L donates energy kits to ABMS

Submitted photo

Students in Nicki Bowser's seventh-grade Arcanum science class conducted a unit on energy. The program was called Be E3 Smart (energy efficiency education) and was funded by Dayton Power and Light. Bowser attended a training workshop to help assist students in meeting the state of Ohio energy science curriculum standards. During this unit, students learned how energy is produced and used. They also learned ways to conserve energy and increase energy efficiency in their own homes. With the help of Dayton Power and Light, Bowser was able to send home an energy saving kit with every seventh-grader. The kits contained four CFL light bulbs, an LED night light, an energy savings booklet, a hot water tester, room temperature tester, and refrigerator/freezer tester. All of the items were designed to help reduce electricity and fuel usage in their homes. The students conducted experiments at home with their parents in order to do this. Shown with kits are Maria Brehm, Austen Hittle, Alan Evans, Kate Summers and Kristin Moore. A special thank you goes to Dayton Power and Light for their generosity in helping try to save energy.

School District News Coverage
School districts submitted photos and students' names to their local newspaper.

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. More than 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, the University of Dayton, 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 LOW INCOME AFFORDABILITY

PROGRAM DESCRIPTION

Through the Residential Low Income Affordability Program, home energy audits and inspections are conducted, and cost-effective efficiency measures are installed for qualifying customers. Two categories of 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 Low Income Affordability Program is to identify and implement energy efficiency measures for qualifying homes, reducing the home owners' electric bill and saving energy. The program has the secondary benefit of reducing customer arrearages, which can help save money for all customers.

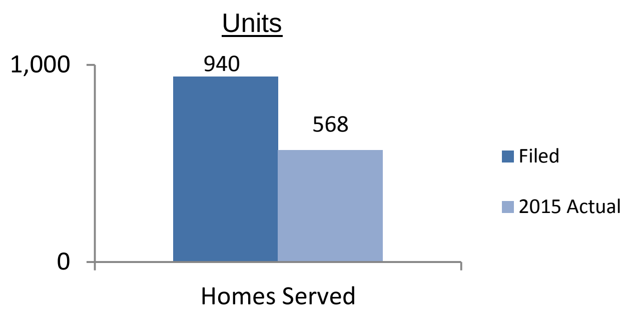
This program is available to low-income residential electric customers within the DP&L service territory with household incomes equal to or less than 200 percent of the federal poverty level or who are qualified and approved for one of the following: the Ohio Home Weatherization Assistance Program (HWAP), 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.

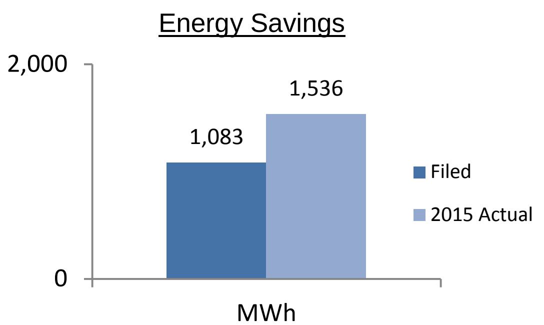
The program is implemented by the Ohio Partners for Affordable Energy (OPAE) through community action agencies located in DP&L's service area.

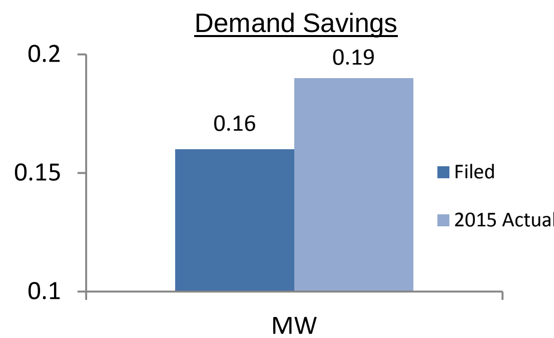
PERFORMANCE SUMMARY

During 2015, 568 customers' homes throughout the DP&L service territory were served through this program, resulting in gross annualized energy savings of 1,536 MWh and peak demand savings of 0.19 MW.

2015 Performance

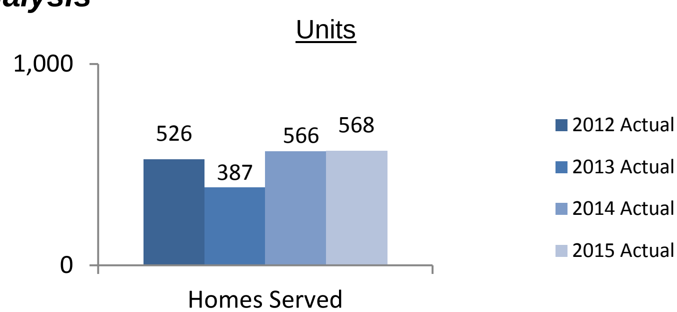


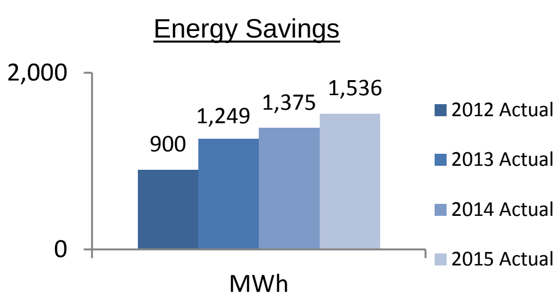


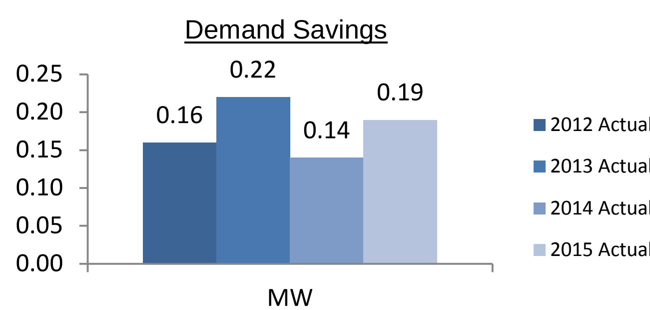


All “filed” numbers are taken from DP&L’s program portfolio filing; Case No. 08-1094-EL-SSO.

Four-Year Trend Analysis







__Budget, Cost Summary__

Budget Category	Filed 2015	Actual 2015
Incentive Costs	$997,892	$927,486
Marketing & Admin	$251,834	$227,696
Total Costs	$1,249,726	$1,155,182

IMPLEMENTATION REVIEW

__Implementation Strategy__
DP&L has partnered with Ohio Partners for Affordable Energy (OPAE), based in Findlay, Ohio, to bring low-income customers the benefits of this program. OPAE implements this same type of program for FirstEnergy and AEP.

The program is provided to eligible customers at the same time (piggyback) as OPAE and subcontracting agencies deliver other state, utility, and community-based weatherization and energy efficiency services. The piggyback approach is designed to save administrative costs and provide more benefits in a timely, cost-effective manner.

__Targeted Products__
OPAE or subcontracting agencies may begin their work with a home audit to determine necessary measures. For the customers who heat or cool their homes with electricity, eligible measures may include ceiling and perimeter insulation and duct sealing or insulation. For all other 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.

DP&L places a high priority on safety. We recognize that certain weatherization and energy efficiency measures cannot be completed or installed because of unsafe conditions like 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.

The cost of the efficiency solutions funded through this program can be a maximum for any single family home of $5,000, and a multi-family home of $50,000.

Targeted Locations
OPAE delivers the program through the community action agencies located in the DP&L service area. These agencies include Community Action Program of the Greater Dayton Area; Clinton County Community Action Program; Community Action Agency of Champaign, Delaware, Logan, Madison, Shelby, and Union Counties; Community Action Commission of Fayette County; Highland County Community Action Organization; and Pickaway County Community Action Organization. This ensures that customers throughout the DP&L service area will be reached through the program.

Staffing
The program is managed by OPAE through the community action agencies. OPAE is responsible for managing the relationships with the agencies to ensure that eligible work is being performed in eligible customers' homes. Through the agencies, OPAE ensures that 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.

Marketing
This program is marketed and delivered to clients of the community action agencies. In 2015, DP&L performed no additional marketing.

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 is responsible for ensuring that all services, materials, and supplies are of good quality and installed in a professional, workmanlike way, and that all contractors are trained and certified to complete work according to the Weatherization Program Standards.

Using the existing network of community action agencies allows program resources to be effectively administered. DP&L funds are used to piggyback with currently existing programs, creating efficiencies in program delivery.

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.

NON-RESIDENTIAL PROGRAMS

NON-RESIDENTIAL PRESCRIPTIVE REBATES

PROGRAM DESCRIPTION

The Non-Residential Prescriptive Rebate Program (Rapid Rebates® Program) provides non-residential customers with incentives for new equipment purchases that reduce energy consumption and demand. Technologies that are 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 Rapid Rebates® 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.

DP&L began accepting online Rapid Rebate® applications on April 1, 2009. In 2015, 100 unique measures were offered through the Rapid Rebates® Program. Seventy-five of these were applied for and utilized by customers. In 2015, DP&L received 1,407 Rapid Rebate® applications, of which 869 were paid, 34 were denied approval or cancelled, and 504 applications were pending at the end of 2015.

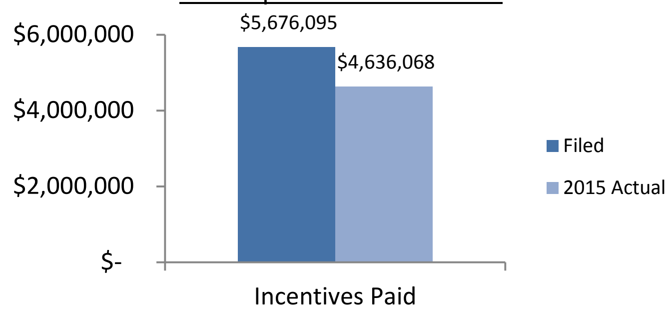
PERFORMANCE SUMMARY

During 2015, DP&L paid $4,191,842 in Rapid Rebates® to business and government customers, resulting in gross annualized energy savings of 60,503 MWh and peak demand savings of 9.07 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.

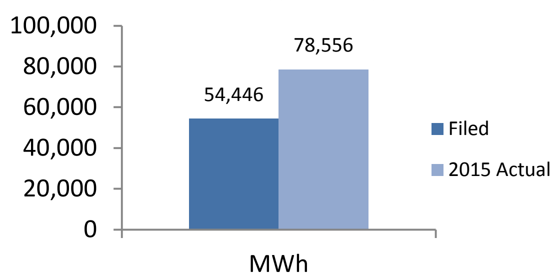
It should be noted that an additional 8,653 MWh and 1.76 MW in savings were realized through the Midstream Prescriptive Rebate channel which included $316,278 in incentives. Also, in 2015 DP&L extended the Appliance Recycling Program to business customers. This resulted in 82 units collected from business customers which accounts for 111 MWh of energy savings, 0.02 MW of peak demand savings and $3,550 in incentives paid. Additionally, five percent of savings and costs from the Residential Lighting Program have been reallocated to the Non-Residential Prescriptive Rebate Program, representing 9,288 MWh, 2.19 MW and $124,398 of incentive costs. This is due to the fact that program evaluations and national trends suggest that five percent of bulbs in retail locations were purchased by non-residential customers. As such, all metrics in this section include Midstream Program costs and savings, Appliance Recycling costs and savings, as well as a proportional five percent reallocation from the Residential Lighting Program.

2015 Performance

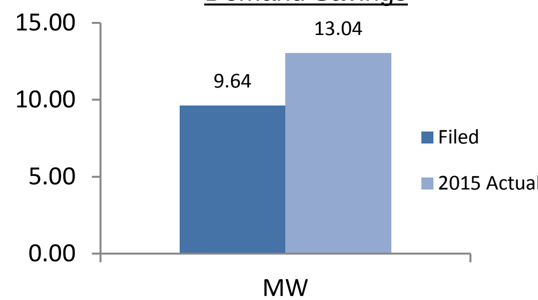
Prescriptive Rebate Dollars



Energy Savings



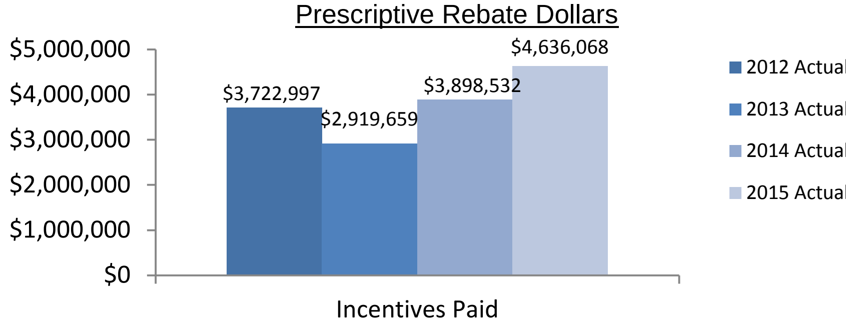
Demand Savings



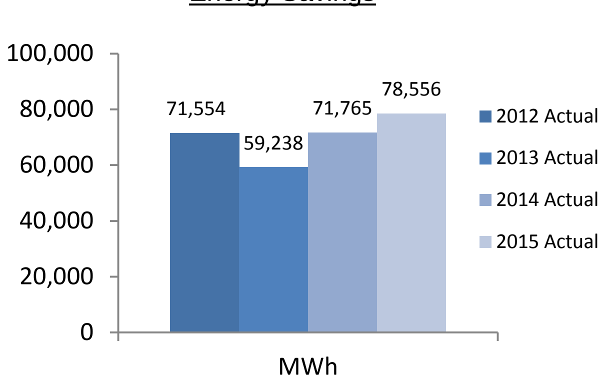
All “filed” numbers are taken from DP&L’s program portfolio filing; Case No. 13-0833-EL-POR.

Four-Year Trend Analysis

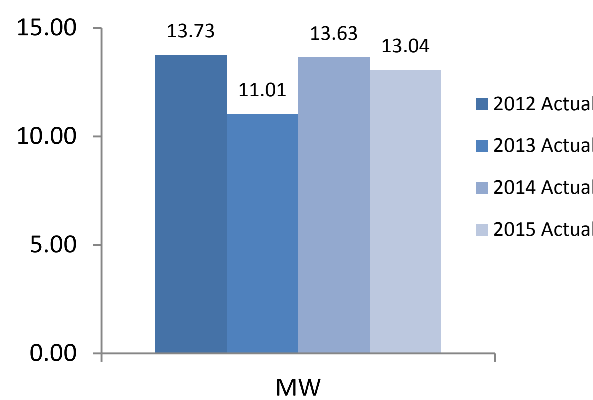
Prescriptive Rebate Dollars



Energy Savings



Demand Savings



Budget, Cost Summary

Budget Category	Filed 2015	Actual 2015
Incentive Costs	$5,469,919	$4,636,068
Marketing & Admin	$1,661,467	$1,686,051
Total Costs	$7,131,386	$6,322,119

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 that 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.

In May 2014, DP&L began offering a midstream, buy-down of lighting sold through 18 electrical 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 program. CLEAResult is the implementer of the midstream channel. In 2015, midstream sales accounted for approximately 11% of 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 2015, 100 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. Rebate checks disbursed to customers ranged from $10 to $175,000.

Prescriptive Rebate Allocation

Product Type	Rebate Dollars Paid	Energy Saved (MWh)	Demand Saved (MW)
Lighting	$3,185,975	44,422	6.14
HVAC	$479,707	7,113	1.72
Compressed Air	$331,100	2,443	0.19
Motors	$195,060	6,526	1.02
Midstream Lighting Channel	$316,278	8,653	1.76
Residential Reallocation	$124,398	9,288	2.19
Appliance Recycling	$3,550	111	0.02
TOTAL	**$4,636,068**	**78,556**	**13.04**

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 that 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. 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 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 or the assigned vendor 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. A verification audit is performed on every prescriptive rebate greater than $10,000. Additionally, DP&L audits a random sampling of rebates less than $10,000. In 2015, 8.1 percent of Rapid Rebates less than $10,000 were audited. The breakdown in the number of audits performed is as follows:

Rebate Value	Rapid
<$10,000	95
>$10,000	81
% audits	14%

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

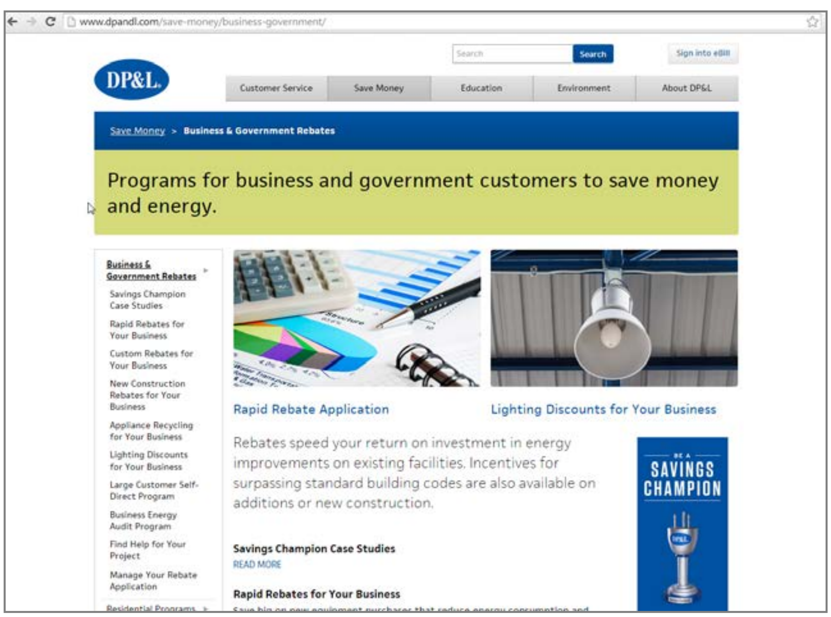
In order to promote the prescriptive rebate program to business and government customers, DP&L employed a variety of marketing methods. These methods included publication of program information on the company website, print literature, bill inserts, inserts in local business journals, presentations at 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 $4,191,842 in prescriptive incentives paid to customers in 2015, Channel Partners were involved in securing $2,211,390 or 53 percent of those dollars.

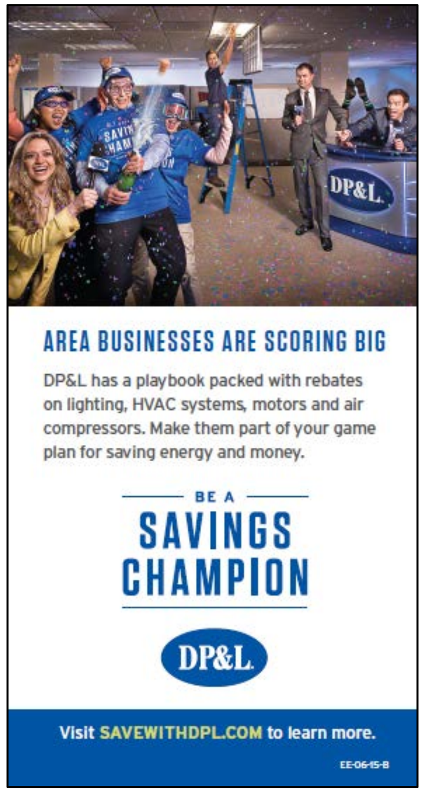
DP&L partnered with DRG and Vectren to sponsor the Bring Your Green Challenge. The Bring Your Green Challenge is a friendly year-long contest for government buildings, commercial property owners/managers and office tenants to reduce costs while reducing greenhouse gas emissions and resources used. The 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. Participants are also eligible for a 50% increase in standard rebate values. The initiative began in August of 2015 and will continue through August of 2016 with results to be provided in the 2016 status report.

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

Newsletter
Channel Partners are kept up-to-date on program news and changes through a quarterly Channel Partner newsletter, the "Rapid Review."



Website
The Business Rebates pages on the DP&L website 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.



Bill Insert
Bill inserts were mailed to 50,000 customers in February, March, May, June, and July.

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

Print Ads
The Business Rebate programs were advertised through placement of ads in local and regional magazines and newspapers including Dayton Daily News, which has a circulation of over 100,000.

Event Sponsorships
DP&L Business Programs frequently sponsor and participate in community- and vendor-sponsored events. Events in 2015 included: DRG3 Sustainability Luncheons, Dayton Green Expo and numerous Channel Partner training and customer appreciation events.

Collaborative Partners
DP&L continues to work with its collaborative partners to promote programs. For instance, DP&L worked with Ohio Environmental Council to host a Combined Heat and Power workshop in 2015.

OHIO HOSPITAL ASSOCIATION

The Ohio Manufacturers' ASSOCIATION

Ohio Environmental Council

[UNLEASHING THE POWER OF GREEN]

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 Prescriptive Rebate Program, some of which have been previously discussed.

The Rapid Rebate® section of the DP&L website 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 access to their application's status, the ability to upload documents to their application, and the ability to assign their rebate to a vendor.

In addition to being an effective means of marketing the program, Channel Partners are also a valuable resource for delivering the program to customers in a quality manner. Channel Partners are trained on both the measures that are rebated through the program and on the application process. Many Channel Partners have taken the rebate programs and used them to offer a "turn-key" experience for the customer, including the approximate rebates in customer quotes and applying for the 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. Channel Partners who are listed on the rebate application are automatically enrolled. Once a minimum of $10,000 in DP&L Rapid Rebates® have been attributed to a Channel Partner, they begin to earn a cash bonus equal to 5 percent of the DP&L rebates paid to the customer. This incentivizes the Channel Partner to complete the rebate application for the customer. In 2015, DP&L paid $185,476 in Channel Partner Rebate Rewards.

As a quality control measure, the auditing process ensures that 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 that 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 that DP&L phone representatives had a basic understanding of the program, could assist customers in navigating the website 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 is 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 2015, DP&L received 160 Custom Rebate applications, of which 61 were paid, 9 were denied approval, and 90 applications were pending at the end of 2015.

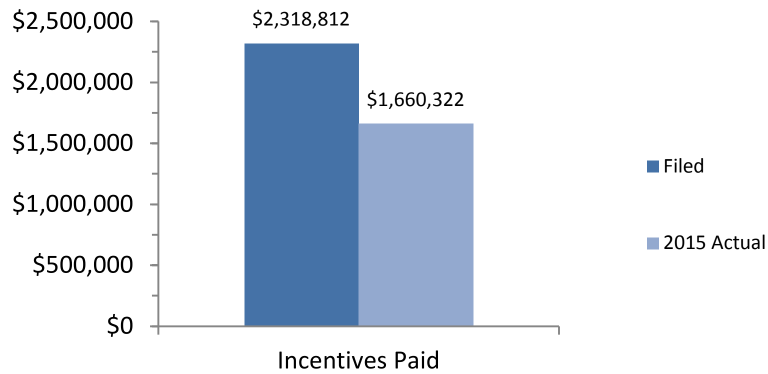
New Construction Rebates are included in the Custom Rebate Program. The New Construction Rebates promote energy efficient design strategies by incenting reductions in the amount of energy that a completed new construction project or major addition would use. In 2015, DP&L received 48 New Construction Rebate applications. These are in addition to the 32 New Construction Rebate applications received but not paid in 2010 through 2014. (New construction projects have lead times spanning multiple months.) Thirty-one of the outstanding 79 New Construction Rebates were paid in 2015, accounting for 5,542 MWh and 1.6 MW of annual savings.

The Business Audit Program is also funded through the Custom Rebate budget. All commercial and industrial customers with facilities served by DP&L are eligible to participate. The objective of the audit program is to help customers understand how energy is being used, prioritize potential projects, calculate project paybacks and identify rebates for which they are eligible. DP&L reimburses 50 percent of the cost of the audit and will pay the remaining 50 percent if the customer implements electricity-saving projects within 1 year of the audit. DP&L does not supply the auditing services. Rather, customers can choose the third-party audit firm they would like to utilize. In 2015, thirty-three (33) entities applied for audits of 56 facilities. Since the program's inception in September 2010, 179 facility audits have been completed.

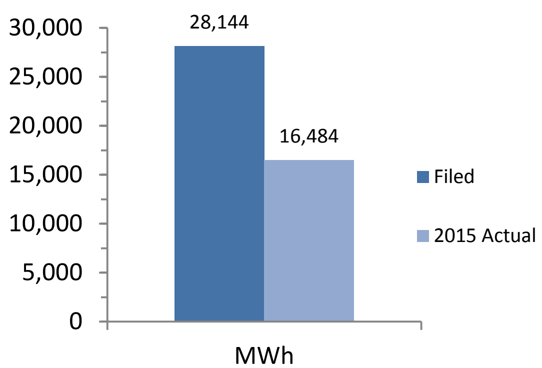
PERFORMANCE SUMMARY
During 2015, DP&L paid $1,660,322 in Custom Rebates to business and government customers, resulting in gross annualized energy savings of 16,484 MWh and peak demand savings of 2.12 MW. Keys to the program's success include continued operation of a customer-friendly online application system, quality customer service and follow through, and strong relationships with Channel Partners.

2015 Performance

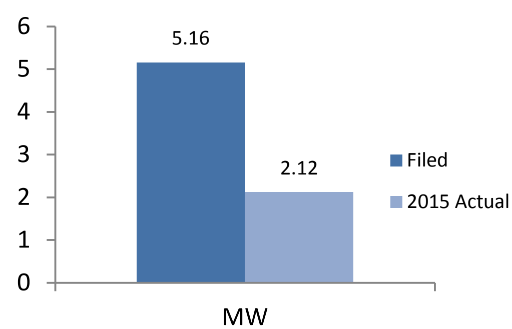
Custom Rebate Dollars



Energy Savings



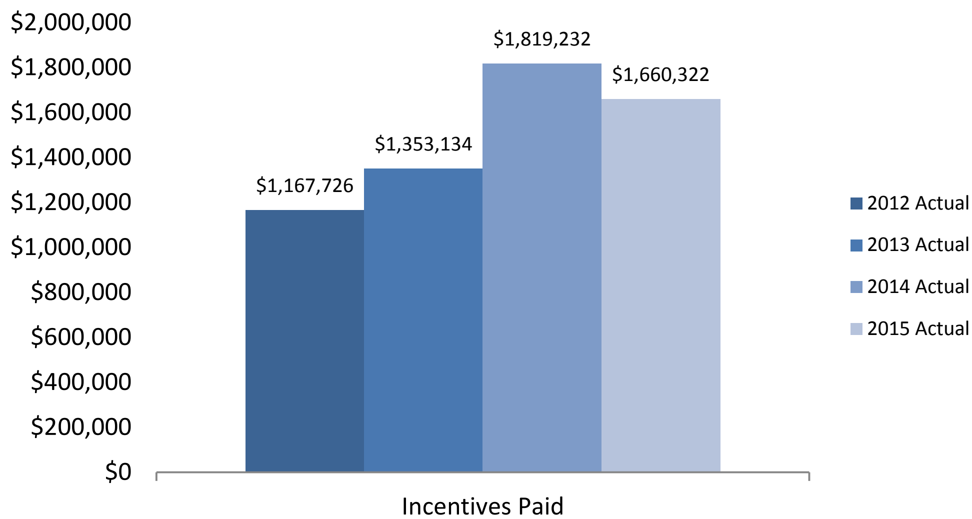
Demand Savings



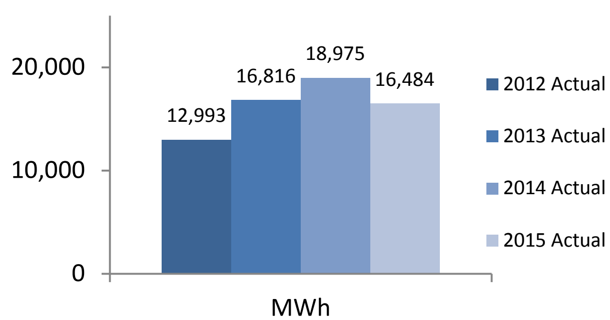
All "filed" numbers are taken from DP&L's program portfolio filing; Case No. 13-0833-EL-POR.

Four-Year Trend Analysis

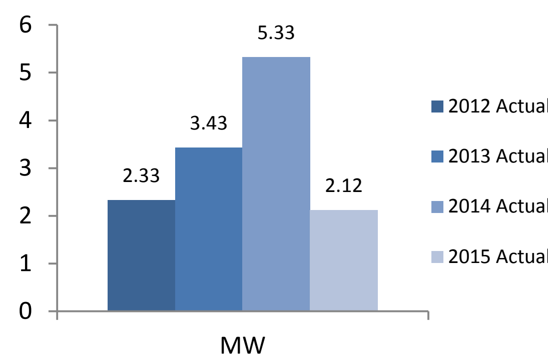
Custom Rebate Dollars



Energy Savings



Demand Savings



Budget, Cost Summary

Budget Category	Filed 2015	Actual 2015
Incentive Costs	$2,318,812	$1,660,322
Marketing & Admin	$1,108,240	$982,350
Total Costs	$3,427,052	$2,642,672

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 this lower volume of 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 ranged from $32 to $319,853.

In June of 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 2015.

A low-cost no-cost HVAC controls and scheduling initiative involving 32 local school districts was begun in 2015. The initiative is referred to as "On-Board," and is a collaborative effort between DP&L, Waibel Energy Systems and the Southwest Ohio Educational Purchasing Council. Savings will be reported and rebates paid at the end of the evaluation phase in 2016.

Custom Rebate Allocation

Product Type	Rebate Dollars Paid	Energy Saved (MWh)	Demand Saved (MW)
Lighting	$177,265	3,412	0.22
HVAC	$404,990	3,837	0.21
Other, includes: • Refrigeration measures • Multi-compressor compressed air systems	$311,564	3,692	0.34
New Construction	$530,197	5,543	1.35
Business Audits	$132,306	-	-
On Board	$104,000	-	-
Total	**$1,660,322**	**16,484**	**2.12**

In 2015, 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

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.

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

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. To be eligible for a whole building incentive, the customer must provide documentation of an energy model in accordance with ANSI/ASHRAE/IESNA Standard 90.1-2007, 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, tax ID and contractor contact information. On the second page, customers enter a detailed project description, their baseline energy and demand usages, and their proposed energy and demand usages. 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 that 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 or the assigned vendor 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. A verification audit is performed on every Custom Rebate greater than $10,000. Additionally, DP&L audits a random sampling of rebates less than $10,000. In 2015, 30.7 percent of rebates less than $10,000 were audited. The breakdown in the number of audits performed is as follows:

Rebate Value	Custom
>$10,000	35
<$10,000	29
% audits	56.1%

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 promoted the Custom Rebate Program as it promoted its Rapid Rebates. DP&L employed a variety of marketing methods, including publication of program information on the company website, print literature, bill inserts, inserts in local business journals, presentations at community- and vendor-sponsored events, one-on-one marketing through major account managers, and the creation of 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 $1,424,016 in Custom incentives paid to customers in 2015, Channel Partners were involved in securing $284,587 or 19.9 percent of those dollars.

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


DP&L Rapid Review
An update for our valued Channel Partners

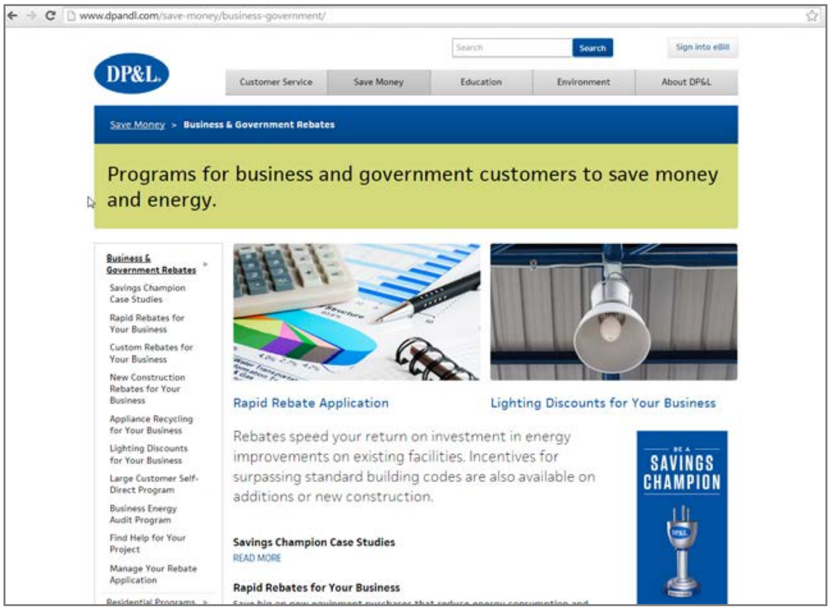
Thank you for a successful 2015!
We appreciate everyone's participation in our programs and are excited for a great 2016!

2016 Channel Partner Workshop
Invites have been sent out for this years workshop. Please don't forget to register for one of them to fulfill one of the Channel Partner requirements. We are looking forward to seeing everyone!

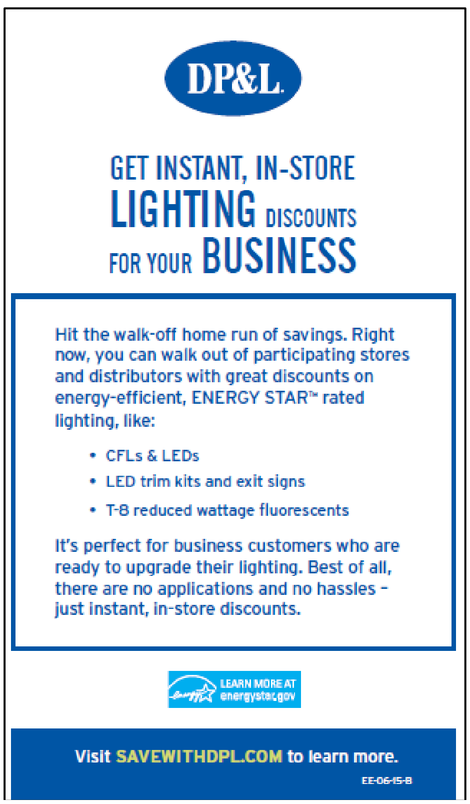
2016
DP&L BUSINESS REBATES
GROW YOUR BUSINESS
LEARN HOW TO PARTNER WITH DP&L AT FREE WORKSHOPS FOR CONTRACTORS AND DISTRIBUTORS

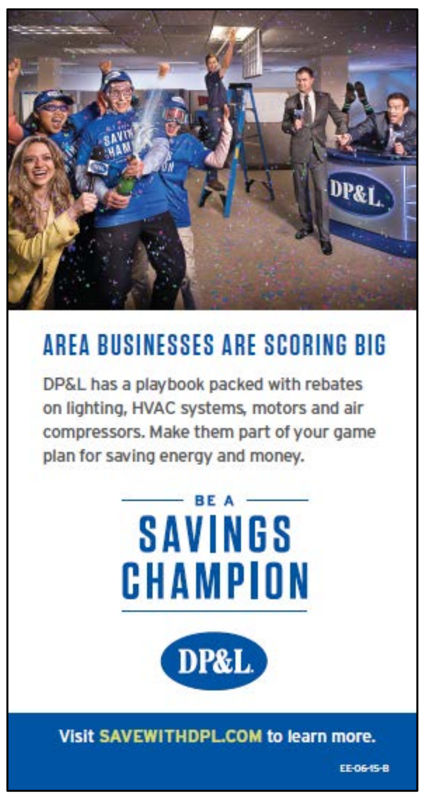
Please visit www.dpandl.com/workshop to register and complete the online registration form.

Newsletter
Channel Partners are kept up-to-date on program news and changes through a quarterly Channel Partner newsletter, the "Rapid Review."



Website
The Business Rebates pages on the DP&L website 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.





Bill Insert
Bill inserts were mailed to 50,000 customers in February, March, May, June, and July.

Print Literature
DP&L used

standard print materials for hand outs at meetings with customers and at a variety of speaking events.

Print Ads
The Business Rebate programs were advertised through placement of ads in local and regional magazines and newspapers including Dayton Daily News, which has a circulation of over 100,000.

Event Sponsorships

DP&L Business Programs frequently sponsor and participate in community- and vendor-sponsored events. Events in 2015 included: DRG3 Sustainability Luncheons, Dayton Green Expo and numerous Channel Partner training and customer appreciation events.

Collaborative Partners

DP&L continues to work with its collaborative partners to promote programs. For instance, DP&L worked with Ohio Environmental Council to host a Combined Heat and Power workshop in 2015.

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 website acts as the main information portal for customers, contractors, distributors and other program participants. The website 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 access to their application's status, the ability to upload documents to their application, and the ability to assign their rebate to a vendor.

In addition to being an effective means of marketing the program, 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 taken the rebate programs and used them to offer a "turn-key" experience for the customer, including the approximate rebates in customer quotes and applying for the 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.

As a quality control measure, the auditing process ensures that 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 that 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 that DP&L phone representatives had a basic understanding of the energy efficiency programs, and could assist customers in navigating the website or point them to the Energy Efficiency Inbox.

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 2015, 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, 2012 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 2015 prescriptive 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.

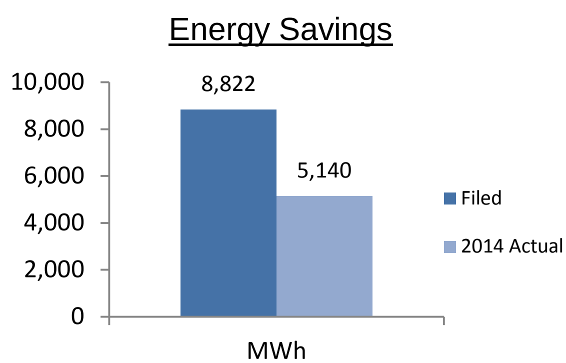
PERFORMANCE SUMMARY

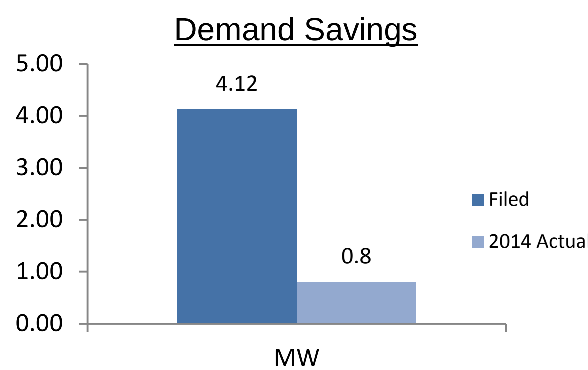
During 2015, DP&L paid eleven applications with customers requesting a one-time incentive payment for historical energy efficiency projects. These applications were filed using the PUCO-issued mercantile template format and resulted in demand savings of 0.58 MW and energy savings of 3,736 MWh*.*

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.

2015 Mercantile Program Summary		Approved by PUCO	Energy Savings (kWh)	Demand Savings (kW)	Incentive Payment
One-Time Incentive Payments for Energy Efficiency					
Kramer Graphics	15-0182-EL-EEC	✓	46,332	0.2	$2,794.86
The Eco-Groupe, Inc.	15-0496-EL-EEC	✓	1,615,880	200.9	$112,030.30
Data Yard (Correction)	14-1451-EL-EEC	✓	39,382	0.0	$2.953.65
Dollar Tree	15-0371-EL-EEC	✓	34,112	8.0	$1,770.65
Vandalia Butler Board of Education	15-0497-EL-EEC	✓	1,036,807	0.0	$77,760.53
Tire Discounters	15-0663-EL-EEC	✓	27,635	0.0	$1,530.00
Field & Stream	15-0498-EL-EEC	✓	49,737	23.5	$4,990.13
Spinnaker Coating, LLC	15-0708-EL-EEC	✓	166,278	28.3	$4,050.00
Champaign Family YMCA	15-0880-EL-EEC	✓	9,572	7.5	$2,700.00
Wright Patterson Air Force Base	15-1239-EL-EEC	✓	248,380	18.0	$8,809.50
Eaton Schools	15-1297-EL-EEC	✓	462,249	295.7	$56,846.18
Subtotal Energy Efficiency Incentive Payments			**3,736,364**	**582.1**	**$276,235.80**
Energy Efficiency Rider Exemptions					
	10-2205-EL-EEC	✓	1,403,964	221.8	
TOTAL 2015 Mercantile Savings			**5,140,328**	**803.9**	**$276,235.80**

2015 Performance





All "filed" numbers are taken from DP&L's program portfolio filing; Case No. 13-0833-EL-POR.

Budget, Cost Summary

Budget Category	Filed 2015	Actual 2015
Incentive Costs	$637,479	$276,236
Marketing & Admin	$194,040	$144,645
Total Costs	$831,519	$420,881

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 that 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 worked with its major account managers to identify large customers who may have implemented past efficiency projects. Additionally, DP&L educated industry contractors and distributors about the availability of the program. Their knowledge about local efficiency projects was used to establish leads for potential customers that may have implemented projects in the 2012 to 2014 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.

PJM DEMAND RESPONSE

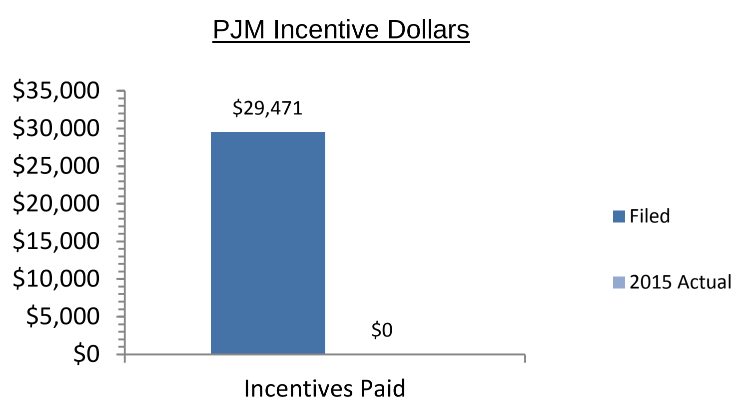
PROGRAM DESCRIPTION
The Non-Residential PJM Demand Response program allows mercantile customers to commit their PJM Demand Response attributes to DP&L.

The objective of the program is to supplement the peak demand reductions achieved from energy efficiency programs in order to ensure compliance with the peak demand reduction benchmarks. Savings are claimed based on the actual peak demand response participating customers report into PJM's eLRS system in a given program year.

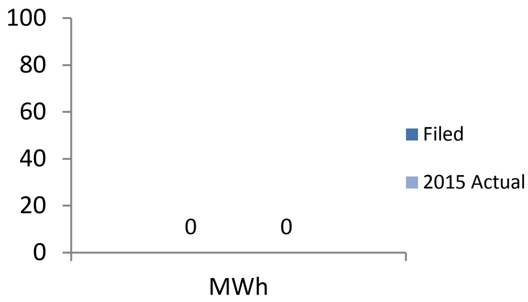
This program is available to customers who consume 700,000 kWh or more per year or are part of a regional or national account. All customers taking delivery service from DP&L are eligible for this program regardless of their choice of generation supplier. Qualifying customers must meet the requirements of the PJM Demand Response program and be participating in the program through a curtailment service provider.

PERFORMANCE SUMMARY
During 2015, DP&L was able to achieve compliance with the peak demand reduction benchmarks solely through its energy efficiency programs. As such, DP&L did not utilize the PJM Demand Response program in 2015.

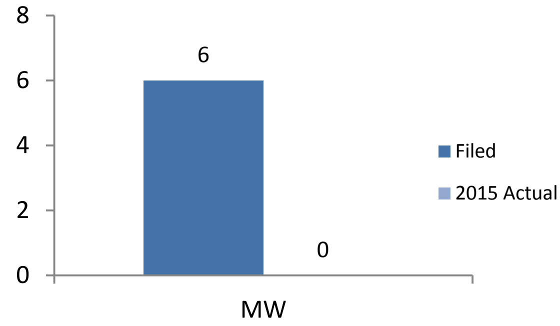
2015 Performance



Energy Savings



Demand Savings



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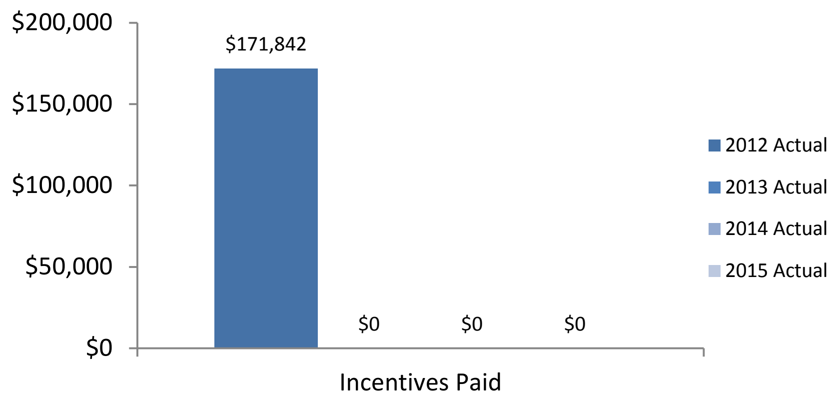
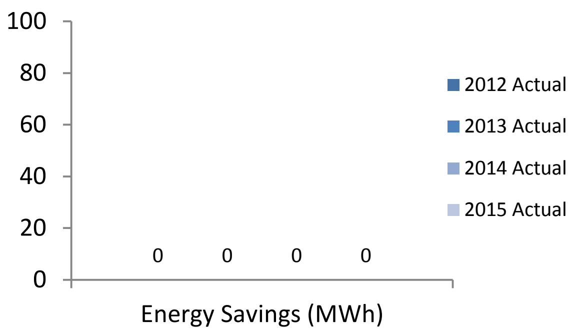
Four-Year Trend Analysis

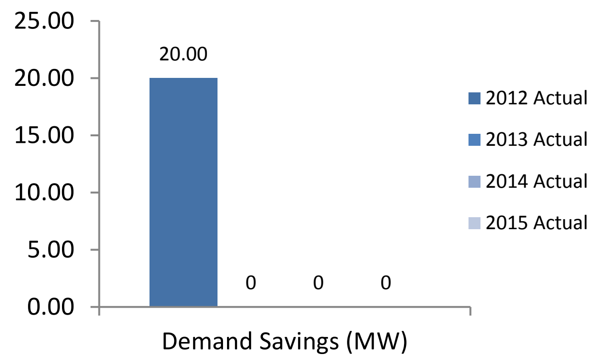
Program Dollars



Energy Savings



Demand Savings



Budget, Cost Summary

Budget Category	Filed 2015	Actual 2015
Incentive Costs	$26,807	$0
Marketing & Admin	$7,200	$0
Total Costs	$34,007	$0

PILOT PROGRAMS

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 programs may also inform mid-stream adjustments to the current plan programs as needed.

Pilot Programs are intended to cover all DP&L customer segments, both residential and business. All customers taking delivery service from DP&L are eligible for participation in pilot programs regardless of their choice of generation supplier.

PERFORMANCE SUMMARY
During 2015, DP&L completed four pilot programs: Residential Appliance Rebates, People Working Cooperatively, Small Business Direct Install and Cogged V-Belts. Total energy savings from 2015 pilot programs were 2,550 MWh and peak demand savings were 0.52 MW.

Budget, Cost Summary

Budget Category	Filed 2015	Appliance Rebates	PWC	SBDI	Cogged V-Belts	Total
Incentive Costs	$747,828	$142,200	$0	$340,217	$4,618	$487,035
Marketing & Admin	$320,498	$132,930	$305,236	$14,268	$16,527	$468,961
Total Costs	$1,068,326	$275,131	$305,236	$354,485	$21,145	$955,996

RESIDENTIAL PILOT PROGRAMS

APPLIANCE REBATES

In July 2015, DP&L began a 4-month Appliance Rebate Pilot Program. DP&L offered a $50 rebate for the purchase of ENERGY STAR™ certified refrigerators, clothes washers, and Wi-Fi enabled thermostats (including learning thermostats, such as the Nest). This program was intended to reach residential customers who were considering the purchase of an appliance and encourage the selection of an energy-efficient model. The program was primarily promoted through in-store marketing materials along with training of retail sales representatives. Other marketing efforts included customer bill inserts, flyers and promotional materials, and news media coverage. Customers were able to choose between submitting an online or paper application.

Throughout the four months, DP&L issued 2,844 appliance rebates for customers. DP&L issued the most rebates for efficient clothes washers (1,344 units) followed by refrigerators (1,103 units) and Wi-Fi enabled thermostats (397 units). Forty four percent of applications were submitted online and 56 percent were submitted via mail. In-store signage was placed in 40 retail locations throughout the DP&L service territory. Program staff conducted more than 400 visits to retail locations to ensure that signage was properly displayed, along with printed rebate applications, and that retail staff was trained on program guidelines and processes.

Residential Appliance Rebate Pilot		
Costs	Energy Saved (MWh)	Demand Saved (MW)
$275,131	476	0.06

PEOPLE WORKING COOPERATIVELY

In September 2014, DP&L began a pilot program that intended to enhance PWC's "whole house" critical repairs, energy conservation and modification programs. 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. An added benefit of this pilot program is reduced electric costs for low income customers.

During 2015, 175 customers participated in the PWC pilot program which accounted for 158 MWh of energy savings and .02 MW in demand savings. A majority of the savings were attributed to upgrading customers' lighting and refrigerators.

People Working Cooperatively Pilot		
Costs	Energy Saved (MWh)	Demand Saved (MW)
$305,236	158	0.02

NON-RESIDENTIAL PILOT PROGRAMS

SMALL BUSINESS DIRECT INSTALL

In June 2014, DP&L began a 12-month Small Business Direct Install Pilot Program (SBDI), which completed in May 2015. This program was intended to reach small non-residential customers with limited resources (both time and money) and limited understanding of energy efficiency initiatives. Customers whose monthly demand was less than 100kW were eligible for the program. Customers were eligible to receive certain lighting measures (primarily LED lamps) at no charge. Additional lighting measures were made available at 25% cost share to the customer.

From June 2014 through May 2015, DP&L served 90 businesses through the SBDI Pilot Program. These lighting retrofits resulted in gross annualized energy savings of 1,368 MWh and peak demand savings of 0.05 MW. The savings realized and costs incurred in 2014 were reported in DP&L's 2014 Portfolio Status Report.

Small Business Direct Install Pilot			
Year	Costs	Energy Saved (MWh)	Demand Saved (MW)
2014	$181,818	513	0.02
2015	$354,485	855	0.03

COGGED V-BELTS

In May 2015, DP&L began a seven-month Cogged V-Belt Pilot. DP&L and AEP-Ohio collaborated with Argonne National Laboratories and the Midwest Energy Efficiency Alliance to offer a midstream incentive program to promote the sale of cogged v-belts. The utility partners were interested specifically in program formats that reduced transaction costs and administrative burdens but still delivered significant energy savings to businesses. Although switching a smooth v-belt to a cogged v-belt represents a relatively small efficiency gain (about 3%), cogged v-belts represent a large aggregated energy-savings opportunity. DP&L's goal was to gain a solid understanding of existing market share, the measure's energy savings, and the most effective incentive strategies. Navigant Consulting was contracted by DP&L and AEP-Ohio to perform the evaluation of the cogged v-belt pilot. The Navigant report is attached as Exhibit 2.

Cogged v-belt sales over and above established historical sales baseline were tracked for participating distributors. DP&L had one participating distributor branch location in our service territory and AEP-Ohio had four branch locations. Over the seven-month pilot program duration, the DP&L branch location reported a 14.8% lift in cogged v-belt sales.

Cogged V-Belt Pilot		
Costs	Energy Saved (MWh)	Demand Saved (MW)
$21,145	1,060	0.13

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.

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 is not seeking to recover 4 kV to 12 kV costs through the Energy Efficiency Rider.

PERFORMANCE SUMMARY

DP&L reported savings associated with a 4 kV to 12 kV project in the 2013 Portfolio Status Report (14-0738-EL-POR). DP&L did not undertake any additional transmission and distribution infrastructure projects in 2015.

CUSTOMER EDUCATION

In 2015, DP&L's customer education activities included a mass media campaign, in-person events and sponsorship of and participation in various community events and conferences.

Budget, Cost Summary

Budget Category	Filed 2015	Actual 2015
General Education, Awareness Building	$902,493	$596,093
Total Costs	$902,493	$596,093

MASS MEDIA CAMPAIGN

During the course of 2015, DP&L aired a multi-media educational and promotional campaign that included television, radio, print, outdoor, 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. The campaign continued from 2014 and ran from January through November, 2015.

The concept of the campaign is a sports-hero theme entitled "Savings Champion." The use of savings has a two-fold message – save money and save energy. DP&L created everyday situations where customers make changes to their energy habits and are rewarded with play-by-play announcers humorously describing the action as if it were a sporting event.

DP&L's Savings Champion Campaign received the honor of winning the Best Overall Campaign among 800 submissions in the E-Source Utility Ad Awards Contest in 2014. An independent group of judges selected the winners based on message, creativity, results, call to action or brand connection, and overall impression.

Kym Wootton, director of marketing at E Source said, *"We received more than 800 submissions this year—our biggest entry pool to date. Utilities know they have to be innovative to get the attention of their residential and business customers, and it was great to see some of their new tactics. We're seeing humor used increasingly in video ads. Utilities are tapping social media to promote their programs and creating outdoor advertisements that generate buzz in the community. It's encouraging that utilities are using humor and creativity to get their messages across, and that they're also targeting and segmenting customers so effectively."*

*In left photo (from left), energy efficiency team members **Lyle Garrison, Kara McMillen** and **Julie Birchfield** represent DP&L at awards ceremony. At right, TV commercial features sportscasters touting energy-saving tips.*

DP&L earns 1st place in Utility Advertising Competition

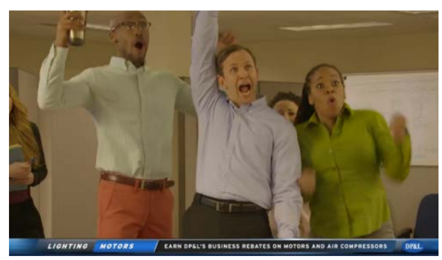
Campaign encouraging customer energy efficiency best of 800 entries nationwide

Television Script 1

Announcer Voice Over	Visuals	
BOB: There's a break in the action so let's take a look at that last play. [CRAWL Get up to $1,600 on HVAC rebates] DAN: What an amazing spin move. This is dazzling technique, Bob. BOB: And here's the follow through…	Open on a woman installing a CFL in a lamp. Cut to a wider shot of the woman and her husband who are puzzled by the sudden appearance of two sports anchors sitting at a desk in their home. A crawl appears at the bottom of the screen with more information. Cut to a montage of clips	 

DAN: Unbelievable! BOB: Let's go down to the field and Stacey.	that show the woman installing a CFL. One cut shows the DP&L sticker on a pack of CFLs that is on the table. A telestrator helps illustrate the action. As a super, the Energy Star logo appears.	
STACEY: Guys, the story here is that the Wilsons got instant in-store discounts from DP&L on energy efficient CFLs like this one. What a heads-up move. [CRAWL: Each CFL can save $30 over its lifetime]	Cut back to the anchor desk. Cut to the husband very casually flipping the switch so the bulb turns on.	
DAN: Thanks, Stacey! Woooo! [CRAWL: Free refrigerator recycling - earn $40 - save $10/month]	Cut back to the anchor desk. Cut to Stacey by the lamp. The woman and husband are standing behind her still wondering what's going on. Stacey has a CFL in her hand.	
STACEY VO: Be a savings champion. Visit savewithdpl.com.	Cut back to the anchor desk where the wife, husband and two anchors have Savings Champions t-shirts and hats on. They have popped a bottle of champagne and are celebrating while holding the plug trophy high. They are also wearing goggles like one would see in a locker room celebration. Logo and website appear over moving footage.	 

Television Script 2

Announcer /Voice Over	Visuals	
BOB: And we're back. Dan, tell our viewers what they missed. [CRAWL: Get business rebates on HVAC upgrades] DAN: Thanks, Bob. What an action-packed play. Ya know, replacing old bulbs with super efficient bulbs is a smart move for businesses BOB: Stacey, what's the word on the floor? STACEY: Guys, not only does DP&L offer lighting rebates for businesses, they also have rebates for motors, HVAC and air compressors. [CRAWL: DP&L offers business rebates on motors & air compressors] DAN: That's a big-time score! STACEY VO: Be a savings champion. Visit savewithdpl.com.	DIRECTION/SFX Open on an office setting. It is a sea of cubicles and there is fluorescent lighting hanging from the ceiling. We hear typical office sounds. We are focused on an installer (and maybe a few others) as well as the manager who is responsible for having the lighting installed. The installer puts one final twist to the bulb. Cut to see a cubical wall fall to the floor revealing our two anchors. As Dan speaks, we cut away to the 3rd party installer we saw in the first scene along with the manager. The installer is sitting in one of a few chairs that are lined up off to the side. An old, darker looking bulb is subbed out for a new, brighter bulb. The seated installer gets up and "goes into the game." Cut as the new bulb is twisted in and lights. Cut to co-workers who are behind the two anchors. They stand up and cheer the new, brighter bulb(s). Cut to Stacey. She is sitting on a person's desk	    

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<td>in a cubicle.

Cut back to the announcer desk. The manager is on the shoulders of co-workers and everyone in the scene is celebrating. He is holding the plug trophy. From behind, more co-workers run up and drench them all with Gatorade. The action starts out in real time and then rapidly ramps down to slow motion. Logo and website appear over moving footage.</td>
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Print

BE A
SAVINGS CHAMPION
SAVEWITHDPL.COM
DP&L
DP&L
Area businesses are scoring big
DP&L has a playbook packed with rebates on lighting, HVAC systems, motors and air compressors. Make them part of your game plan for saving energy and money.
INFO
FOR INFO ON BECOMING A SAVINGS CHAMPION, VISIT SAVEWITHDPL.COM
DP&L

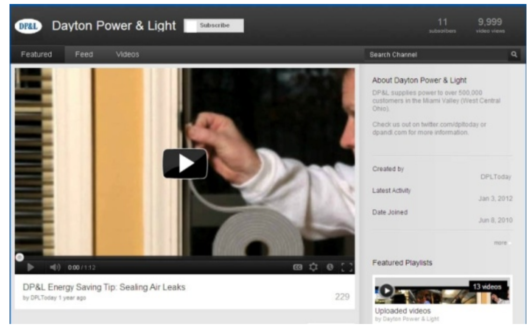
Events

While not a part of the paid media plan, in-person events played a significant role in the Savings Champion campaign. In-person events allowed DP&L to bring the campaign to life and to directly connect with customers.

The premier event was DP&L sponsor night at a game for Dayton's minor league baseball team, the Dayton Dragons. DP&L staff set up on the plaza outside the stadium to share information about energy efficiency programs. Customers could take their picture at the actual DP&L broadcasting desk used in the television commercials. And, customers were given free energy-efficient CFL bulbs on their way out of the game to reinforce savings ideas from the campaign.

OTHER ACTIVITIES

Over the course of 2015, DP&L performed other education and awareness activities, some at the request of organizations and customers. These included:



- Sponsorship of and participation in various events and conferences including the Ohio Weatherization Conference, the Dayton Home and Garden Show, an energy fair at Wright-Patterson Air Force Base, Association for Energy Engineers Green Expo, presentations to the Building Owners and Managers Association and luncheons for the Dayton Regional Green Sustainability Initiative.

- Energy efficiency presentations to community groups, using a presentation created by DP&L called “Top Ten Ways to Save Energy in the Home.”
- Participation in Earth Day events hosted by some of our largest customers.
- Sponsoring an Energy Bike program. Teachers participating in our school education program can pick up the energy bike from a DP&L facility and use it for teaching and demonstrations in their classrooms.
- Various interviews with the news media about ways to reduce energy consumption.

RECOMMENDATIONS

The previous pages of this report contain a thorough description of each energy efficiency program, how it is being implemented and marketed, and the results produced to date. These recommendations are based, in part, on this program review, and as such, DP&L finds it unnecessary to duplicate that review in this section.

Further, DP&L undertook a comprehensive review of its programs as a part of developing its 2013-15 portfolio plan, which was filed in April of 2013 as PUCO Case No. 13-0833-EL-POR and 13-0837-EL-WVR. The programs in that plan were reviewed with stakeholder groups and a stipulation settlement was reached with all parties. The plan was approved by the Commission on December 4, 2013.

Overall, DP&L is pleased with the progress of its energy efficiency initiatives. The program spending in 2015 was 12 percent below filed budgets while program savings performance was 109 percent of 2015 filed targets.

As with any type of implementation, there is always opportunity to improve, including recommendations outlined in the Cadmus report (Exhibit 1). Over the course of the coming year, DP&L will continue to work with its implementation vendors, its collaborative members and its evaluations provider to make adjustments and improvements to its programs.

Consistent with DP&L's 2013-2015 Portfolio Plan filed April 15, 2013 (13-0833-EL-POR) and approved on December 4, 2013, DP&L recommends continuing all of the programs that are contained in the portfolio plan.

Filed Program	Recommendation
Residential Lighting	Continue
Residential HVAC Rebates	Continue
Residential Appliance Recycling	Continue
Residential School Education	Continue
Residential Low Income Affordability	Continue
Non-Residential Prescriptive Rebates	Continue
Non-Residential Custom Rebates	Continue
Non-Residential Mercantile	Continue
Non-Residential PJM Demand Response	Continue
Pilot Programs	Continue
T&D Infrastructure	Continue
Education, Awareness Building & Market Transformation	Continue

THE DAYTON POWER & LIGHT COMPANY
2015 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 2015 based on the preceding three calendar years (2012, 2013, and 2014) 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)(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 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 2015 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 (2012, 2013, and 2014), 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.

2012: 13,936,670 MWh
2013: 13,829,968 MWh
2014: 14,024,927 MWh

DP&L 2015 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 (2012, 2013, and 2014), 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.

2012: 3,046 MW
2013: 2,937 MW
2014: 2,756 MW

Normalizing Adjustments

Adjustment for Mercantile Customers

Pursuant to O.R.C §4928.66(A)(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 customer load change, 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 2009-2014 timeframe, were approved by the Commission under the 60 day automatic approval in 2010, 2011, 2012, 2013, 2014, and 2015 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).

<u>DP&L 2015 Normalized Energy Efficiency Baseline Calculation</u>

DP&L's 2015 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 2012, 2013, and 2014 are averaged over the three years, to produce DP&L's 2015 Normalized Energy Efficiency Baseline of 13,806,336 MWh.

<u>DP&L 2015 Energy Efficiency Reduction Benchmark Calculation</u>

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 2018."

DP&L's 2015 Normalized Energy Efficiency Baseline of 13,806,336 MWh is multiplied by the 2015 Energy Efficiency Reduction Benchmark percentage of 1.00% pursuant to O.R.C. §4928.66(A)(1)(a). The result is DP&L's 2015 Incremental Energy Efficiency Reduction Benchmark of 138,063 MWh. DP&L's 2015 cumulative Energy Efficiency Reduction Benchmark is 726,247 MWh. The calculations are shown on Schedule 1.

<u>DP&L 2015 Normalized Peak Demand Baseline Calculation</u>

DP&L's 2015 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 2012, 2013, and 2014 are averaged over the three years, to produce DP&L's 2015 Normalized Peak Demand Baseline of 2,835 MW.

<u>DP&L 2015 Peak Demand Reduction Benchmark Calculation</u>

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 2018."

DP&L's 2015 Normalized Peak Demand Reduction Baseline of 2,835 MW is multiplied by the 2015 Peak Demand Reduction Benchmark percentage of 5.50% pursuant to O.R.C. §4928.66 (A)(1)(b). The result is DP&L's 2015 Peak Demand Reduction Benchmark of 155.9 MW. The calculation is shown on Schedule 2.

Schedule 1

THE DAYTON POWER & LIGHT COMPANY
2015 Benchmark Report
Energy Efficiency Baseline and Benchmark Calculation

		2012	2013	2014	2015
1	**Baseline Calculation Components**				
2	Retail MWh Sales [1]	13,936,670	13,829,968	14,024,297	
3					
4	**Normalizing Adjustments**				
5	Mercantile Customer Adjustment [2]	34,588	38,938	43,111	
6	Total Adjusted Retail Sales (2)+(5)	13,971,258	13,868,906	14,067,408	
7	Weather Normalization Factor [3]	0.99308	0.98849	0.98349	
8	Normalized Retail Energy Sales (6)*(7)	13,874,577	13,709,275	13,835,155	
9					
10	**2015 Normalized Energy Efficiency Baseline**				
11	3 Year Normalized Average (MWh)				13,806,336
12					
13	**Calculation of 2015 Energy Efficiency Reduction Benchmark**				
14	Normalized Preceding 3 Year Average Sales (11)				13,806,336
15	2015 Incremental Energy Efficiency Reduction Benchmark % [4]				1.00%
16	2015 Incremental Energy Efficiency Reduction Benchmark (14)*(15)				138,063
17	2014 Energy Efficiency Reduction Benchmark [5]				588,184
18	**2015 Cumulative Energy Efficiency Reduction Benchmark (16)+(17)**				**726,247**

[1] Retail sales for the period 2012-2014 are reported in PUCO Form FE-D1 (Case No. 16-724-EL-FOR). See Workpaper A, Column (6).

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

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

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

[5] 2014 Cumulative Energy Efficiency Reduction Benchmark as established in Case No. 15-777-EL-POR, Schedule 1, line 21.

THE DAYTON POWER & LIGHT COMPANY

2015 Benchmark Report

Peak Demand Baseline and Benchmark Calculation

		2012	2013	2014	2015
1	**Baseline Calculation Components**				
2	Peak MW Demand [1]	3,046	2,937	2,756	
3					
4	**Normalizing Adjustments**				
5	Mercantile Customer Adjustment [2]	13	15	15	
6	Total Adjusted Peak Demand (2)+(5)	3,059	2,952	2,771	
7	Weather Normalization Factor [3]	0.94288	0.96084	1.00544	
8	Normalized Peak Demand (6)*(7)	2,884	2,836	2,786	
9					
10	**2015 Normalized Peak Demand Reduction Baseline**				
11	3 Year Normalized Average (MW)				2,835
12					
13	**Calculation of Normalized 2015 Peak Demand Reduction Benchmark**				
14	Normalized Preceding 3 Year Average Peak Demand (11)				2,835
15	2015 Peak Demand Reduction Benchmark % [4]				5.50%
16	**2015 Peak Demand Reduction Benchmark (14)*(15)**				**155.9**

[1] Peak demand for the period 2012-2014 is reported in PUCO Form FE-D3.
See Workpaper B.

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

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

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

THE DAYTON POWER & LIGHT COMPANY
2015 Benchmark Report

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

		1	2	3	4	5	5a	6	7	8
	YEAR	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	TRANSPORTATION (a)	OTHER (b)	ENERGY EFFICIENCY & DEMAND RESPONSE	TOTAL END USER CONSUMPTION 1+2+3+4+5-5a	LOSSES AND UNACCOUNTED FOR	NET ENERGY FOR LOAD 6+7
-5	2011	5,424,545	3,713,941	3,560,411	817	1,428,005		14,127,719	400,646	14,528,365
-4	2012	5,181,338	3,698,607	3,650,639	1,625	1,404,461		13,936,670	455,260	14,391,930
-3	2013	5,226,437	3,697,532	3,552,428	3,913	1,349,658		13,829,968	400,670	14,230,638
-2	2014	5,344,082	3,714,874	3,651,720	3,336	1,310,285		14,024,297	396,028	14,420,325
-1	2015	5,187,751	3,742,101	3,684,745	3,885	1,302,505		13,920,987	271,748	14,192,735
0	2016	5,311,576	3,759,985	3,780,198	3,656	1,393,371	168,779	14,417,564	528,573	14,946,137
1	2017	5,392,184	3,817,047	3,837,566	3,711	1,414,517	324,114	14,789,139	530,808	15,319,947
2	2018	5,485,832	3,883,339	3,904,215	3,776	1,439,083	480,971	15,197,216	534,272	15,731,488
3	2019	5,536,213	3,919,002	3,940,070	3,810	1,452,299	640,178	15,491,573	533,389	16,024,962
4	2020	5,533,842	3,917,324	3,938,383	3,809	1,451,678	798,245	15,643,280	527,354	16,170,634
5	2021	5,543,029	3,923,827	3,944,921	3,815	1,454,088	953,849	15,823,529	522,548	16,346,077
6	2022	5,586,593	3,954,666	3,975,925	3,845	1,465,516	1,107,879	16,094,424	521,184	16,615,608
7	2023	5,629,565	3,985,085	4,006,508	3,875	1,476,788	1,260,178	16,361,998	519,825	16,881,823
8	2024	5,693,874	4,030,608	4,052,276	3,919	1,493,658	1,409,573	16,683,908	520,674	17,204,582
9	2025	5,728,547	4,055,153	4,076,953	3,943	1,502,754	1,555,139	16,922,489	518,745	17,441,234
10	2026	5,777,446	4,089,768	4,111,753	3,976	1,515,582	1,696,339	17,194,864	518,377	17,713,241

(a) Transportation includes railroads & railways.

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

THE DAYTON POWER & LIGHT COMPANY
2015 Benchmark Report

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

	Native Load					Internal Load			
	Year	Summer	Demand Response	Net Summer	Winter (a)	Summer	Demand Response	Net Summer	Winter (a)
-5	2011	3146			2329	3146			2329
-4	2012	3046			2424	3046			2424
-3	2013	2937			2777	2937			2777
-2	2014	2756			2568	2756			2568
-1	2015	2845			2453	2845			2453
0	2016	2927	110	2817	2527	2927	110	2817	2527
1	2017	2970	133	2837	2574	2970	133	2837	2574
2	2018	3007	156	2851	2602	3007	156	2851	2602
3	2019	3031	180	2851	2595	3031	180	2851	2595
4	2020	3020	203	2817	2596	3020	203	2817	2596
5	2021	3032	226	2806	2610	3032	226	2806	2610
6	2022	3051	248	2803	2631	3051	248	2803	2631
7	2023	3068	270	2798	2651	3068	270	2798	2651
8	2024	3095	269	2826	2667	3095	269	2826	2667
9	2025	3115	267	2848	2685	3115	267	2848	2685
10	2026	3136	266	2870	2707	3136	266	2870	2707

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

THE DAYTON POWER AND LIGHT COMPANY
2015 Benchmark Report
Adjustment for Mercantile Customers

		Demand Savings (kW)			Energy Savings (kWh)		
Ln	Customer	2012	2013	2014	2012	2013	2014
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	2,053.1	2,257.1	2,473.6	10,553,662	11,777,911	13,169,576
20	**Total 2011 Adjustment**	**2,935.6**	**3,139.6**	**3,356.1**	**14,496,825**	**15,721,074**	**17,112,739**
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, and 2015 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
2015 Benchmark Report
Adjustment for Mercantile Customers

		Demand Savings (kW)			Energy Savings (kWh)		
Ln	Customer	2012	2013	2014	2012	2013	2014
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	127,922	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	189,623	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	-	128,859	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	22,615	56,845	56,845
55	Customer AS	6.5	6.5	6.5	35,395	35,395	35,395
56	Customer AT	88.8	193.0	193.0	170,839	420,485	420,485
57	Customer AU	-	29.1	29.1	-	46,409	59,532
58	Customer AV	19.2	23.1	23.1	250,906	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**	**2,963.6**	**3,313.4**	**3,313.4**	**8,177,321**	**8,698,066**	**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	-	62,182	62,687
66	Customer BA	-	3.7	3.7	915	7,004	7,004
67	Customer BB	1.6	2.5	2.5	3,403	5,850	5,850
68	Customer BC	-	2.3	2.3	47,717	188,773	188,773
69	Customer BD	-	37.2	37.2	-	99,294	198,588
70	Customer BE	-	-	30.5	-	-	367,804
71	Customer BF	-	10.6	10.6	-	44,362	115,403
72	Customer BG	-	-	30.0	-	37,922	135,168
73	Customer BH	-	308.3	308.3	4,132	139,753	139,753
74	Customer BI	-	62.7	62.7	-	366,243	427,286
75	Customer BJ	-	-	41.8	-	4,208	173,925
76	Customer BK	-	-	40.0	-	-	214,461
77	Customer BL	-	7.1	7.1	-	18,592	44,055
78	Customer BM	-	30.7	30.7	11,897	138,154	138,154
79	**Total 2014 Adjustment**	**1,167.4**	**1,861.4**	**2,003.7**	**295,219**	**1,339,492**	**2,446,066**

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THE DAYTON POWER AND LIGHT COMPANY
2015 Benchmark Report
Adjustment for Mercantile Customers

		Demand Savings (kW)			Energy Savings (kWh)		
Ln	Customer	2012	2013	2014	2012	2013	2014
80	**2015 Mercantile Customer Adjustment ***						
81	Customer BN	-	-	22.9	-	-	55,295
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	-	-	24,453
85	Customer BR	-	200.9	200.9	-	1,216,257	1,615,884
86	Customer BS	-	-	-	3,391	39,384	39,384
87	Customer BT	-	-	8.0	-	-	32,740
88	Customer BU	-	-	-	-	-	218
89	Customer BV	-	-	-	-	-	731,528
90	Customer BW	-	-	-	-	-	1,647
91	Customer BX	-	14.3	15.6	8,933	146,396	245,924
92	Customer BY	-	295.7	295.7	-	171,058	462,249
93	**Total 2015 Adjustment**	**269.2**	**780.1**	**812.5**	**311,743.0**	**1,872,514.0**	**3,508,741.0**
94							
95	**Total Adjustment (All Years)**	**12,764.9**	**14,523.6**	**14,914.8**	**34,587,973.3**	**38,938,011.0**	**43,110,820.6**

* These Mercantile Applications (except the EER exemption applications) were approved by the Commission in 2010, 2011, 2012, 2013, 2014, and 2015 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
2015 Benchmark Report
2012 Weather Normalization

2012 Actual Calendar Retail Sales

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YTD	
Residential Non-Heating	329,303	260,920	236,382	201,656	270,233	340,123	459,607	418,632	213,603	196,142	269,131	296,898	3,492,630	
Residential Heating	243,991	197,327	134,751	103,378	104,160	112,887	141,893	112,739	92,222	112,065	169,646	195,421	1,720,480	**Peak**
Total Residential	**573,294**	**458,247**	**371,133**	**305,034**	**374,393**	**453,010**	**601,500**	**531,371**	**305,825**	**308,207**	**438,777**	**492,319**	**5,213,110**	MW
														July
Commercial	314,708	284,805	279,806	278,358	318,225	341,967	371,142	351,883	303,745	300,496	272,913	291,068	3,709,116	Actual
Industrial	300,825	308,639	293,420	301,278	338,663	311,766	326,712	306,547	309,384	324,197	273,857	272,105	3,667,393	**3046**
Public Authorities	113,426	104,904	102,945	103,948	116,891	114,807	130,904	120,297	118,697	111,400	98,157	103,651	1,340,027	
Street Railway	110	161	144	131	135	145	126	133	134	130	149	137	1,635	Load Factor[1]
Street Lighting	6,156	5,695	5,639	5,488	5,620	5,417	5,273	5,477	5,466	5,802	5,571	5,910	67,514	55.55%
Total Non-Residential	**735,225**	**704,204**	**681,954**	**689,203**	**779,534**	**774,102**	**834,157**	**784,337**	**737,426**	**742,025**	**650,647**	**672,871**	**8,785,685**	
Total Retail	**1,308,519**	**1,162,451**	**1,053,087**	**994,237**	**1,153,927**	**1,227,112**	**1,435,657**	**1,315,708**	**1,043,251**	**1,050,232**	**1,089,424**	**1,165,190**	**13,998,795**	

2012 WN Calendar Retail Sales

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YTD	
Residential Non-Heating	343,285	275,532	254,842	209,117	210,663	292,106	323,008	402,351	213,966	193,718	265,049	319,630	3,303,267	
Residential Heating	274,576	232,396	215,869	110,804	92,445	102,468	111,216	109,073	90,846	105,733	159,815	250,812	1,856,053	
Total Residential	**617,861**	**507,928**	**470,711**	**319,921**	**303,108**	**394,574**	**434,224**	**511,424**	**304,812**	**299,451**	**424,864**	**570,442**	**5,159,320**	**WN Peak[2]**
														MW
Commercial	326,725	293,741	274,647	278,687	294,259	331,512	334,485	347,512	312,018	300,496	271,907	303,863	3,669,852	July
Industrial	300,825	308,639	293,420	301,278	338,663	311,766	326,712	306,547	309,384	324,197	273,857	272,105	3,667,393	WN
Public Authorities	115,910	105,368	102,945	103,948	114,712	113,622	127,316	119,869	119,304	111,400	98,157	103,651	1,336,202	**2872**
Street Railway	110	161	144	131	135	145	126	133	134	130	149	137	1,635	
Street Lighting	6,156	5,695	5,639	5,488	5,620	5,417	5,273	5,477	5,466	5,802	5,571	5,910	67,514	
Total Non-Residential	**749,726**	**713,604**	**676,795**	**689,532**	**753,389**	**762,462**	**793,912**	**779,538**	**746,306**	**742,025**	**649,641**	**685,666**	**8,742,596**	
Total WN Retail Sales	**1,367,587**	**1,221,532**	**1,147,506**	**1,009,453**	**1,056,497**	**1,157,036**	**1,228,136**	**1,290,962**	**1,051,118**	**1,041,476**	**1,074,505**	**1,256,108**	**13,901,916**	

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]

DAYTON POWER & LIGHT COMPANY
2015 Benchmark Report
2013 Weather Normalization

2013 Actual Calendar Retail Sales

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YTD
Residential Non-Heating	316,265	265,323	274,263	230,274	233,045	307,448	347,834	374,566	257,868	212,217	263,008	319,853	3,401,964
Residential Heating	244,843	224,362	214,782	126,429	96,382	104,859	115,411	115,331	95,137	107,897	178,491	234,720	1,858,644
Total Residential	**561,108**	**489,685**	**489,045**	**356,703**	**329,427**	**412,307**	**463,245**	**489,897**	**353,005**	**320,114**	**441,499**	**554,573**	**5,260,608**
Commercial	302,243	282,791	295,728	273,880	314,703	326,453	348,457	350,708	310,784	312,051	289,055	299,216	3,706,069
Industrial	273,439	265,924	291,120	281,472	322,820	303,780	314,784	324,711	300,197	328,967	285,983	261,106	3,554,303
Public Authorities	112,144	99,403	109,967	101,361	116,320	112,968	123,388	117,770	116,384	114,881	101,596	101,307	1,327,489
Street Railway	195	372	379	343	259	314	321	348	297	334	344	408	3,914
Street Lighting	5,865	5,587	1,439	1,193	1,358	1,220	1,153	1,364	1,263	1,588	1,425	1,729	25,184
Total Non-Residential	**693,886**	**654,077**	**698,633**	**658,249**	**755,460**	**744,735**	**788,103**	**794,901**	**728,925**	**757,821**	**678,403**	**663,766**	**8,616,959**
Total Retail	**1,254,994**	**1,143,762**	**1,187,678**	**1,014,952**	**1,084,887**	**1,157,042**	**1,251,348**	**1,284,798**	**1,081,930**	**1,077,935**	**1,119,902**	**1,218,339**	**13,877,567**

Peak
MW
September
Actual
2937

Load Factor[1]
51.16%

2013 WN Calendar Retail Sales

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YTD
Residential Non-Heating	330,314	266,267	259,773	230,185	192,962	290,787	353,720	356,576	228,336	196,959	256,617	324,156	3,286,652
Residential Heating	275,909	226,545	175,541	134,969	87,687	101,299	116,817	111,432	88,357	108,932	162,939	245,010	1,835,437
Total Residential	**606,223**	**492,812**	**435,314**	**365,154**	**280,649**	**392,086**	**470,537**	**468,008**	**316,693**	**305,891**	**419,556**	**569,166**	**5,122,089**
Commercial	314,351	283,522	289,327	273,880	302,919	323,241	350,395	346,903	305,347	305,906	287,364	302,226	3,685,381
Industrial	273,439	265,924	291,120	281,472	322,820	303,780	314,784	324,711	300,197	328,967	285,983	261,106	3,554,303
Public Authorities	114,664	99,517	109,967	101,361	115,164	112,564	123,552	117,323	115,742	113,885	101,596	101,631	1,326,966
Street Railway	195	372	379	343	259	314	321	348	297	334	344	408	3,914
Street Lighting	5,865	5,587	1,439	1,193	1,358	1,220	1,153	1,364	1,263	1,588	1,425	1,729	25,184
Total Non-Residential	**708,514**	**654,922**	**692,232**	**658,249**	**742,520**	**741,119**	**790,205**	**790,649**	**722,846**	**750,680**	**676,712**	**667,100**	**8,595,748**
Total WN Retail Sales	**1,314,737**	**1,147,734**	**1,127,546**	**1,023,403**	**1,023,169**	**1,133,205**	**1,260,742**	**1,258,657**	**1,039,539**	**1,056,571**	**1,096,268**	**1,236,266**	**13,717,837**

WN Peak[2]
MW
September
WN
2822

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]**

DAYTON POWER & LIGHT COMPANY
2015 Benchmark Report
2014 Weather Normalization

2014 Actual Calendar Retail Sales

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YTD
Residential Non-Heating	344,066	302,806	270,713	213,384	230,895	320,599	333,323	327,616	256,978	191,194	268,178	318,492	3,378,244
Residential Heating	316,577	260,233	219,245	119,438	103,018	106,794	108,817	109,872	91,454	104,127	184,568	228,003	1,952,146
Total Residential	**660,643**	**563,039**	**489,958**	**332,822**	**333,913**	**427,393**	**442,140**	**437,488**	**348,432**	**295,321**	**452,746**	**546,495**	**5,330,390**
Commercial	327,879	294,965	301,979	268,523	306,704	334,330	343,401	337,738	303,818	301,823	286,924	305,103	3,713,187
Industrial	296,466	267,929	300,504	291,207	314,237	322,997	308,066	325,156	303,563	352,938	298,939	270,385	3,652,387
Public Authorities	111,264	99,422	107,511	99,471	113,973	111,794	116,665	117,156	110,431	107,621	95,748	98,743	1,289,799
Street Railway	397	391	371	310	291	255	493	(15)	276	305	299	333	3,706
Street Lighting	1,728	1,399	1,397	1,175	1,406	1,242	1,153	1,268	1,215	1,539	1,405	1,730	16,657
Total Non-Residential	**737,734**	**664,106**	**711,762**	**660,686**	**736,611**	**770,618**	**769,778**	**781,303**	**719,303**	**764,226**	**683,315**	**676,294**	**8,675,736**
Total Retail	**1,398,377**	**1,227,145**	**1,201,720**	**993,508**	**1,070,524**	**1,198,011**	**1,211,918**	**1,218,791**	**1,067,735**	**1,059,547**	**1,136,061**	**1,222,789**	**14,006,126**

Peak
MW
September
Actual
2756

Load Factor[1]
53.81%

2014 WN Calendar Retail Sales

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YTD
Residential Non-Heating	327,685	285,470	259,874	224,237	183,707	262,196	414,365	289,300	258,009	195,780	253,936	331,397	3,285,956
Residential Heating	285,784	223,070	188,822	137,411	91,643	93,499	127,399	101,191	91,331	109,298	149,425	259,493	1,858,366
Total Residential	**613,469**	**508,540**	**448,696**	**361,648**	**275,350**	**355,695**	**541,764**	**390,491**	**349,340**	**305,078**	**403,361**	**590,890**	**5,144,322**
Commercial	310,071	278,917	297,451	268,523	295,232	318,773	365,784	327,720	308,666	301,224	282,289	313,368	3,668,018
Industrial	296,466	267,929	300,504	291,207	314,237	322,997	308,066	325,156	303,563	352,938	298,939	270,385	3,652,387
Public Authorities	111,264	99,422	107,511	99,471	113,973	111,794	116,665	117,156	110,431	107,621	95,748	98,743	1,289,799
Street Railway	397	391	371	310	291	255	493	(15)	276	305	299	333	3,706
Street Lighting	1,728	1,399	1,397	1,175	1,406	1,242	1,153	1,268	1,215	1,539	1,405	1,730	16,657
Total Non-Residential	**719,926**	**648,058**	**707,234**	**660,686**	**725,139**	**755,061**	**792,161**	**771,285**	**724,151**	**763,627**	**678,680**	**684,559**	**8,630,567**
Total WN Retail Sales	**1,333,395**	**1,156,598**	**1,155,930**	**1,022,334**	**1,000,489**	**1,110,756**	**1,333,925**	**1,161,776**	**1,073,491**	**1,068,705**	**1,082,041**	**1,275,449**	**13,774,889**

WN Peak[2]
MW
September
WN
2771

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]**

THE DAYTON POWER & LIGHT COMPANY
2015 Benchmark Report
Weather Normalization Factors

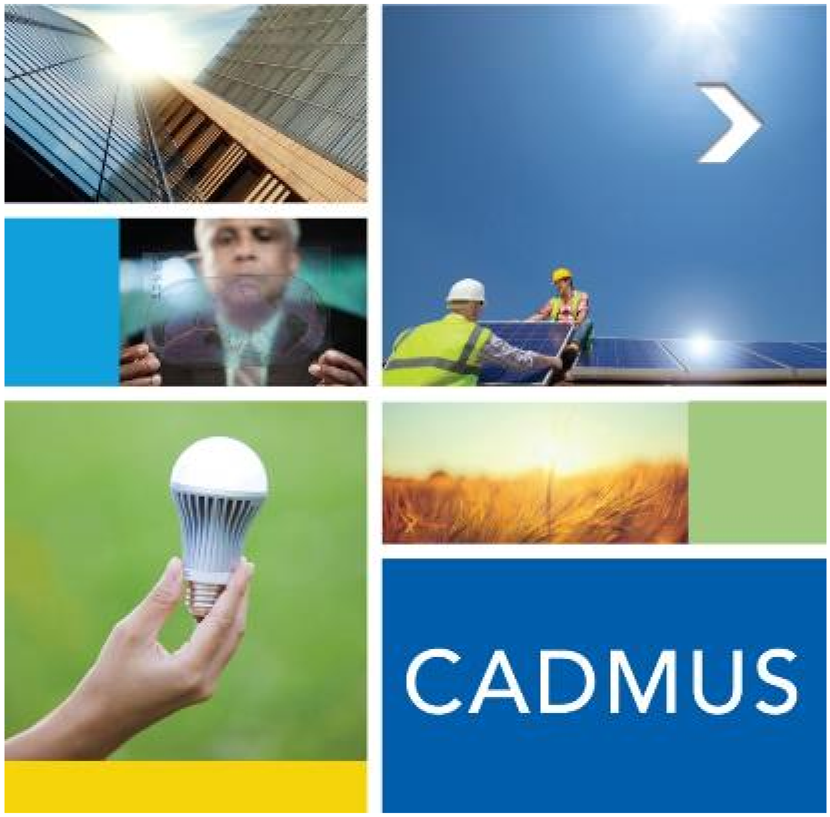
Year	Actual Calendar Retail Sales[1]	Weather Normalized Retail Sales[2]	Energy Weather Normalization Factor[3]
	(a)	(b)	(c)
2012	13,998,795	13,901,916	0.99308
2013	13,877,567	13,717,837	0.98849
2014	14,006,126	13,774,889	0.98349

	Actual System Peak Demands[1]	Weather Normalized Peak Demands[2]	Demand Weather Normalization Factor[3]
2012	3,046	2,872	0.94288
2013	2,937	2,822	0.96084
2014	2,756	2,771	1.00544

[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).



2015 Evaluation, Measurement, and Verification Report

May 12, 2016

Dayton Power and Light
1900 Dryden Rd,
Dayton, Ohio 45439

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CADMUS

Prepared by:
Cadmus

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Executive Summary

In 2013, Dayton Power and Light (DP&L) filed a three-year Energy Efficiency and Demand Response Plan outlining a portfolio of residential and business programs in response to Senate Bill 221 (S.B. 221). This plan articulated the continuation of programs established in DP&L's first three-year portfolio plan, filed in 2010 and ultimately approved by the Public Utilities Commission of Ohio.

DP&L selected Cadmus to evaluate its residential and commercial energy-efficiency portfolio for the 2015 program year. This document summarizes the results from evaluation of the 2015 programs.

Primary impact evaluation objectives included the following:

- Assess the appropriateness of the programs' gross *ex ante* claimed savings;
- Calculate gross *ex post* saving estimates; and
- Determine program and portfolio cost-effectiveness.

Primary process evaluation objectives included:

- Assess overall satisfaction with select programs; and
- Identify any program design and delivery changes that would improve performance with select programs.

Table 1 provides saving results by program, both as *ex ante* claimed and evaluated adjusted gross. Adjusted gross energy savings exceeded filed program goals (112%). Adjusted gross demand reduction fell just shy of the filed program goals with 91% of the demand reduction goal.

Table 1. Portfolio Evaluation Results

Program	2015 Program Goals		*Ex Ante* Claimed Savings		Verified Gross Savings		Adjusted Gross Savings	
	kWh	kW	kWh	kW	kWh	kW	kWh	kW
Residential								
Lighting	50,573,236	6,044	50,864,843	6,088	51,346,721	6,146	50,413,429	5,311
Appliance Recycling	4,273,944	757	5,232,325	817	5,144,135	797	3,620,470	567
Low-Income (OPAE)*	1,083,240	162	1,536,221	195	1,536,221	195	1,345,730	170
HVAC Rebates	8,814,339	2,712	9,602,721	1,656	9,602,721	1,656	9,490,639	1,619
Be E3 Smart	2,376,762	20	4,204,437	287	4,204,437	287	4,162,367	281
Commercial and Industrial								
Prescriptive	54,446,250	9,636	78,555,936	13,040	76,628,434	12,617	80,583,691	11,882
Custom	28,143,971	5,163	16,483,813	2,126	16,483,813	2,126	16,561,765	2,029
Pilot Programs								
Small Business Direct Install (SBDI)	Not Filed**	Not Filed**	854,829	299	854,829	299	776,118	313
Appliance Rebate	Not Filed**	Not Filed**	476,548	65	476,548	65	528,883	49
Low-Income (PWC)*	Not Filed**	Not Filed**	157,974	24	157,974	24	157,974	24
Total	**149,711,742**	**24,498**	**167,969,648**	**24,596**	**166,435,834**	**24,210**	**167,641,066**	**22,244**

*Two Low Income Weatherization programs were implemented in 2015: one by the Ohio Partners for Affordable Energy (OPAE) and one by People Working Cooperatively (PWC).
**Pilot program funding was established in the 2013–2015 Portfolio Plan, but energy saving goals were not established.

Table 2 provides program and portfolio-level realization rates, comparing adjusted gross savings and demand reduction against *ex ante*.

Table 2. Portfolio Realization Rates

Program	kWh	kW
Residential		
Lighting	99%	87%
Appliance Recycling	69%	69%
Low-Income (OPAE)	88%	88%
HVAC Rebates	99%	98%
Be E3 Smart	99%	98%
Non-Residential		
Prescriptive	103%	91%
Custom	100%	95%
Pilot Programs		
Small Business Direct Install	91%	105%
Appliance Rebate	111%	75%
Low-Income (PWC)	100%	100%
Total	**100%**	**90%**

Cadmus found portfolio-level realization rates of 100% for energy and 90% for demand reductions, compared to *ex ante* claimed savings. Both the energy and demand realization rates align with realization rates observed in previous evaluation efforts. The demand realization rate has consistently fallen below the energy realization rates. Low demand realization rates for almost every program drove this trend: eight out of ten programs had demand realization rates below 100%. The *ex ante* savings adhere to outdated assumptions in the Ohio Technical Reference Manual (TRM). Applying the Ohio TRM savings is a reasonable approach for DP&L and adheres to Ohio Commission policy. However, some of the Ohio TRM's inaccurate assumptions and methodologies drive a significant portion of the low program realization rates.

The Residential Lighting and Nonresidential Prescriptive programs have the most significant impact on the portfolio demand reduction, accounting for about three-quarters of portfolio adjusted demand reduction. The portfolio demand reduction realization rate of 90% was caused by lower evaluated coincidence factors and a smaller percentage of residential bulbs allocated to the commercial program than previous years. Figure 1 and Figure 2 provide additional details.

Figure 1. Historical Portfolio-Level *Ex Ante* and Adjusted Gross kWh Savings Realization Rates

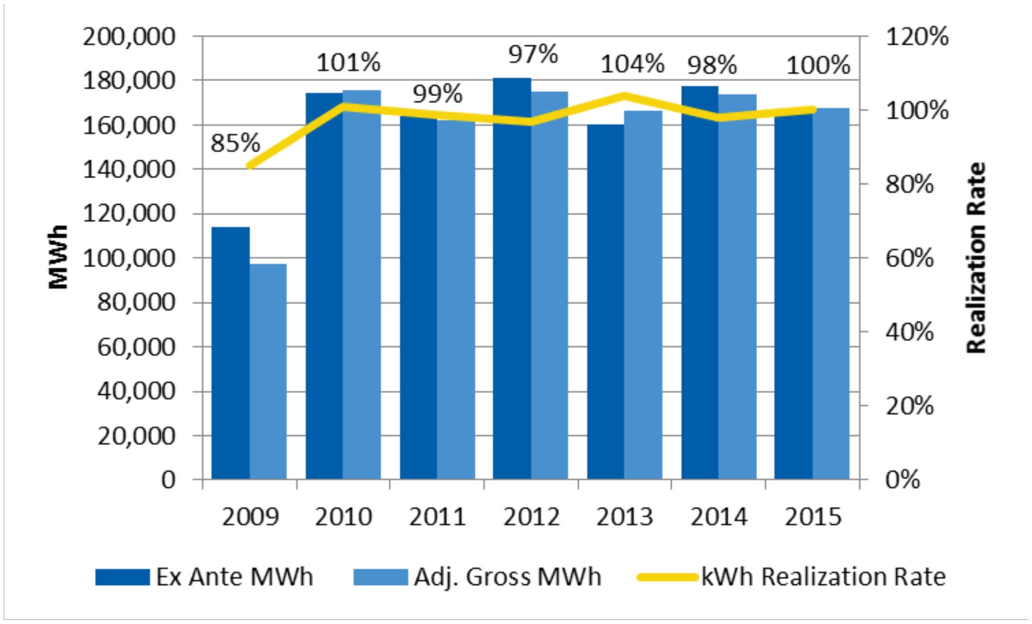
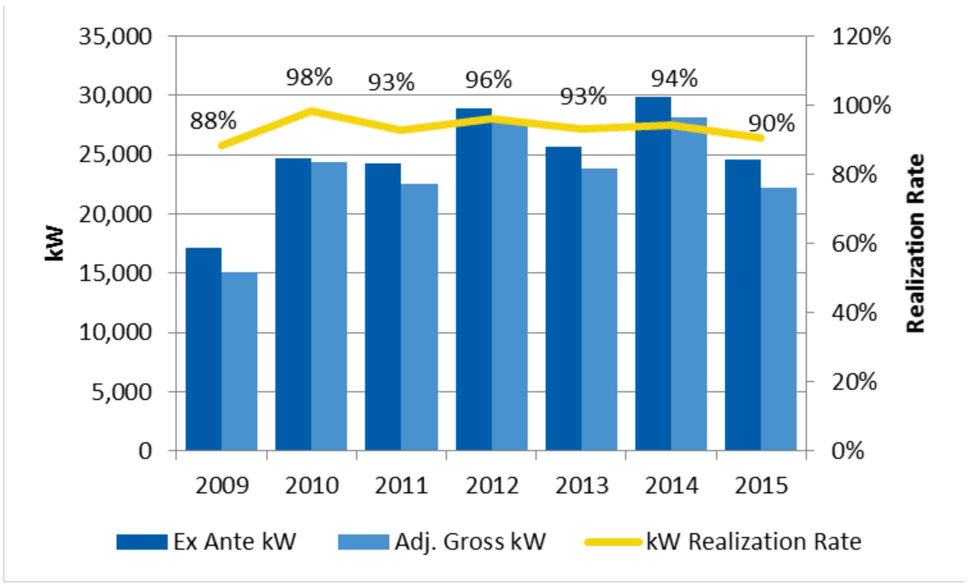


Figure 2. Historical Portfolio-Level *Ex Ante* and Adjusted Gross kW Savings Realization Rates



In general, DP&L has achieved realization rates very close to 100% for energy savings and just slightly under that for demand in all years, except 2009 (when the programs started). In general, differences between *ex ante* claimed and adjusted gross saving resulted from differences in calculation methodology, data sources available at the time, or both.

Of the seven programs with filed kWh goals, five achieved them (compared against adjusted gross savings). Exceptions included the Appliance Recycling and Nonresidential Custom programs. These programs produced less-than-expected savings. The Nonresidential Custom program participation fluctuates each year and was lower than previous years in 2015. For the Appliance Recycling program, the overall trend in decreased unit age and the energy standards of the early 1990s made a large impact on decreased savings per unit.

The overall portfolio proved cost-effective, with a total resource cost (TRC) of 1.78 and a utility cost test (UCT) of 3.51. As with the previous evaluation, individual residential programs fell below the 1.0 TRC benefit/cost ratio, including the Residential HVAC Rebate and the Residential Low Income programs. The HVAC Rebate program, however, proved cost-effective for the UCT. The Nonresidential Prescriptive, Custom and SBDI programs proved cost-effective from both TRC and UCT perspectives. Consistent with the previous two evaluations, Cadmus used *ex ante* savings to calculate cost-effectiveness results.

Cadmus primarily focused 2015 process activities on the newer programs to determine customer satisfaction, identify potential program design improvements and refine impact evaluation parameters. Cadmus investigated the nonresidential midstream lighting channel by implementing an online survey. The survey collected primary data from program participants which informed the analysis to determine a program-level in-service rate. Surveys and interviews from previous evaluations for the longer standing programs, such as the Residential Lighting and Nonresidential Prescriptive programs, have consistently shown trends of high satisfaction levels for most delivery elements (e.g., rebate amounts, energy savings, incented equipment, and overall program experiences).

Cadmus performed a billing analysis of the long-running low income program implemented by OPAE. The billing analysis largely confirmed the *ex ante* savings, revealing an energy and demand realization rate of 88%. The billing analysis results show that refrigerator, freezer, lighting, and HVAC *ex ante* savings estimates are reasonable, while the air sealing, insulation, and water-heating ex ante savings may be overestimating actual savings.

DP&L continued to diversify its portfolio, adding two residential pilot programs (Appliance Rebate and a second Low-Income program implemented by PWC) and completing the nonresidential SBDI pilot program that kicked-off in 2014. Both the impact and process evaluation pieces revealed a successful first year for the Appliance Rebate pilot: the program's *ex ante* and adjusted savings exceeded energy savings goals and interviews and surveys suggest a smooth program design and implementation with satisfied customers. The evaluation found that PWC's Low-Income program experienced a slow start: the program had difficulty identifying eligible participants that were DP&L customers with electric heat and there was a disconnect between DP&L and PWC regarding data collection expectations. After few check-in meetings with DP&L, PWC and Cadmus, the program made some adjustments and showed momentum closing out 2015.

Conclusions

DP&L has historically utilized the evaluation process to its fullest extent. Each year, as evaluations provide feedback, DP&L has adjusted program design and delivery accordingly. DP&L has effectively optimized evaluation results and recommendations to enhance the delivery of their services to program participants. As a result, realization rates have been converging to near 100%.

Using deemed values to estimate project savings that are based on the best, current knowledge is common, industry practice. In some cases, these savings estimates prove inaccurate for individual projects or measures, but in aggregate they estimate overall savings well. Evaluation results for these projects provide timely feedback to make course corrections either in the delivery method or the estimated savings. DP&L has always been exemplary in utilizing these evaluation results to make such corrections across the portfolio and for individual programs.

The Ohio TRM was established in 2010 for electric and gas utilities in the state of Ohio. The intention of the TRM was to provide a consistent framework for characterizing measure level energy estimates and assumptions for electric and gas utilities to use for planning and reporting purposes. Many utilities, including DP&L, use the TRM to forecast measure level saving estimates and impacts. The TRM was developed with the best, current information and also provided recommendations for ongoing updates and maintenance. However, few updates have been made since the document's inception, resulting in many out of date savings assumptions and/or data. This outdated information drives much of DP&L's low measure realization rates because the evaluated savings employ updated assumptions and data. Cadmus recommends the Public Utility Commission of Ohio investigate options for updating the TRM.

In summary, Cadmus found DP&L's overall accounting of energy savings and demand reduction to adhere to best practices and found nothing beyond what, in our professional opinion, is expected. As is normal, Cadmus identified areas where incremental changes could improve program offerings and implementation, and are noted throughout the evaluation report.

Introduction and Purpose of the Study

For the impact evaluations, Cadmus assessed and documented program savings, including the *gross* savings relative to *ex ante* claimed saving values.

For the process evaluations, Cadmus sought to achieve the following:

- Document satisfaction and feedback from the perspectives of participants, and program and implementation staff for select programs
- Provide timely feedback to enable program process improvements

Table 3 provides the evaluation effort's general researchable questions and supporting activities. The sections that follow present program-specific researchable questions.

Table 3. 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 • Participant customer surveys • Program database review
How effective have the programs been in recruiting and training market actors?	• Program and implementation staff interviews
What barriers exist to increased customer participation, and how effectively do the programs address those barriers?	• Program and implementation staff interviews • Participant customer surveys
What gross and demand reductions did the programs achieve?	• Program database review • Data verification • Site visits • Telephone surveys • Engineering analysis • Billing analysis • Regression analysis
How satisfied were customer and market actors with the program?	• Participant customer surveys
Were the programs cost-effective? Was the portfolio cost-effective?	• Cost-effectiveness tests

Overall Evaluation Methodology

Cadmus evaluated each program using a unique set of techniques and activities. Primary evaluation activities included the following:

- Using engineering calculations to verify program *ex ante* claimed savings and to determine adjusted program gross kWh savings and kW reductions.
- Performing site visits to verify measure installations.

- Conducting a detailed review of project documentation, calculations, audit reports, and assumptions.
- Conducting telephone surveys with participants to evaluate program processes and to inform the impact evaluation.
- Conducting a billing analysis for low-income participants.
- Benchmarking important metrics from each program evaluation against those from recent comparable programs to provide additional context in interpreting the results.

The tables in the program sections below present the following:

- ***Ex Ante* Claimed Gross Savings:** Savings based on *ex ante* participation and calculation assumptions. Dayton Power and Light (DP&L) used multiple sources for claimed savings—primarily the State of Ohio Energy Efficiency Technical Reference Manual (Ohio TRM),[1] 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 J 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 phone or on-site verification. The unit energy savings (UES) estimation approach (e.g., Ohio TRM or deemed savings) remained the same as *ex ante* claimed savings.
- **Adjusted Gross Savings:** Savings due to adjustments in *ex ante* participation, based on phone 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.[2]

Adjusted gross savings represent 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.

1 The Ohio TRM was filed August 6, 2010, under Case No. 09-0512-GE-UNC.

2 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 PUCO Case No. 09-512-GE-UNC (*Ohio TRM Joint Objections and Comments*). Where appropriate, the text notes this.

Threats to Validity

Known threats to this evaluation's validity, possible bias sources, and the methods used to address these issues include the following:

- For the Appliance Recycling Program (ARP), Cadmus assessed sources of uncertainty and bias resulting from differences in the implementer's assessment of appliance characteristics, specifically the age and usage of units. Implementer staff may receive different training in regard to recognizing qualifying units (e.g., age, working condition), all of which would be uploaded into the tracking database, thus potentially causing bias.
- Across all programs, to address telephone survey nonresponse bias, Cadmus utilized survey best practices, including: calling at different times of day; calling on weekends; and scheduling callbacks.
- In all cases using regression models, Cadmus made every attempt to guard against errors associated with omitted variables, improper functional forms, and inclusion of erroneous data.
- Across all program, Cadmus implemented thorough quality control processes, ensuring multiple reviews and reviewers for every analysis and write-up.
- The new pilot programs introduce uncertainty into the evaluation by virtue of the limited years of data: DP&L and the evaluation team have less history with these program compared to some of the longer running programs. The evaluation addressed this inherent uncertainty by increasing scrutiny through the process evaluation activities.

Description of Programs Covered in Study

In 2015, DP&L offered 10 programs: five residential, two commercial and industrial, and three pilot programs (the evaluation did not include mercantile customer participation or associated savings, but Cadmus did calculate cost-effectiveness for this program). Table 4 provides reported participation, per program.

Table 4. Claimed Program Participants

Program	Reported Quantity	Unit Type
Lighting	1,584,471	CFLs and LEDs sold*
Appliance Recycling	3,610 / 82	Appliances recycled in residential / nonresidential applications
Low-Income (OPAE)	568	Homes
HVAC Rebate	8,438	Equipment rebated
Be E3 Smart	9,298	Energy Education Kits Distributed
Prescriptive	1,257 / 75,235 / 79,224	Prescriptive projects completed / Midstream lamps sold / Upstream lamps sold
Custom	114	Projects completed
SBDI	46 / 54	100% / 75% rebate projects completed
Appliance Rebate	2,844	Rebates
Low-Income (PWC)	175	Projects completed

*Reflects 95% of all bulbs sold through the Residential Lighting Program. The remaining 5% were allocated to the nonresidential prescriptive program's *ex ante* savings.

The 2015 *DP&L Annual Portfolio Status Report* presents program overviews in the program-specific sections.

Appliance Rebate Pilot Program

This chapter describes the evaluation approach, detailed findings, conclusions, and recommendations for the Residential Appliance Rebate Pilot Program. Piloted for the first time in 2015, the Residential Appliance Rebate pilot was designed to increase awareness and sales of ENERGY STAR refrigerators, clothes washers, and Wi-Fi enabled thermostats by offering rebates following purchases. The program offered a rebate of $50 for each ENERGY STAR-certified appliance. The program limited rebate eligibility for up to two quantities of each appliance type. Qualifying appliances included residential clothes washers, refrigerators, and Wi-Fi thermostats. To qualify, applicants were required to be residential customers within DP&L's service territory and were required to purchase eligible appliances between July 1, 2015, and October 31, 2015. The applicant could submit a paper or online application.

Evaluation Overview

Table 5. Key Researchable Questions

Researchable Question	Activity Used to Address Question
What gross electric savings and peak demand reductions result?	• Participant customer surveys
What are customer satisfaction levels with the rebate program?	• Participant customer surveys
Was it simple to obtain and provide the information required to receive rebates?	• Participant customer surveys • Stakeholder interviews
What are the most common ways customers are finding out about the promotion?	• Participant customer surveys • Stakeholder interviews
Is the pilot cost-effective?	• Cost-effectiveness analysis

Detailed Evaluation Findings

DP&L surpassed its participation goal of engaging 2,250 participants (achieving 2,812 unique pilot program participants). The program nearly exceeded its contracted savings goals of 380,000 kWh and 50 kW[3] by achieving 528,883kWh in adjusted savings and 48.80kW in adjusted demand reduction. Adjusted gross savings represented realization rates of 111% and 28% against *ex ante* claimed energy savings and demand reduction, respectively.

DP&L met four program objectives through the pilot program's launch:

- Promoting ENERGY STAR-rated appliances
- Cultivating customer satisfaction
- Helping families save energy
- Promoting awareness of DP&L's other energy efficiency programs

[3] These goals were not filed with Public Utilities Commission of Ohio

The following key findings relate to the impact and process evaluation:

- Table 6 provides program *ex ante* claimed, verified, and adjusted gross savings and demand reduction, broken down by appliance type.

Table 6. Residential Appliance Program Claimed and Achieved Energy Savings

Appliance Type	*Ex Ante* Claimed Savings		Verified Gross Savings		Adjusted Gross Savings		
	kWh	kW	kWh	kW	kWh	kW	Precision*
Refrigerators	156,626	28	156,626	28	69,166	12	± 1.3%/± 14.2
Clothes Washers	271,488	38	271,488	38	345,751	37	± 12.6%/ ± 10.0
Wi-Fi Thermostats	48,434	0	48,434	0	113,966	0	± 22.2%/ N/A
Total**	**476,548**	**65**	**476,548**	**65**	**528,883**	**49**	± 9.5%

*Precision at 90% confidence.

**Values in table may not sum to 100% exactly due to rounding

Key Impact Evaluation Findings:

- Refrigerator *ex ante* savings proved much higher in comparison to adjusted gross savings due to the federal minimum efficiency standards used. The new minimum efficiency took effect in September 2014 for refrigerators (before the Appliance Rebate Program's launch date). Therefore, Cadmus used the minimum efficiency standards, based on the updated federal baseline, whereas the *ex ante* values referred to the 2010 Ohio TRM and the previous federal standard.
- Similarly for clothes washers, the new federal baseline took effect March 7, 2015, shortly before the Appliance Rebate Program's launch. Therefore, Cadmus used the minimum efficiency standards, based on the updated federal baseline, whereas the *ex ante* values refer to the 2010 Ohio TRM and the previous federal standard. The new federal standard baseline was based on new metrics for integrated modified energy factors (IMEF) and integrated water factor (IWF) as well as unit configurations (front loading vs. top loading). The new metrics are more comprehensive than previous MEF and water factor (WF) metrics- accounting for stand-by power consumption.
- Adjusted savings also varied from the *ex ante* savings because Cadmus employed algorithms from the Mid-Atlantic TRM to calculate savings for each rebated unit. The participant survey informed the savings calculations by providing inputs for the average number of annual wash cycles (311)—results similar to the 320 cycles per year listed in the 2010 Ohio TRM. Though the new federal baseline increased the minimum efficiency requirements, these changes resulted in increased energy savings and a slight decrease in demand reduction.
- Per direction from DP&L, CLEAResult based *ex ante* savings on the deemed savings values in the OHIO TRM for refrigerators and clothes washers and the Illinois TRM for Wi-Fi thermostat, respectively. Cadmus performed engineering analyses to calculate the adjusted gross savings for these measures.

- For Wi-Fi thermostats, adjusted savings increased in comparison to *ex ante* savings. As the 2010 Ohio TRM did not contain a savings methodology for Wi-Fi/smart thermostats, the *ex ante* savings referred to deemed savings values cited in the 2015 Illinois TRM. Due to weather-related factors, that influenced the heating and cooling system inputs needed for the savings algorithms, Cadmus used algorithms from the Wisconsin TRM v5.0 and replaced heating and cooling energy-savings fractions, heating system capacities, and system efficiency ratings, based on survey results and on findings from the Residential Heating and Cooling Rebate Program. Similar to DP&L's ex ante demand reduction calculation, Cadmus determined demand reductions of 0 kW for all thermostats because the evaluation could not identify a credible CF to calculate kW for this measure.

Key Findings of Process Evaluation:

- The online participant survey results (n=228) indicated the majority of participants (84%) were "highly satisfied" with the overall appliance rebate program. Twelve percent of surveyed participants were "somewhat satisfied" with the overall programs.
- Three percent of surveyed participants indicated they were "not too satisfied" or "not at all satisfied" with the program, stating that delays in receiving rebates caused their dissatisfaction. Most dissatisfied participants reported not receiving the rebate amounts for as long as two months from their application submission. This represented, however, a relatively small percentage of surveyed participants. Cadmus confirmed this, based on application post-mark dates and invoice issue dates (provided in the sample DP&L provided). As many as 96% of participants stated they were "very satisfied" or "somewhat satisfied" with the time required to receive rebate amounts following application submission. The majority of surveyed participants (85%) said they received the incentive check in less than six weeks from the application date.
- When asked about whether they visited DP&L's website to find methods for saving energy in their homes, 48% of survey respondents answered "yes." Of those visiting the website, 59% found it "very easy" to find relevant data and 34% found it "somewhat easy." Survey respondents offered the following suggestions to improve the website:
  - Assemble a centralized list of topics on same page
  - Provide intuitive and better headings to locate rebate information, other than "Save Money."
- When asked about customer satisfaction about appliances purchased, a majority of respondents said they were "very satisfied" with their new appliances (e.g., 80% of refrigerator purchasers; 82% of clothes washer purchasers; and 95% of Wi-Fi thermostat purchasers).
- Participants cited retailers, bill inserts, and DP&L's website as their top three sources for learning about the Appliance Rebate program: 62% of respondents learned of the program from retailers and store attendants; 20% learned of it through bill inserts; and 18% learned of it through DP&L's website.

Evaluation Data Collection Methods

In evaluating the 2015 program, Cadmus used the approaches discussed below.

Participant Survey

In two rounds (i.e., August and November), DP&L provided Cadmus with a list of all program participants. This list provided details about premise addresses, types of appliance purchased, makes and models of appliances, and whether rebate applications were submitted by postal mail or e-mail.

Based on this, Cadmus developed an online survey and asked program participants (via e-mail) to visit this survey to confirm their purchase of specific appliances. The survey asked participants about their existing counterpart appliances, their appliance-usage habits, and their experience with the rebate application and program in general. The e-mail survey went to all participants submitting the rebate application via e-mail and any participants listing their e-mail addresses.

The survey's design customized the survey questions for each respondent, asking only questions related to the relevant appliance type they purchased. Upon launch, the survey allowed participants two weeks to respond. A week after the launch, Cadmus sent e-mails to participants, reminding them about responding to the survey. After closing the survey, Cadmus summarized the results, identifying the frequencies for different answer choices. All survey respondents confirmed purchasing their appliance type, make, and model, with the results matching DP&L's records.

Engineering Analysis

Cadmus designed the survey instrument to identify type and manufacturer details for each appliance purchased per each unique participant and asked the participant to confirm the data's accuracy. Cadmus confirmed appliances' ENERGY STAR ratings, based on manufacturer names and model numbers.

The survey asked participants questions built around deriving input values for the savings algorithms. For example, the survey asked customers that purchased clothes washer about their average number of wash cycles per week. Cadmus used these data to calculate the average number of wash cycles per year per unit. For inputs that could not be confirmed based on survey findings, Cadmus relied on inputs listed in the 2010 Ohio TRM and the Mid-Atlantic TRM v5.0.

For savings associated with Wi-Fi thermostats, Cadmus relied on manufacturer data, but also drew information from the Residential Heating and Cooling Rebate Program analysis, the 2010 Ohio TRM, and the Mid-Atlantic TRM v5.0.

Stakeholder Interviews

Cadmus conducted two Appliance Rebate Program stakeholder interviews:

- One interview with two DP&L staff
- One interview with two implementer staff from CLEAResult

These interviews explored program design and implementation, marketing and outreach, program successes and challenges, and data tracking.

Impact Evaluation Methodology and Findings

The program offered rebates to customers who purchased ENERGY STAR certified appliances. Therefore, program-related energy savings resulted from an ENERGY STAR appliance that uses less energy than the federal standard baseline associated with the same appliance. To calculate savings related to refrigerators and clothes washers, Cadmus employed the federal standard baselines shown in Table 7.

Table 7. Summary of Baseline Updates

Baseline Efficiency Updates	Federal Standard Effective Date
Refrigerator	September 15, 2014
Clothes Washer	March 7, 2015

Refrigerators

Data Collection

Cadmus used model numbers of each rebated unit to obtain model parameters from the ENERGY STAR refrigerator database; these included:

- Verification of ENERGY STAR certification
- Annual energy use of each efficient unit
- Annual energy use of the federal baseline unit

Cadmus used these algorithms and inputs from the 2010 Ohio TRM in conjunction with savings listed for each model in the ENERGY STAR database of qualified products.

Analysis

Consistent with the implementation dates shown in Table 7, Cadmus used the recent federal standard, in place September 15, 2014, as the baseline for all units rebated. Cadmus also confirmed that the ENERGY STAR appliance database referred to the new federal baseline for calculating savings.

Table 8 shows algorithms used to calculate savings associated with purchasing ENERGY STAR refrigerators.

Table 8. Evaluated Savings Algorithms for Refrigerators

Parameter	Algorithm for Evaluated Energy Savings, kWh	Algorithm Source
Energy Savings Algorithm (kWh)	$\Delta kWh = kWh_{Base} - kWh_{EE}$	2010 Ohio TRM
Demand Reduction Algorithm (kW)	$\Delta kW = \frac{\Delta kWh}{8760} * TAF * LSAF$	

Table 9 defines each variable in above algorithms.

Table 9. Refrigerator Savings Input Parameters

Input	Definition	Source and Value
kWh_{Base}	Rated annual energy consumption of the comparable baseline unit	ENERGY STAR-Qualified Product List: based on make and model information tracked through the program data; the value is a function of the unit's adjusted volume and product category.
kWh_{EE}	Rated annual energy consumption of the rebated unit	ENERGY STAR-Qualified Product List: based on make and model information tracked in the program data; the value is a function of the unit's adjusted volume and product category.
8,760	Annual operating hours	2010 Ohio TRM: 8,760, the refrigerator is assumed plugged in and operating continuously.
TAF	Temperature Adjustment Factor	2010 Ohio TRM. 1.3.
LSAF	Load Shape Adjustment Factor	2010 Ohio TRM, 1.18.

Findings

Cadmus' engineering analysis indicated adjusted gross energy savings and demand reduction were 56% lower than *ex ante* savings, due to the change in the new federal baseline. The *ex ante* savings referenced deemed savings (202 kWh) from the 2010 Ohio TRM which refer to the previous federal baseline, while adjusted gross savings calculated by Cadmus refer to the new, more stringent federal baseline.

This change in the referenced federal baseline reduced gross energy savings from 156,626 kWh to 69,166 kWh and demand reduction from 27.57kW to 12.11 kW. The new federal baseline for refrigerators took effect September 15, 2014. Therefore, DP&L should consider using this as the baseline for calculating savings associated with purchasing ENERGY STAR-rated refrigerators for future appliance programs. Table 9 below shows the average savings and demand reduction per unit by Tier level.

Table 10. Unit Energy Savings and Demand Reduction

Tier Level	Quantity	Ex Ante Unit Savings		Adjusted Unit Savings	
		kWh	kW	kWh	kW
1	1,007	142	0.03	60	0.01
2	40	142	0.03	122	0.02
3	56	142	0.03	68	0.01

The Tier 3 refrigerators that customers purchased through the program were all compact refrigerators (by chance), resulting in lower savings compared to the full-sized, tier 2 units. The Tier 3 refrigerators rebated had an average capacity of 3.0 ft^3, compared to the overall average of 28.2 ft^3.

Clothes Washers

Data Collection

Cadmus obtained specifications for each rebated clothes washer from the ENERGY STAR clothes washer database, using unit model information provided by DP&L's tracking databases. The research consisted of identifying each unit's IMEF, IWF, and capacity (ft^3).

Analysis

To determine electricity savings for clothes washers, Cadmus used algorithms from the Mid-Atlantic TRM v5.0. Algorithm inputs derived from the Mid-Atlantic TRM V5.0 and the ENERGY STAR database. Consistent with the implementation dates shown in Table 7, Cadmus used the new federal baseline taking effect on March 7, 2015, to calculate savings for the entire evaluation period.

Algorithms shown in Table 11 provided savings for each clothes washer.

Table 11. Evaluated Savings Algorithms for Clothes Washers

Parameter	Algorithm for Evaluated Energy Savings, kWh	Algorithm Source
Energy Savings Algorithm (kWh)	$\Delta kWh = Capacity * N_{cycles} * \left[\frac{Weighting_{Base}}{IMEF_{Base}} - \frac{Weighting_{Eff}}{IMEF_{Eff}}\right]$	Mid-Atlantic TRM V5.0
Base Weighting	$Weighting_{Base} = \%CW_{Base} + \%DHW_{Base} * \%ElectricDHW + \%Dryer_{Base} * \%ElectricDryer$	
Efficient Weighting	$Weighting_{Eff} = \%CW_{Eff} + \%DHW_{Eff} * \%ElectricDHW + \%Dryer_{Eff} * \%ElectricDryer$	
Demand Reduction Algorithm (kW)	$\Delta kW = \frac{\Delta kW}{Hours} * CF$	

Table 12 defines each variable in the algorithms listed above.

Table 12. Clothes Washer Savings Input Parameters

Parameter	Definition	Source and Value
Capacity	Rated capacity (ft^3)	ENERGY STAR-Qualified Product List: based on the make and model information tracked in the program data.
$IMEF_{Base}$	Baseline MEF	Federal baseline IMEF for clothes washers since March 7, 2015: 1.29 top loading; 1.84 front loading.
$IMEF_{Eff}$	Rated MEF of rebated unit	ENERGY STAR-Qualified Product List: based on the make and model information tracked in the program data.
N_{cycles}	Average washer loads per year	Survey results, 311: based on the average number of cycles per household with the new clothes washer.
Weighting	Applied to distribute energy use	Mid-Atlantic TRM V5.0: distributed weight of energy consumed between clothes washers, hot water heaters, and dryers, see Table 13.
Hours	Annual hours that clothes washers run	2010 Ohio TRM, 311: based on an assumption of 1 hour/cycle.
CF	Summer peak CF	2010 Ohio TRM, 0.033: based on metered CEE Tier 3 clothes washer operations.

Table 13 lists the distribution of energy consumption between clothes washers, hot water heaters, and dryers needed for clothes washing.

Table 13 Distribution of Clothes Washer Energy Consumption*

Case	Percentage of Total Energy Consumption		
	%CW	%DHW	%Dryer
Federal Standard	8%	31%	61%
ENERGY STAR, CEE Tier 1	8%	23%	69%
ENERGY STAR, CEE Tier 2	14%	10%	76%
ENERGY STAR, CEE Tier 3	14%	10%	77%

*Mid-Atlantic TRM V5.0; values based on a weighted average of top loading and front loading units (per available product from the California Energy Commission (CEC) Appliance database) and consumption data from Life-Cycle Cost and Payback Period Excel-based analytical tool.

Findings

Cadmus found higher adjusted gross savings and lower demand reduction than *ex ante* savings and demand reduction, respectively. Table 13 shows average, adjusted energy savings and demand reduction, listed by clothes washer type.

Table 14. Clothes Washer Unit Savings by Configuration

Configuration	Quantity	Ex Ante Savings		Adjusted Savings	
		kWh	kW	kWh	kW
Front Load	489	202	0.028	136	0.014
Top Load	855	202	0.028	327	0.035

The following discussion addresses differences in the calculation methodology, identified by Cadmus and leading to increased savings and demand reduction.

Change in federal baseline: *Ex ante* savings estimates referred to deemed savings of 202 kWh per clothes washer, based on the 2010 Ohio TRM. The Ohio TRM savings methodology used the previous federal standard baseline. To calculate adjusted savings, Cadmus used the new federal baseline taking effect on March 7, 2015, to calculate adjusted energy savings and demand reduction.

Updates to clothes washer configurations, MEF, and WF metrics: Deemed savings calculations in the Ohio TRM did not differentiate savings across types of clothes washers (e.g., front loading, top loading). Consequently, Cadmus used the manufacturer brand name and appliance model number to identify the configuration of each rebated unit. By using these data along with the CEE Tier identification for each clothes washer, Cadmus could determine the IMEF[4]. Cadmus chose to use the Mid-Atlantic TRM because it has proven to be a reliable resource for savings methodologies and estimates and it uses the new IMEF and IWF parameters to calculate savings. As the 2010 Ohio TRM's deemed calculation used the old federal baseline (and MEF[5] and WF[6] parameters), these were not updated to include the new metric as a savings algorithm input.

The *ex ante* savings use the 2010 Ohio TRM's ENERGY STAR Tier 1 deemed savings values, while Cadmus used the Mid-Atlantic TRM's approach (i.e., Table 13) to calculate savings by efficiency tier. Table 15 lists minimum IMEFs for top-loading and front-loading clothes washers, by CEE Tiers.

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4 In May 2012, DOE began using new metrics (e.g., IMEF, IWF), which considered standby and off-mode energy. The 2012 Final Rule IMEF/IWF standard levels were equivalent to MEF/WF levels in the negotiated agreement. Top-loading washers adopt a two-phase standard: a minimum 1.29 IMEF (correlating to 1.72 MEF) and a maximum 8.4 IWF (correlating to 8.0 WF), effective March 2015; and a 1.57 IMEF (2.0 MEF) and 6.5 IWF (6.0 WF), effective January 2018. Effective March 2015, front-loading washers adopted standards of 1.84 IMEF (2.2 MEF) and 4.7 IWF (4.5 WF).

5 Expressed in cubic feet of washer capacity per kWh per cycle, MEF incorporates the machine's electrical energy consumption, hot water energy consumption, and energy required to remove the remaining moisture from clothes.

6 With WF expressed in gallons per cubic feet of capacity, a higher MEF indicates better energy efficiency, while a lower WF indicates better water efficiency.

Table 15. Federal Baseline IMEF for Clothes Washers

Efficiency Level	IMEF		
	Front Loading	Top Loading	Weighted Average
Federal Standard	>=1.84	>=1.29	>=1.66
ENERGY STAR, CEE Tier 1	>=2.38	>=2.06	>=2.26
ENERGY STAR Most Efficient, CEE TIER 2	>=2.74	>=2.76	>=2.74
CEE Tier 3	>=2.92	n/a	>=2.92

Applying the new federal standard baselines proved to be the most significant factor impacting savings and demand reduction.

Clothes washer volume: *Ex ante* savings refer to calculated deemed savings, based on the Ohio TRM that assumes a clothes washer volume of 3.23 cubic feet. To calculate adjusted savings, Cadmus used each clothes washer's model number to identify its volume. The average program clothes washer volume was 4.59 cubic feet, larger than that in the Ohio TRM.

Number of cycles: *Ex ante* savings referred to deemed savings from the 2010 Ohio TRM, which estimated 320 annual wash cycles. Cadmus used the average weekly cycle numbers that participants reported through the survey and extrapolated these data to calculate 311 annual cycles. Similar to the assumption in the 2010 Ohio TRM, Cadmus assumed that every wash cycle lasted for an hour.

Domestic hot water heater and dryer types. Table 16 shows *ex ante* and evaluated domestic water heater (DWH) saturations. The higher saturation of electric water heaters in the program data increased adjusted savings.

Table 16. Ohio Water Heater Fuel Mix as Stated in Ohio TRM

Water Heater Fuel	DWH Saturation	
	2010 OH TRM	Program Data
Electric	27%	37%
Natural Gas	63%	59%
Oil	6%	1%
Propane	4%	4%

To calculate adjusted savings, Cadmus used the fuel type for each hot water heater and dryer, based on the customer data provided by DP&L. The 2010 Ohio TRM also assumes that 66% of homes use an electric dryer and 34% of homes use natural gas dryers (based on 2005 Residential Energy Consumption Survey). Table 17 provides average savings and demand reduction breakdowns by dryer and hot water heater types.

Table 17. Adjusted Unit Savings by Dryer Type and Hot Water Heater Type

Dryer Type	DWH Type	Quantity	kWh	kW
Electric	Electric	485	384	0.041
Electric	Non-Electric	795	196	0.021

Non-Electric	Electric	10	205	0.022
Non-Electric	Non-Electric	54	22	0.002

Table 18 shows average adjusted savings and demand reduction by clothes washer configuration and their efficiency levels.

Table 18. Clothes Washer Adjusted Unit Savings by Configuration and Tier

Configuration	CEE Tier	Quantity	kWh	kW
Front Load	Tier 1	208	141	0.015
Front Load	Tier 2	274	131	0.014
Front Load	Tier 3	7	216	0.023
Top Load	Tier 1	759	314	0.033
Top Load	Tier 2	96	423	0.045

The clothes washer configuration, dryer type, DWH fuel type and the volume of clothes washers impacted savings. Overall, these updates in methodology and inputs led to increased gross energy savings, from 270,882 kWh to 345,167 kWh, and decreased demand reduction from 37.6 kW to 36.6 kW. DP&L should consider using the new federal baseline for calculating savings associated with purchasing ENERGY STAR-rated clothes washers for future appliance programs.

WiFi Thermostats

Data Collection

Cadmus obtained specifications for each rebated thermostat using unit model information provided by the program tracking database. The database also stated the fuel types used by heating systems and the heating and cooling system types.

Analysis

To determine electricity savings from the Wi-Fi Thermostat program, Cadmus used algorithms from the Wisconsin Focus on Energy (FOE) Technical Reference Manual v2.2 (P. 522 – Smart thermostat), as the 2010 Ohio TRM did not provide a savings methodology for Wi-Fi thermostats. Cadmus derived algorithm inputs from the 2010 Ohio TRM and Wisconsin TRM v2.2, and derived load details from the Residential Heating and Cooling Rebate program findings.

Table 19 shows algorithms providing savings for each Wi-Fi Thermostat.

Table 19. Evaluated Savings Algorithms for Wi-Fi Thermostat

Parameter	Algorithm for Evaluated Energy Savings, kWh	Algorithm Source
Energy Savings Algorithm (kWh)	$kWhsaved\ heating = EFLHheating * \frac{\frac{CAP}{HSPF}}{3.412} * ESFheating$ $kWhsaved\ cooling = \left(\frac{1}{SEER}\right) * EFLHcooling * MBtuH * AC\% * ESFcooling$	Wisconsin TRM v2.2
Demand Reduction Algorithm (kW)	$\Delta kW = \frac{\Delta kWhcooling}{EFLHcooling} * CF$	

Table 20 lists savings input parameters for the Wi-Fi Thermostat program.

Table 20. Input Parameters for Wi-Fi Thermostat Savings Calculations

Parameter	Definition	Source and Value
$EFLH_{heating}$	Effective load heating hours	2010 Ohio TRM section in Dayton
$EFLH_{cooling}$	Effective load cooling hours	2010 Ohio TRM section in Dayton
CAP	Heating system capacity	Wisconsin TRM 72 MBtuh for Furnace
HSPF	Heating seasonal performance factor	7.7; 2010 Ohio TRM section, baseline used for heat pumps
$ESF_{heating}$	Heating energy savings fraction	9.43%; Average from survey results applied to Wisconsin TRM table values
$ESF_{cooling}$	Cooling energy savings fraction	8.10%; Average from survey results applied to Wisconsin TRM table values
SEER	Seasonal energy efficiency rating	Based on system type, from Residential Heating and Cooling Rebate Program
MBtuH	Cooling system capacity	29.1. Deemed value from Wisconsin TRM, may be dependent on cooling system type
CF	Coincidence Factor	0; no reliable source for coincidence found

Findings

Cadmus found adjusted gross energy savings were higher than *ex ante* savings. *Ex ante* energy savings referred to deemed savings values in the 2015 Illinois TRM. To calculate adjusted gross energy savings, Cadmus used the effective load heating and cooling hours, and the heating seasonal performance factor (HSPF) from the 2010 Ohio TRM. For other inputs such as furnace capacity, Cadmus referred to the 2015 Wisconsin TRM. For the heating energy savings factor and cooling energy savings factor, Cadmus referred to the 2015 Wisconsin TRM and used the average percentage from the survey results findings. Table 21 lists heating and cooling energy savings fractions by thermostat replacement type, as listed in the Wisconsin TRM and used for savings calculations.

Table 21. Heating and Cooling Energy Savings Fractions by Thermostat Replacement Type

Thermostat Replacement Type	$ESF_{heating}$	$ESF_{cooling}$

Manual to Smart	13.4%	16.1%
Manual to Programmable	7.8%	15.0%
Manual to Programmable	6.8%	n/a
Average Manual to Programmable	7.3%	15.0%
Programmable to Smart	6.6%	1.3%

As savings are only accounted for switching to a Wi-Fi thermostat from a manual or a programmable thermostat, Cadmus discounted savings associated from switching to Wi-Fi from a smart thermostat. To account for loads within the Dayton area, Cadmus used heat pump heating capacities, average seasonal energy efficiency rating (SEER) values for cooling systems, and cooling capacities from the Residential Heating and Cooling Rebate program findings. To calculate the demand reduction, Cadmus researched various TRMs, but, given the lack of credible information regarding peak demand reduction associated with this measure, Cadmus' analysis concluded that demand reductions could not be calculated. Therefore, Cadmus assigned a zero CF to the algorithm, yielding no demand reductions from installation of a Wi-Fi thermostat.

Process Evaluation Findings

Stakeholder Interview Findings

Cadmus conducted two stakeholder interviews with DP&L and CLEAResult to explore the pilot's design and implementation, program successes and challenges, and data tracking and application processing.

Program Design and Implementation

In 2015, DP&L launched the Appliance Rebate pilot program as a pilot in 2015. By offering $50 rebates for qualifying appliances purchased between July 1, 2015, and October 31, 2015, the program sought to increase awareness and sales of ENERGY STAR refrigerators, clothes washers, and Wi-Fi enabled thermostats.

Akin to DP&L's Residential Lighting Program, the pilot program partnered with participating retail outlets to promote eligible equipment and rebates to customers. In 2015, CLEAResult provided training to more than 400 retailer staff—including sales associates, store managers/owners, and department supervisors—to promote the program to customers. Training topics included ENERGY STAR, point-of-purchase (POP) materials, program objectives, and other DP&L programs and incentives (e.g., ARP). CLEAResult staff also worked directly in stores to identify and label eligible appliances.

DP&L and CLEAResult described several marketing and outreach tactics used for the program. The program relied heavily on in-store sales associates and point of purchase (POP) materials in participating retail outlets, highlighting the rebate program and eligible equipment. The program also used news releases, bill inserts, DP&L's website, and social media to inform customers of the rebate offerings.

Customers could complete the rebate forms via mail or through an online rebate portal. Those purchasing eligible appliances through participating retailers received rebate forms at the time of purchase. In addition, customers purchasing their appliances online or through a nonparticipating retailer also could be eligible for the rebate. According to CLEAResult, 45% percent of customers completed a rebate form through the online portal.

To qualify for the DP&L rebate, appliances had to be ENERGY STAR-certified at the time of purchase. According to stakeholder interviewees, identifying rebate-eligible appliances occasionally presented a challenge. At the time of purchase, ENERGY STAR's website no longer listed some products as certified, even though these had ENERGY STAR labels. Customers occasionally submitted applications for appliances not eligible for the rebate. DP&L interviewees explained that when a product had an ENERGY STAR label in store, but the appliance did not qualify, DP&L usually provided the rebate to the customer.

Data Tracking and Application Processing

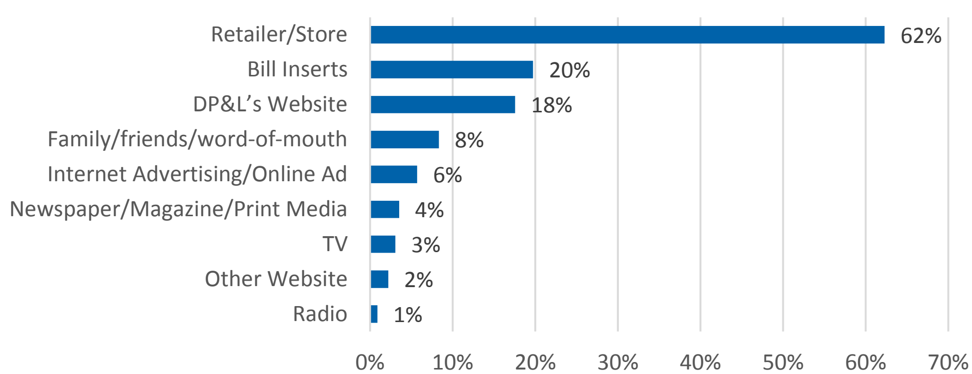
The program used a third-party—EFI—to track and process rebate applications. To verify that applicants were DP&L customers, EFI cross-referenced applicants from a customer list, updated monthly by DP&L. DP&L interviewees said this method for tracking and processing applications generally met DP&L's pilot administration needs. However, as DP&L only updated the customer list once a month, DP&L occasionally had to manually verify customers who had recently moved (and whose new account numbers DP&L's customer list did not yet reflect)—a time-consuming process. DP&L interviewees said more frequent data exports (e.g., weekly) might remedy this issue.

Participant Customer Survey

Participant Awareness and Motivations

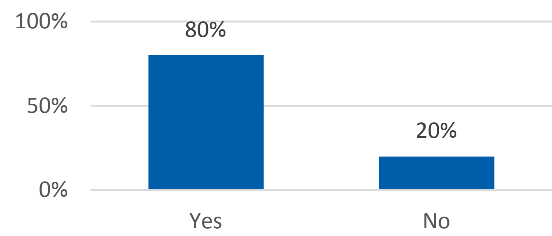
Generally, participants learned about the Appliance Rebate program through three top sources: retailers and store attendants (62%); bill inserts 20%; and DP&L's website (18%). Figure 3 shows the distribution of sources informing participants about the program.

Figure 3. Sources of Participant Awareness of the Program



When asked about what participants did with their old refrigerators and whether they knew of DP&L's Appliance Recycling Program (ARP), 80% said they did know of the program (as shown in Figure 4).

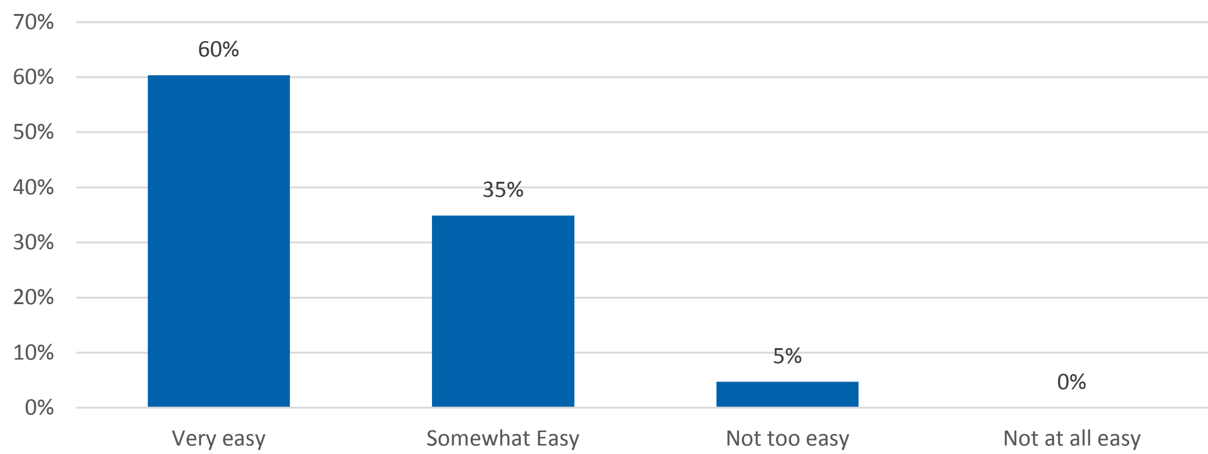
Figure 4. Participant Awareness of DP&L's ARP



Website Visitation

When asked if they visited DP&L's website to look for ways to save energy in their homes, 48% of survey respondents answered "yes." Figure 5 shows 60% of respondents visiting the website found it "very easy" to find relevant data, while 35% characterized this as "somewhat easy."

Figure 5. Ease of Access to Information on DP&L's Website



Survey respondents provided the following suggestions to improve the website:

- Assemble a centralized list of topics on the same page
- Provide intuitive and better headings to locate rebate information (other than "Save Money")

Participant Motivations

Figure 6, Figure 7, and Figure 8 show participants' reported reasons for purchasing a new refrigerator, clothes washer, or Wi-Fi thermostat. Participants could choose multiple answers to identify all reasons for purchasing a new appliance.

Figure 6. Participant Reasons for Purchasing Refrigerator

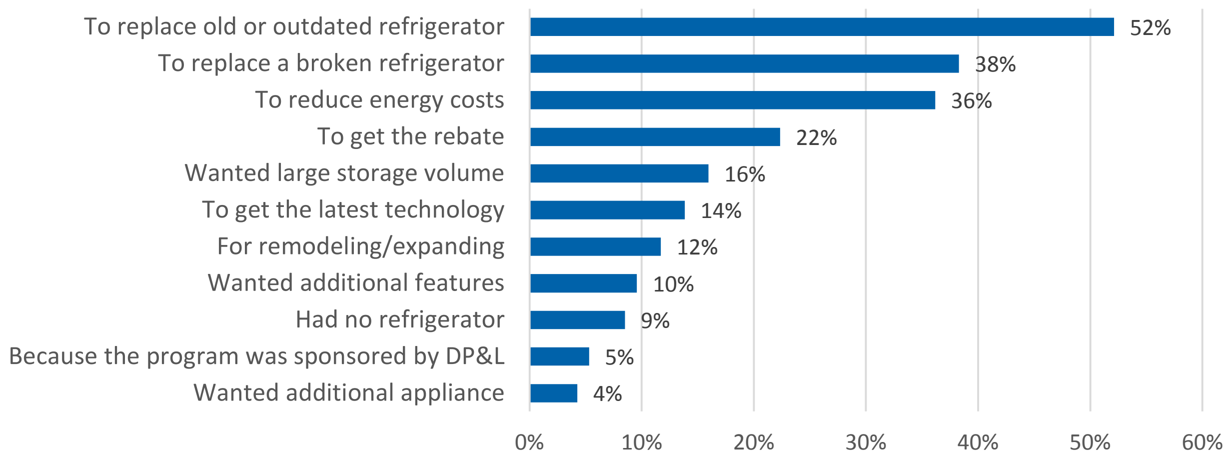


Figure 7. Participant Reasons for Purchasing Clothes Washer

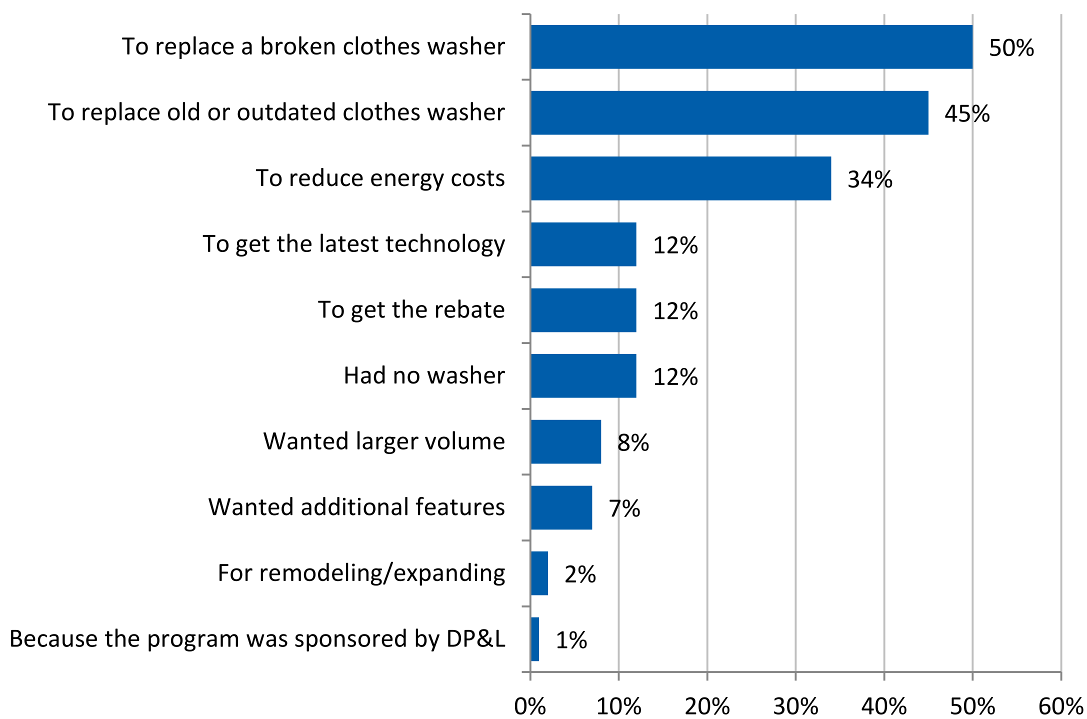
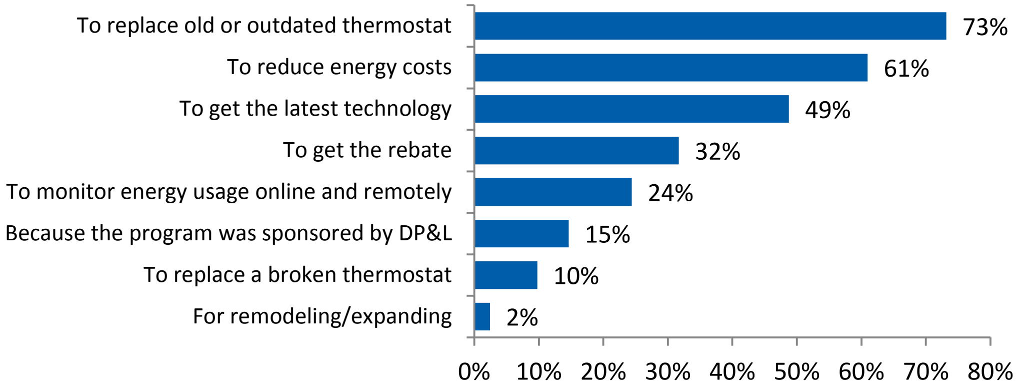


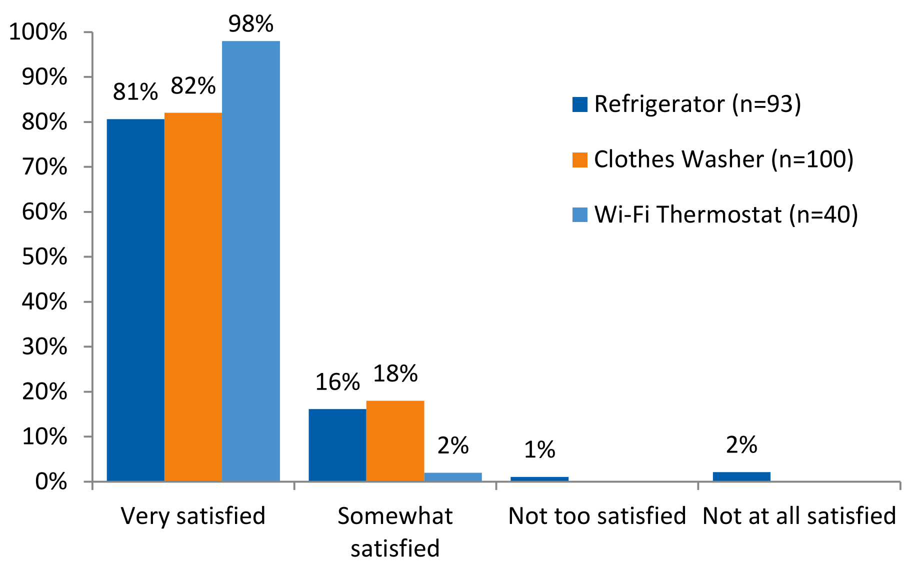
Figure 8. Participant Reasons for Purchasing Thermostat



Participant Satisfaction

When asked about satisfaction with the appliance respondents purchased, 81% purchasing refrigerators, 82% purchasing clothes washers, and 98% purchasing a Wi-Fi thermostat reported they were “very satisfied” with the new appliances. Figure 9 shows these satisfaction levels with the respective appliances.

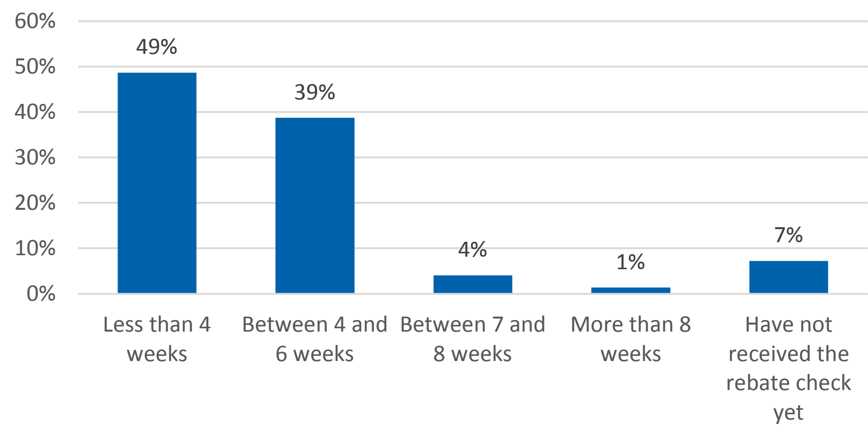
Figure 9. Participant Satisfaction with Appliance Purchase



When asked about the ease of completing the application, 80% of survey respondents found it “very easy” and 19% found it “somewhat easy.” The remaining 1% found it “not too easy.”

When asked about the time required to receive their rebate checks, 85% of survey respondents said they received checks in less than six weeks from the date of application (as noted on DP&L’s rebate application forms). Figure 10 shows the self-reported time required for participants to receive their rebates from DP&L, starting from the date of application date.

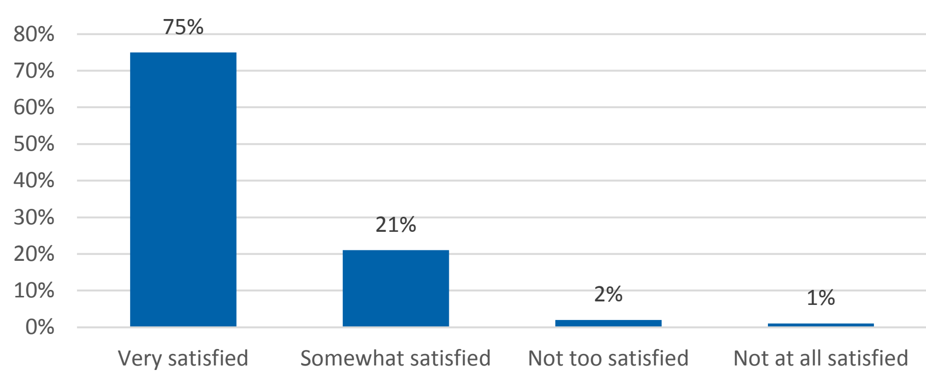
Figure 10. Rebate Timing



Using DP&L's participant database Cadmus confirmed that 98.5% of applications were processed within six weeks, but 1.5% of applications took between 7 to 16 weeks for processing. The delay in time it took to confirm whether a customer is a DP&L residential customer may be one potential causes for the delay in application processing. While a small proportion compared to the majority of applications processed in a timely manner, these longer processing times could prove significant in maintaining customer satisfaction.

Figure 11 shows participants' satisfaction ratings for rebate processing times.

Figure 11. Participant Satisfaction with Rebate Timing

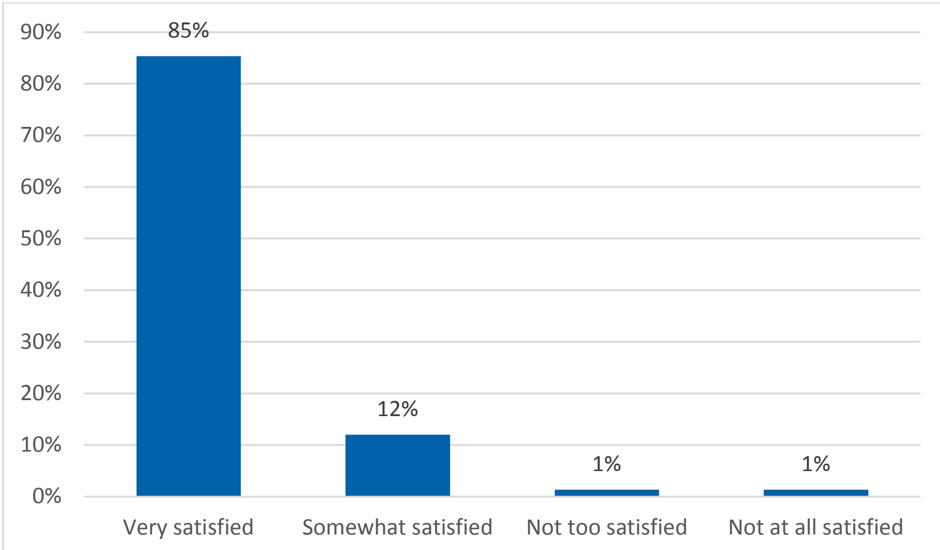


Per the online participant survey (n=228) results, the majority of participants (84%) were highly satisfied with the overall appliance rebate program, though 12% of surveyed participants were somewhat satisfied with the overall program.

For the 3% of surveyed participants indicating they were "not too satisfied" or "not at all satisfied" with the program, the delay in receiving rebate amounts proved the most common reason for their dissatisfaction. Most of these participants stated they did not receive rebate amounts for as long as two months from submitting the application. This still remains a relatively small percentage of surveyed participants: as many as 96% of participants stated they were “very satisfied” or “somewhat satisfied” with the time required to receive the rebate amount after submitting the application.

Figure 12 shows participants’ overall satisfaction ratings for the Appliance Rebate Program.

Figure 12. Overall Participant Satisfaction with the Program



Recommendations

Given the program’s success as a pilot program by exceeding its participant number, energy savings, and demand reduction goals, Cadmus offers only a few recommendations, drawn from the preceding findings:

Create awareness and educate retailers and customers regarding product eligibility. While the program’s application form and DP&L’s website clearly stated refrigerators and clothes washers had to be ENERGY STAR rated to be eligible, instances occurred where customers’ bought ENERGY STAR appliances that did not fit DP&L’s definition of eligible ENERGY STAR-rated appliances. Based on implementer’s feedback, this primarily happened when customers bought ENERGY STAR equipment online or without the help of qualifying retail sales personnel. DP&L based its eligibility criteria on ENERGY STAR’s list of qualifying products, as listed on ENERGY STAR’S website during the pilot’s launch. Despite bringing this list to the attention of retail sales personnel, this information did not appear to extend to all DP&L customers, especially those applied without help from DP&L’s team or participating salesmen. Given the dynamic qualities of the qualifying products list on ENERGY STAR’s website, products on the market may bear an ENERGY STAR logo despite being dropped from the qualified products list, thus making them ineligible for rebates. To ensure participating customers understand DP&L’s definition for eligible equipment, DP&L should consider maintaining a static list of qualifying products on its website that may be updated at predicable intervals throughout the duration of the program, to be used by implementers and participants. DP&L also may consider creating further customer awareness about qualifying products through newspaper advertisements, bill inserts, and other outreach efforts.

Provide a frequently updated list of DP&L residential customers to program implementers. As DP&L issued its residential customer list once a month, program staff reported a lag in DP&L issuing an updated list to implementers and their subcontractors. This caused some delays in the rebate application process. To expedite application processing times, DP&L should consider issuing an updated list of customers biweekly (or more frequently); so implementers can review applications and confirm customers' premise numbers to determine rebate eligibility.

Apply new federal standard baselines to calculate energy and demand savings. Assuming the program design remains similar, future appliance rebate savings should adhere to the latest federal standard baselines. For refrigerators and clothes washers these baselines went into effect in 2014 and 2015 respectively.

Residential Lighting Program

This chapter describes the evaluation approach, detailed findings, conclusions, and recommendations for the Residential Lighting Program.

Evaluation Overview

Cadmus' evaluation of the 2015 Residential Lighting Program followed the researchable questions and evaluation activities outlined in the DP&L *2015 Evaluation, Measurement, and Verification Plans*. Table 22 identifies key researchable evaluation questions.

Table 22. Key Researchable Questions

Researchable Question	Activity Used to Address Question
What are the gross savings?	• Review of secondary sources, the Ohio TRM, and the program database. • Retail and residential allocation phone surveys.
Are 100, 75, 60, and 40W incandescent bulbs available for purchase within DP&L-territory stores?	• Retail in-store surveys.
What percentages of program bulbs are installed in nonresidential applications?	• Commercial allocation survey.
Is the program cost-effective?	• Cost-effectiveness analysis.

Detailed Evaluation Findings

DP&L met its savings goals of 50,573,236 kWh and 6,044 kW by achieving 50,864,843 kWh and 6,088 kW in *ex ante* savings, as well as 51,346,721 kWh in adjusted gross energy savings, but fell short in adjusted gross demand savings (6146 kW). These adjusted gross savings represent realization rates of 99% and 87% against *ex ante* claimed energy and demand savings, respectively. While small discrepancies emerged between *ex ante* and adjusted energy savings, the discrepancies were minimal, and, overall, Cadmus found strong agreement between the *ex ante* and adjusted energy inputs and the methodology. The demand waste heat factor (WHF) input presented the most significant factor driving the demand realization rate below 1.0. More in-depth discussion follows regarding the specifics of these discrepancies.

The following key findings relate to the impact and process evaluation:

- Table 23 (below) provides program *ex ante* claimed and adjusted gross savings and demand reductions.

Table 23. Residential Lighting Program Claimed and Achieved Energy Savings*

Program	*Ex Ante* Claimed Savings		Verified Gross Savings		Adjusted Gross Savings		
	kWh	kW	kWh	kW	kWh	kW	Precision**
CFLs	43,520,845	5,207	43,933,148	5,256	43,281,838	4,558	± 14.6%
LEDs	7,343,998	881	7,413,573	890	7,131,592	753	± 14.3%
Total* **	**50,864,843**	**6,088**	**51,346,721**	**6,146**	**50,413,429**	**5,311**	**± 12.7%**

*Savings reflect the percentage of bulbs installed in residential applications

**Precision at 90% confidence.

***Values in table may not sum to 100% exactly due to rounding.

- In 2015, sales of LED bulbs increased significantly since their introduction into the 2014 Residential Lighting program. Total sales (by the quantity of bulbs) grew from 2.6% in 2014 to 10.9% in 2015. LED's directional nature and their outdoor performance in cold weather made them well suited as reflector bulbs, leading to 13.7% of LED sales being reflectors (compared to <1% of CFLs).
- Consistent with the previous evaluation, the 2015 *ex ante* methodology used the lumen equivalence method to determine delta watts inputs for savings. This method aligned with the approach recommended by the Uniform Methods Project (UMP),[7] and it reflected the method Cadmus used to determine adjusted gross savings in the current and previous evaluations. The use of this methodology contributed to strong agreement between *ex ante* and adjusted savings.
- Table 23 also shows a lower *adjusted* demand reduction than an *ex ante* demand reduction. This largely resulted from Cadmus using a 1.06 WHF for demand (WHF_D), based on the Ohio TRM *Joint Objections and Comments*, and from a small percentage (8%) of bulbs installed outside. *Ex ante* values used the Ohio TRM value of 1.21, as shown below in Table 24.
- While the methodology and most inputs aligned between *ex ante* and adjusted savings, Cadmus found several discrepancies. The following drivers pushed down the realization rates: lower WHFs; and lower reflector baselines used for adjusted saving calculations. The following drivers pushed up the realization rates: a lower percentage of bulbs installed in commercial applications; and higher baselines for exempt bulbs (*ex ante* baselines were incorrectly reduced for exempt bulbs [e.g., candelabra base bulbs, certain globes]).
- Cadmus performed several activities to research program bulbs installed in commercial buildings. Using data obtained through phone and mail-in surveys to residential and small business customers, Cadmus found that 4.1% of program CFLs and LEDs are installed in commercial applications—a finding similar to the 4.2% allocation used in the previous evaluation. Cadmus updated benchmarking completed for the previous evaluation to compare allocation percentages from different studies and utilities. The benchmarking indicated allocation percentages ranged from 0%

[7] The UMP provides the following framework for evaluating residential lighting programs: http://www.nrel.gov/extranet/ump/pdfs/ump-res-lighting-clean.pdf

to 19%. DP&L's values of 5%, 4.2% and 4.1% thus proved reasonable compared to the other results, though they leaned toward the spectrum's conservative end.

- CLEAResult's in-store shelf stocking studies found incandescent inventories generally declined since 2014, particularly in the 60 watt equivalent range where baseline wattage decreased by 20% between the first quarter of 2014 and the first quarter of 2015.

Evaluation Data Collection Methods

Nonresidential Allocation Survey

Though the Residential Lighting Program's upstream lighting component is intended for residential customers, incentives are paid directly to manufacturers and actual participants are unknown. Small business owners are assumed to make up a proportion of customers buying discounted bulbs from participating retailers. As bulbs installed in commercial settings are subject to different savings assumptions, Cadmus estimated the proportion of program bulbs purchased by commercial customers (i.e., nonresidential allocation).

Cadmus conducted a survey with small commercial customers and performed an analysis to estimate this proportion. Cadmus also reviewed allocation studies from several different states and utilities, seeking to benchmark nonresidential allocation results achieved through the survey. Survey results, combined with the general residential customer population survey conducted in 2014, provided a means to derive the percentage of efficient bulbs sold through the program and likely installed in small businesses.

Program Database Review

Cadmus reviewed the data provided by CLEAResult, verifying each measure included model numbers and reported savings. Using the ENERGY STAR light bulb database, Cadmus determined watts, lumens, and other defining characteristics for each bulb, based on its model number and the measure description. Cadmus used other information provided by CLEAResult (e.g., LED/CFL, bulb shape, wattage) for reference when exact matches could not be found.

Impact Evaluation Methodology and Findings

Calculating Adjusted Gross Savings

Cadmus used the following approaches and algorithms to evaluate the 2015 Residential Lighting 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

ISR = in-service rate

HOU = hours of use [hours/day]

WHF_e = WHF for energy

WHF_d = WHF for demand

CF = summer peak coincidence factor

Table 24 shows values used to calculate energy and demand reductions for *ex ante*, verified, and adjusted gross savings. Additional details follow.

Table 24. 2015 Lighting Evaluation Inputs

Savings Algorithm Input	*Ex Ante* Inputs	Verified Inputs	Adjusted Residential Inputs	Commercial Inputs*
HOU	2.85	2.85	2.85	9.66
WHF_e	1.07	1.07	1.06	1.095
WHF_d	1.21	1.21	1.06	1.20
ISR_{CFL}	0.86	0.86	0.86	0.86
ISR_{LED}	0.98	0.98	0.96	0.96
ΔWatts	Varies**	Varies**	Varies**	Varies**
CF	0.11	0.11	0.11	0.76
Allocation	95%	95.9%	95.9%	Ex ante = 5% Verified/Adjusted = 4.1%

*Inputs used to calculate *ex ante*, verified, and adjusted savings for bulbs installed in commercial applications

**Both 2015 *ex ante* and adjusted ΔWatts inputs were based on lumen equivalence and varied by bulb.

Installation Rates

Cadmus calculated a 78% first-year installation rate using data from the 2013 inventory study—a result similar to the 76% calculated from the 2010 site visits and the 77% recommended by the Ohio TRM. As statistical differences could not be detected between these results, Cadmus deferred to the Ohio TRM value, resulting in an 86% final installation rate after adjusting for installation—over time—of bulbs in storage.

Cadmus used a 96% installation rate for LEDs—an average from recent site visit data in several states. As part of the 2013 DP&L Residential Lighting Program evaluation, Cadmus conducted an inventory study; this revealed 100% LED installation rates, though based only on five homes. Based on recent benchmarking across other inventory studies (shown in Table 25), Cadmus considers 96% a reasonable estimate for LED in-service rates (ISRs). Given LEDs' higher prices over CFLs, users more readily install them after purchase.

Table 25. Inventory Studies' LED ISR

Utility	LED ISR
DP&L	100%
Midwest Utility 1	91%
Midwest Utility 2	96%
Midwest Utility 3	91%
Southern Utility 1	100%
Average	**96%**

Hours of Use

Cadmus used the Ohio TRM hours of use (HOU) value of 2.85 hours per day to calculate savings for residential bulbs sold through the program—the same value used in the previous year's study of the Residential Lighting program. In 2012, Cadmus estimated the HOU using a statistical model that used a pooled set of light meter data from evaluations in various states (including Maryland, Missouri, Maine, and Michigan) and from the 2009 DP&L evaluation. Cadmus modeled HOU as a function of room types, existing CFL saturations, and the presence of children in a home, resulting in an estimated 2.26 hours per day. In 2011, the same model, containing fewer pooled meters, estimated 2.39 hours per day.

Waste Heat Factor

Cadmus used a 1.06 WHF when calculating energy and demand reductions—the same values used in the previous Cadmus evaluation. In 2013, this value was updated with indoor/outdoor weighting to reflect 2013 inventory study results. The inventory study found the exact same percentage of bulbs installed outside as that found in site visits conducted during 2009 (8%). As the percentage of bulbs installed outdoors did not change, WHF values remained the same. Cadmus applied the indoor/outdoor weighting after a review of the Ohio TRM WHF value of 1.07 indicated it did not include bulbs installed outside. Consistent with the previous evaluation, the WHF for demand was updated from the *ex ante* value of 1.21 to 1.06 reflect the Ohio TRM *Joint Objections and Comments.*

Coincidence Factor

Consistent with previous evaluations, Cadmus used a 0.11 CF to determine demand reductions. As the Ohio TRM used a 0.11 CF and the Ohio TRM *Joint Objections and Comments* document suggested a 0.16 CF, Cadmus performed a high-level review of CFs from other comparable TRMs. The 0.11 value aligned with other TRM values. Given these comparisons, using the 0.11 value appeared reasonable.

Wattage Baseline

Cadmus used baseline wattage values shown in Table 26 to calculate adjusted gross savings. These final baseline wattages derived from an in-store shelf stocking study conducted by CLEAResult. This shelf stocking study was conducted in quarters 1 and 3 of 2015; quarters 2 and 4 used the baseline for the previous quarter. The shelf stocking study included visiting 30 to 45 participating stores each quarter and documenting whether stores maintained inventories of standard incandescent bulbs. Documentation included noting inventories of each standard bulb category (e.g., 60-watt, 40-watt) and photographing bulb packages. Cadmus applied wattage baselines from the end of 2014 for the small number of bulbs that appeared in the 2015 evaluation but were actually sold at the end of 2014.

Table 26. Adjusted Savings Quarterly Baseline Wattages

Lumen Bin	Incandescent Baseline Wattage	Halogen (EISA) Baseline Wattage*	2014 Baseline Wattage	2015 Baseline Wattages**			
			Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4
3,301–4,815	200	NA	200	200	200	200	200
2,601–3,300	150	NA	150	150	150	150	150
1,490–2,600	100	72	72	72	72	72	72
1,050–1,489	75	53	54	53	53	53	53
750–1,049	60	43	49	45	45	44	44
310–749	40	29	31	32	32	31	31
0–309	25	NA	25	25	25	25	25

*Based on the 2007 Energy Independence and Security Act (EISA).

**2015 100 and 75 watt baseline wattages used EISA baseline wattage

The 2015 shelf stocking study results showed that very few stores carried 100 or 75 watt incandescent bulbs, suggesting that fluctuations in 100 and 75 watt inventory results may be attributable to sampling error. For this reason, Cadmus used the Halogen EISA baseline wattage in 2015 for the 100 and 75 watt incandescent equivalent categories. These halogen baselines resulted from EISA, which, though banning the manufacture of standard, inefficient bulbs, did not ban their sale. As stores sell through inventories of incandescent bulbs, the evaluation's baseline analysis calculates a weighted baseline for bulbs within the lumen range controlled by EISA (310–2,600 lumens). The calculated baseline reflects a weighted average between the incandescent baseline and the more efficient halogen baseline, based on incandescent inventories.

Nonresidential Allocation Survey

Cadmus calculated the nonresidential allocation of program bulbs by estimating the total number of program bulbs reported as installed in small commercial applications in 2015, and then dividing this estimate by the total number of program bulbs sold in 2015. Cadmus used data from general-population customer surveys and from DP&L's customer records to estimate the nonresidential allocation of program bulbs.

Cadmus surveyed DP&L's general residential customer population and a subset of its small commercial customer base to estimate the percentage of customers (from each population) purchasing CFLs and/or LEDs from a participating retailer during the previous year. The resulting nonresidential allocation of bulbs purchased from participating retailers was 4.1% for small commercial customers. Appendix F describes the full methodology and findings.

Cadmus also reviewed allocation studies from the states and utilities shown in Table 27, revealing a wide spectrum of results and methodologies. Comparing these studies proved challenging due to differing approaches and the relatively small number of responses from individuals installing bulbs in commercial applications (see the last column in Table 27). Calculating a straight average of all Table 27 results produces a 6.4% nonresidential allocation. The 4.1% nonresidential allocation result from the 2015 DP&L study falls below the 6.4% average and may provide a conservative estimate.

Table 27. Benchmarking Results

Utility	State	Study Type	% Commercial Allocation	Report Year	Study Participants
PPL	PA	Small Business Phone Survey	17.1%	2013	301
PECO	PA	Store Intercept Study	12.2%*	2013	144
Midwest Utility	–	Store Intercept Study	11.0%	2014	495
Duke Energy	NC	Store Intercept Study	10.0%	2013	175
Focus on Energy	WI	Store Intercept Study	7.1%	2014	293
Focus on Energy	WI	Residential & Nonresidential Phone Surveys	5.8%	2015	1,186*
EmPOWER	MD	Store Intercept Study	5.2%	2012	455
DP&L	**OH**	**Residential Phone Survey**	**5.0%**	**2012**	**301**
MetEd	PA	Residential Phone Survey	4.9%	2014	
Midwest Utility	–	Residential Phone Survey	4.7%	2014	242
Consumer's Energy	MI	Residential Phone Survey	4.7%	2014	
DP&L	**OH**	**Residential Mail Survey**	**4.2%**	**2014**	**638**
DP&L	**OH**	**Residential & Commercial Phone Surveys**	**4.1%**	**2015**	**1,223****
Efficiency Maine	ME	Residential Phone Survey	4.0%	2012	
PacifiCorp	UT	Store Intercept Study	3.9%	2014	385
Midwest Utility	–	Store Intercept Study	3.0%	2011	611
ComEd	IL	Store Intercept Study	3.0%	2014	1,114
Ameren IL	IL	Store Intercept Study	3.0%	2014	343

*911 Residential Customers; 275 Commercial Customers

**933 Residential Customers; 290 Commercial Customers

Recommendations

Drawn from the preceding findings, Cadmus offers the following recommendations:

Monitor the transition to LEDs to avoid losing program sales to less efficient lighting products.

As DP&L shifts away from CFLs towards LEDs over the next year, consideration should be made to grandfather CFLs qualified for the current ENERGY STAR specification while simultaneously accelerating the transition to LEDs. While the long term goal is to shift the entire target of the lighting program towards LEDs, the backsliding in other jurisdictions, coupled with the significant increase in halogen sales should be acknowledged: without program intervention, potential exists for halogens to cannibalize higher-efficiency lighting sales.

Adjust the 60- and 40-watt incandescent equivalent baselines to the EISA baseline wattage values. Results from the in-store shelf stocking study show nearly depleted 60- and 40-watt inventories. Based on the sell-through rate of the 60-watt and 40-watt incandescent inventories, Cadmus projects 60-watt inventories will be depleted sufficiently by the end of 2016 to warrant program planning using the EISA 60-watt equivalent baseline wattages.

Residential Appliance Recycling Program

This chapter describes the evaluation approach used, presents detailed findings, and offers conclusions and recommendations for the Residential ARP.

In November 2015, JACO, the program Implementer, notified DP&L that it was going out of business and would cease all operations, including scheduling additional appliance pick-ups, completing previously scheduled pick-ups, and providing customer telephone support. DP&L immediately suspended ARP (see DP&L's *Annual Report*[8] for steps taken to suspend the program).

Evaluation Overview

Cadmus' evaluation of the 2015 Residential ARP followed researchable questions and evaluation activities outlined in DP&L's *2015 Evaluation, Measurement, and Verification Plans*. Table 28 identifies key researchable evaluation questions.

Table 28. Key Researchable Questions

Researchable Questions	Activity
What are average energy savings?	• Regression model • Participant survey
How accurately and consistently are relevant appliance unit data collected?	• Review of program database
How satisfied are customers with the program and DP&L overall? How efficient has program delivery been?	• Participant survey

Detailed Evaluation Findings

Adjusted gross savings fell short of DP&L's savings goals of 4,273,944 kWh and 757 kW, achieving 3,620,470 kWh and 567 kW in adjusted gross savings. Even with suspending the program in November, *ex ante* savings exceeded the goals (5,232,325 kWh and 817 kW). The adjusted gross savings represented realization rates of 62% realization rates against *ex ante* claimed energy savings and demand.

Overall, two factors drove the realization rate: the overall trend in decreasing units' age as the program matured; and the increasing proportion of units manufactured after the early 1990s' energy standards. The adjusted gross savings account for both factors. *Ex ante* claimed savings derive from the Ohio TRM, which has not been updated to reflect these trends.

The following key findings relate to the impact and process evaluation:

- Table 29 provides program *ex ante* claimed and adjusted gross savings and demand reductions.

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[8] DP&L 2014 Portfolio Status Report: http://dis.puc.state.oh.us/DocumentRecord.aspx?DocID=d3636564-926a-4158-9a5b-bd08089092fa

Table 29. Residential ARP Claimed and Achieved Energy Savings

Program	*Ex Ante* Claimed Savings		Verified Gross Savings		Adjusted Gross Savings		
	kWh	kW	kWh	kW	kWh	kW	Precision*
Refrigerators	3,997,280	639	3,997,280	639	2,835,280	465	± 9.8%
Freezers	877,020	141	877,020	141	515,355	85	± 23.0%
Kits	358,025	37	269,835	17	269,835	17	± 13.9%
Total**	**5,232,325**	**817**	**5,137,490**	**797**	**3,620,470**	**567**	**± 8.5%**

*Precision at 90% confidence.

**Values in table may not exactly sum to 100% due to rounding.

- The recycled unit age reversed its year-on-year decline; an appliance recycled through the program in 2015 averaged 23 years old, a five-year increase from 2014 but on par with 2013. Unit sizes remained flat, continuing to average 19 cubic feet. These factors led to higher adjusted gross savings per unit in comparison to 2014.
- Program participation increased over 2014 despite the early suspension of the program. 2,774 refrigerators and 678 freezers were recycled in 2014 while 2,905 refrigerators and 705 freezers were recycled in 2015, an overall increase of 5%. This increase contributed to higher program savings overall.
- The part-use factor, defined as the average proportion of the year during which appliances ran, did not change significantly for either equipment measure compared with the 2014 program year evaluation. Refrigerators recycled throughout the 2014 program year operated 89% of the time; freezers operated 86% of the time, compared to respective part-use factors of 86% and 82% in 2015.
- At the time of appliance pick up, participants received a kit of energy-efficient measures. This kit exhibited low measure installation rates. A follow-up telephone survey found installations as follows:
  - 20% for energy-efficient showerheads
  - 32% for kitchen aerators
  - 29% for bathroom aerators
  - 65% for CFLs

  These low installation rates are consistent with the low installation rates seen in 2014 and led to low kit-driven savings. However, calculating cost-effectiveness with and without the kits indicated larger program net benefits when offering the kit.
- Bill inserts proved the most common way participants first learned of the program; the participant survey found 39% first learned about the program through this avenue or through another form of direct mail—findings similar to the 2014 evaluation.
- Approximately 97% of participants reported being “very satisfied” or “satisfied” with the program, with 80% of all participants stating they were “very satisfied” with the program. The 2014 evaluation produced similar findings.

Evaluation Data Collection Methods

In evaluating the 2015 program, Cadmus used the approaches detailed below.

Program Database Review

In December 2015, JACO—the program implementer—abruptly ceased operations and did not deliver the final program tracking database to Cadmus or DP&L. Instead, DP&L provided Cadmus with JACO's monthly extracts containing appliance pickup data. Cadmus reviewed these data to test their reliability and found them consistent with the quality of previous JACO database extracts. Cadmus used these data as the final dataset in evaluating the program.

Participant Telephone Survey

In September 2015, Cadmus surveyed a sample of 2015 ARP participants by appliance type, seeking to complete an additional survey in December 2015 to achieve 90% confidence within 10% precision for refrigerators and 90% confidence within 20% precision for freezers. However, due to the program's suspension and the inaccessibility of JACO's tracking database, Cadmus could not complete the December 2015 surveys.

As shown in Table 30, Cadmus surveyed 35 participating households reported to have recycled a refrigerator through the program and 30 participating households reported to have recycled a freezer. To achieve the desired confidence and precision levels when conducting the evaluation, Cadmus combined responses from the 2014 participant survey (conducted in December 2014) with responses from the September 2015 survey.

Table 30. Participant Survey Goals and Achievements

Total Participants Sampled	Total Planned 2015 Completes	Achieved 2015 Completes
Recycled Freezer	40	30
Recycled Refrigerator	70	35
Total	**110**	**65**

The survey questions sought to determine how participants learned of the program, how they used appliances they recycled, their program satisfaction levels, and their demographics.

The survey included questions addressing the following pertinent issues:

- **Verification of Measure Removed.** This survey section, which ensured contact with the appropriate individuals, contained questions related to participation recall, involvement in the decision-making process, and measure removal.
- **Appliance Context and the Decision-Making Processes.** These questions addressed key aspects of the participants' decision-making process and informed the verification analysis.
- **Program Satisfaction.** These questions collected process-related information regarding participants' satisfaction with the program and, if applicable, their reasons for dissatisfaction. The questions also addressed whether participants would refer others to the program.

- **Demographics.** This section captured household and respondent characteristics, including income, age, the home type and square footage, energy use, and household income.

In Situ Metering Data Set

Consistent with previous evaluations, Cadmus developed a multivariate regression model to estimate average unit energy consumption (UEC) for retired refrigerators and freezers. This model relied on an aggregated *in situ* metering dataset,[9] consisting of approximately 594 appliances, metered during evaluations conducted in California, Michigan, and Wisconsin between 2009 and 2013.

In greater detail, the following Impact Evaluation Methodology and Findings section explains the refrigerator model specifications and the corresponding freezer model Cadmus developed and used in the 2015 evaluation.

Impact Evaluation Methodology and Findings

Table 31 shows distributions of refrigerators and freezers by configuration, drawn from the JACO monthly extracts.

Table 31. Program Participation by Measure

Measure	Configuration	Participation
Recycled Refrigerator	Bottom Freezer	113
	Side-by-Side	844
	Single Door	89
	Top Freezer	1859
	Refrigerator Total	**2905**
Recycled Freezer	Chest	249
	Upright	460
	Freezer Total	**705**
Total		**3,610**

Summary of Program Participation

Cadmus analyzed JACO's monthly extracts for the 2015 DP&L ARP. Table 32 shows the average age and size of units collected in 2015.

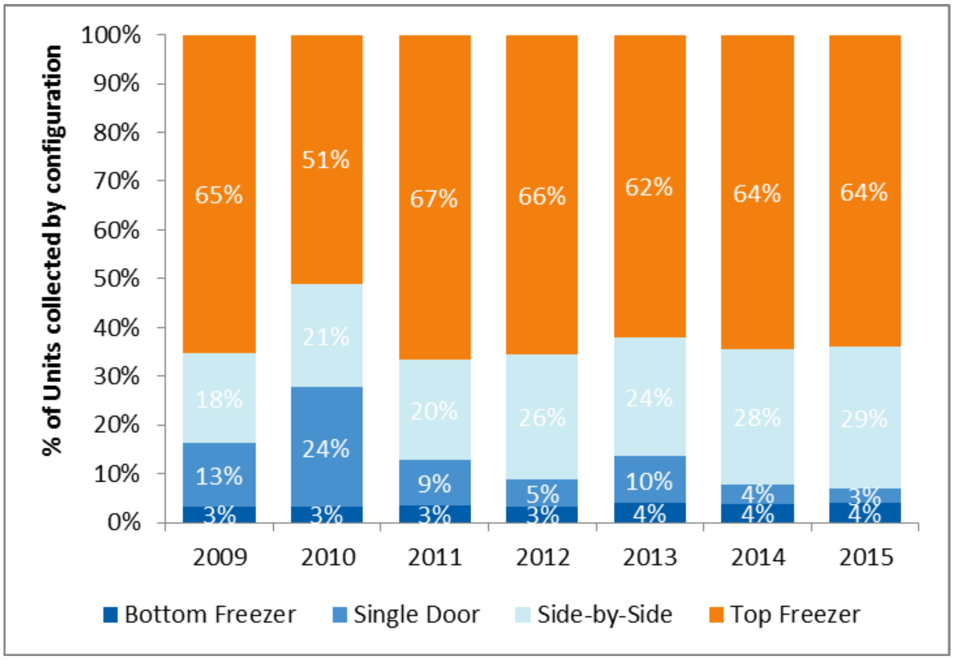
Table 32. Average Unit Age and Unit Size

Appliance	Average Age (Years)	Average Size (ft^3)
Refrigerator	22	19
Freezer	27	16

9 *In situ* metering takes place in the environment where appliances are typically used; this approach contrasts with lab testing, which meters units under controlled conditions.

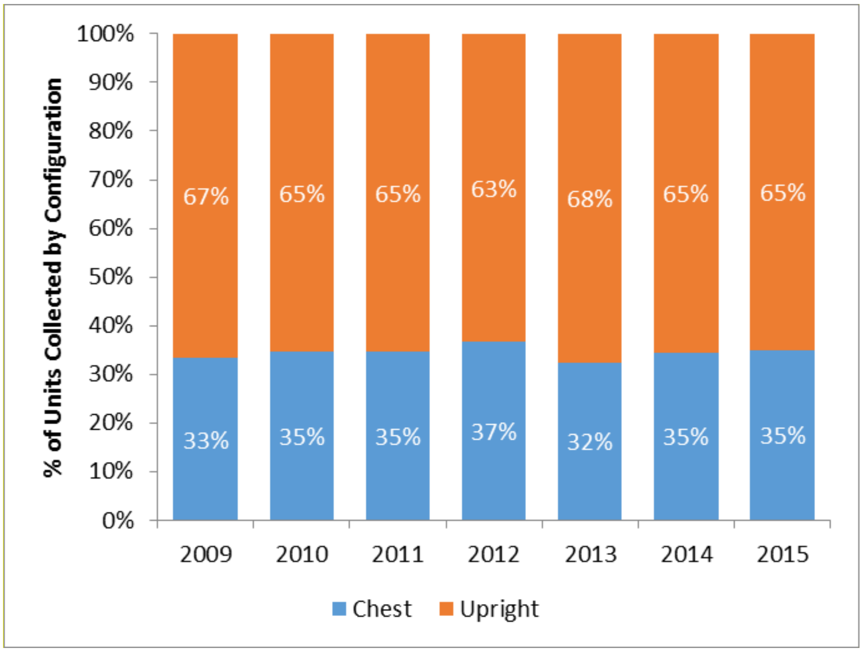
To determine trends in unit age, size, and configuration, Cadmus compared 2015 results to tracking data results from past years. As shown in Figure 13, the configuration of refrigerators did not change substantially over the past several program years.

Figure 13. Refrigerator Configuration by Program Year



As shown in Figure 14, freezer configurations did not substantially change over the program's life.

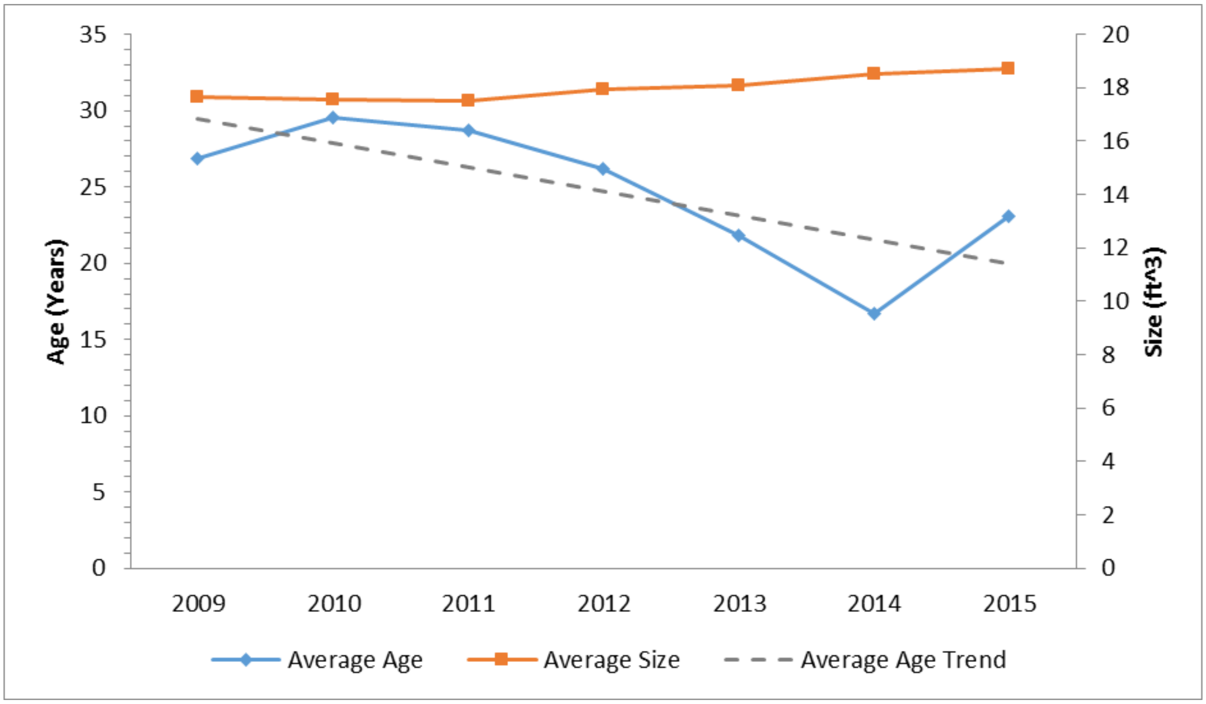
Figure 14. Freezer Configuration by Program Year



In 2015, recycled appliances averaged 23 years old, with 19 cubic feet of internal capacity. As shown in Figure 15, the average appliance size did not change substantially since the program's inception, but the average unit age decreased steadily from 2012–2014, until increasing in 2015. Cadmus reviewed the 2015 data and other promotional factors to determine a cause for the age increase, but could not identify elements that would have a large impact on increased unit size. Consequently, 2014 may just have been an outlier year. The linear regression trend line in Figure 15 shows the overall downward trend.

The age decline serves as the primary driver of UEC decreases over the program's life. Even with 2015's increase in average appliance age, UECs have fallen over time, largely due to the 1990 National Appliance Energy Conservation Act (NAECA) standard (and therefore consuming substantially less energy than pre-standard units). Cadmus' regression model estimated that an average refrigerator recycled after 1990 consumed approximately 375 kWh less per year than one manufactured prior to the standard change (with 200 kWh less for freezers). This included standards set in 1993 and 2001.

Figure 15. Appliance Age and Size by Program Year



Average Annual Gross Energy Consumption

Cadmus used regression models to estimate consumption for refrigerators and freezers (shown below in Table 33) using the aggregated *in situ* metering dataset from the previous evaluation.[10] Each independent variable's coefficient indicated that variable's influence on daily consumption, holding all other variables constant. A positive coefficient indicated an upward influence on consumption; a negative coefficient indicated a downward effect.

The coefficient's value indicated the marginal impact of a one-point increase in the independent variable on the UEC. For instance, a 1 cubic foot increase in refrigerator size resulted in a 0.059 kWh increase in daily consumption. In the case of dummy variables, the coefficient value represented the difference in consumption, assuming the given condition was true. In the refrigerator model, for example, the coefficient for the variable indicating a refrigerator as a primary unit was 0.560; all else remaining equal, a primary refrigerator consumed 0.560 kWh more per day than a secondary unit.

Table 33 details the final model specifications used to estimate energy consumption of participating refrigerators.

Table 33. Refrigerator and Freezer UEC Regression Model Estimates

[10] DP&L 2014 Evaluation Report, PDF document page 163 and 164: http://dis.puc.state.oh.us/DocumentRecord.aspx?DocID=d3636564-926a-4158-9a5b-bd08089092fa

(Dependent Variable = Average Daily kWh)

Independent Variables	Refrigerator		Freezer	
	Coefficient	p-Value	Coefficient	p-Value
Intercept	0.805	0.537	-0.955	0.796
Age (years)	0.021	0.01	0.045	0.017
Dummy: Manufactured Pre-1990	1.036	0.191	0.543	0.421
Size (ft^3)	0.059	0.026	0.12	0.035
Dummy: Single Door	-1.751	0.339	N/A	N/A
Dummy: Side-by-Side	1.12	0.206	N/A	N/A
Dummy: Primary	0.56	0.19	N/A	N/A
Dummy: Chest Freezer	N/A	N/A	0.298	0.269
Interaction: Unconditioned Space x HDDs*	-0.04	0.011	-0.031	0.015
Interaction: Unconditioned Space x CDDs**	0.026	0.022	0.082	0.036

After estimating the final regression models, Cadmus analyzed the corresponding characteristics (i.e., the independent variables) for participating appliances (as captured in the JACO monthly extracts). Table 34 summarizes program averages or proportions for each independent variable.

Table 34. 2015 Participant Mean Explanatory Variables*

Independent Variables	Participant Population Mean Value	
	Refrigerator	Freezer
Age (years)	22.12	27.06
Dummy: Manufactured Pre-1990	0.25	0.51
Size (ft^3)	19.4	15.95
Dummy: Primary	0.97	N/A
Dummy: Single Door	0.03	N/A
Dummy: Side-by-Side	0.29	N/A
Dummy: Chest Freezer	N/A	0.35
Interaction: Unconditioned Space x CDDs	0.5	1.87
Interaction: Unconditioned Space x HDDs	6.48	12.42

*CDDs/HDDs are weighted-averages from TMY3 data for weather stations mapped to participating appliance zip codes. TMY3 equals a typical meteorological year, using median daily values for a variety of weather data collected from 1991–2005.

Using values from Table 33and Table 34, Cadmus calculated the estimated annual freezer UEC as follows:

$$Freezer\ UEC =$$

$$365.25\ days *$$

$$((-0.955) +$$
$$0.045*(27.06\ years\ old) +$$
$$0.543*(51\%\ units\ manufactured\ pre\!-\!1990) +$$
$$0.120*(15.95\ ft.3) +$$
$$0.298*(35\%\ units\ that\ are\ chest\ freezers) +$$
$$0.082*(1.87\ Unconditioned\ CDDs) -$$
$$0.031*(12.42\ Unconditioned\ HDDs)\ )=$$
$$853\ kWh/year$$

Figure 16 compares the distributions of estimated UEC values for refrigerators and freezers.

Figure 16. 2015 Distribution of Estimated Annual UECs by Appliance Type

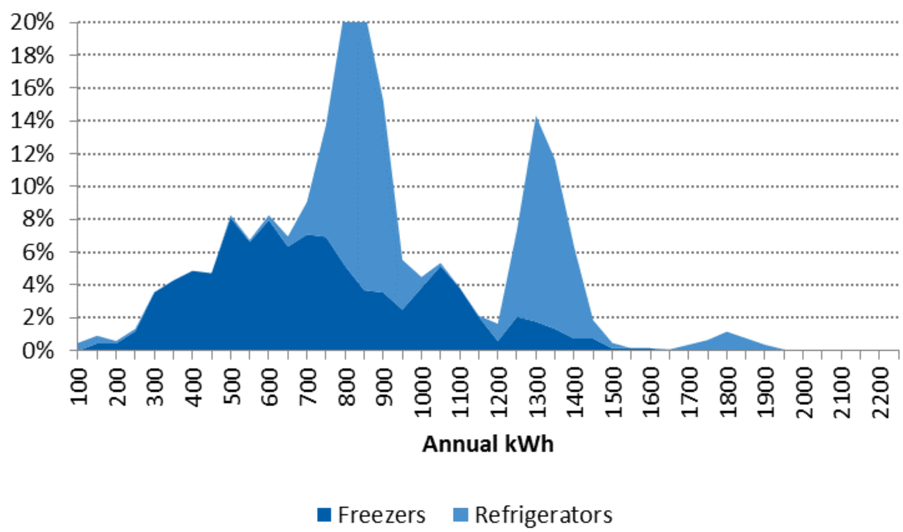


Table 35 presents estimated, per-unit, average, annual, energy consumption for refrigerators and freezers recycled in 2015. Note that annual UECs increased for both appliance types. This largely resulted from the increase in unit age and the increasing share of recycled units manufactured after the 1990 NAECA standard.

Table 35. Estimate of Per-Unit Annual Energy Consumption

Appliance	*Ex Ante* Annual UEC (kWh/year)	*Ex Post* Annual UEC (kWh/year)	Precision at 90% Confidence Interval
Refrigerators	1,376	1,059	± 9.76%
Freezers	1,244	853	± 23.01%

Kit Savings Algorithm and Assumptions

With each pickup ordered, participants could elect to receive an energy-saving kit, which contained the following elements:

- Two 13-watt CFLs
- One energy-efficient showerhead
- One bathroom sink aerator
- One kitchen sink aerator
- Energy-savings educational materials and other program references

Overall, the program distributed 2,139 kits to participants. Table 36 presents an overview of calculated energy savings per kit. Savings were calculated with the same methodology as in the 2014 evaluation.

Table 36. Summary of Kit Energy Savings

Measure	Quantity (per kit)	*Ex Ante* Energy Savings (kWh)	*Ex Ante* Demand Savings (kW)	*Ex Post* Savings (kWh)	*Ex Post* Demand Savings (kW)
13W CFLs	2	63.4	0.007	54.6	0.006
Bathroom Faucet Aerator	1	50.2	0.005	7.24	0.001
Kitchen Faucet Aerator	1	36.3	0.001	36.0	0.001
Energy Efficient Showerhead	1	13.3	0.004	25.2	0.000
Total Per Kit	**NA**	**163.3**	**0.017**	**123.0**	**0.008**

CFL Bulbs

Cadmus used savings calculations outlined in the Ohio TRM and the following assumptions to calculate adjusted gross energy savings and demand reductions for CFLs:

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

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

Table 37 shows inputs and assumptions for the 13-watt CFL calculation.

Table 37. CFL Energy Savings and Demand Reduction Calculation

Input	Assumption	Units	Source
Δ Watts	37.93	W	Cadmus participant survey.
ISR	65%	–	Cadmus participant survey.
HOU	1040	Hrs/year	Ohio TRM.
WHF_e	1.06	–	Adjusted Ohio TRM. Assumed installations were indoors.
WHF_d	1.06	–	Adjusted Ohio TRM, Ohio TRM Joint Objections and Comments.
Summer Peak CF	0.11	–	Ohio TRM.

Using the above inputs, Cadmus determined each CFL saved 27.3 kWh and 0.006 kW per year. Cadmus found 1,396 installations of 13-watt CFLs, leading to savings of 116,773 kWh and summer coincident peak savings of 12.4 kW.

Bathroom and Kitchen Faucet Aerator

Cadmus used the following approach to calculate energy savings and demand reductions for faucet aerators:

$$\Delta kWh = ISR * (GPM_{Base} - GPM_{Low}) * \frac{People}{Home} * \frac{min}{day} * \frac{days}{year} * \frac{1}{\frac{F}{home}} * 8.33 * (T_{FT} - T_{MAINS}) * \frac{1}{1{,}000{,}000} * \frac{1}{RE} * \frac{1}{0.003412}$$

$$\Delta kW = \frac{\Delta kWh}{\frac{People}{Home} * \frac{min}{day} * \frac{days}{year} * \frac{1}{\frac{F}{home}}} * CF$$

Table 38 provides inputs used to calculate adjusted gross savings for bathroom faucet aerators. Cadmus updated Ohio TRM assumptions for the average number of people per household (using household sizes recorded in the ARP participant survey). Additionally, in calculating savings, Cadmus accounted for a 48.29% electric water heater saturation, as determined from Ohio Energy Project's (OEP) Family Home Installation Survey.[11]

Finally, the evaluation used assumptions updated for the 2014 evaluation on the minutes-of-use per person, per day, and the assumed temperature of water used at the faucet, based on a water-metering study Cadmus conducted for Consumers Energy and DTE Energy in Michigan.[12]

Table 38. Bathroom and Kitchen Faucet Aerator Savings Calculation Inputs

Variable	Variable Definition	Bathroom Aerator	Kitchen Aerator	Source
ISR	ISR or fraction of units installed	32%	29%	ARP participant survey.
GPM_{BASE}	Gallons per minute of baseline faucet	2.2	2.2	Cadmus water metering study.
GPM_{LOW}	Gallons per minute of low-flow faucet	1.0	1.5	Bathroom sink aerator: 1.0 GPM Niagara N3210N; kitchen sink aerator: 1.5 GPM Niagara N3115.
#people	Average number of people per household	2.31	2.31	ARP participant survey
min/day	Minutes of use per person,	1.65	4.51	Cadmus water metering study.

11 OEP administered this survey in its capacity as implementer of the BE E[3] Smart Energy Education program.

12 *Michigan Water Meter Study*. March 2013. Power Point presentation to Michigan Evaluation Working Group.

Variable	Variable Definition	Bathroom Aerator	Kitchen Aerator	Source
	per day			
days/yr.	Days faucet used per year	365	365	Ohio TRM Assumption.
F/home	Average number of faucets in the home	2.5	1.00	Adjusted TRM Assumption.
8.33	Constant to convert gals to lbs.	8.33	8.33	Adjusted TRM Assumption.
1	Constant to convert lbs. and of water to BTU	1	1	Ohio TRM Assumption.
T_{FT}	Assumed temperature of water used	86	93	Cadmus water metering study.
T_{MAINS}	Assumed temperature of water entering house	57.7	57.7	Temperature data for Dayton, OH. Averaged monthly water main temperature calculated using the methodology provided in *Building America Research Benchmark Definition*, updated December 2009. Pg.19-20. http://www.nrel.gov/docs/fy10osti/47246.pdf
1,000,000	Unit conversion	1,000,000	1,000,000	Assumed.
RE	Recovery energy	0.98	0.98	Air-Conditioning, Heating and Refrigeration Institute (AHRI) Directory.
0.003412	MMBtuh to kWh	0.003412	0.003412	Ohio TRM Assumption.

Using the above inputs, Cadmus determined bathroom faucet aerators saved 7.23 kWh/unit annually and kitchen faucet aerators saved 35.97 kWh/unit annually. Cadmus used the Ohio TRM algorithm to calculate peak savings, which equated to 0.0010 kW per bathroom faucet aerator installed and 0.0007 kW per kitchen faucet aerator installed.

Taking into account ISR and electric fuel-type saturations for the total aerators distributed, total bathroom and kitchen faucet aerators achieved savings of 15,476 kWh and 2.11 kW, and 76,949 kWh and 1.53 kW, respectively.

Efficient Showerheads

Cadmus used the following approach to calculate adjusted gross energy-savings and demand reductions for showerheads:

$$\Delta kWh = ISR * (GPM_{Base} - GPM_{Low}) * \frac{People}{Home} * \frac{min}{shower} * \frac{shower}{days} * \frac{days}{year} * \frac{1}{\frac{F}{home}} * 8.33 * (T_{FT} - T_{MAINS}) * \frac{1}{1{,}000{,}000} * \frac{1}{RE} * \frac{1}{0.003412}$$

$$\Delta kW = \frac{\Delta kWh}{\frac{People}{Home} * \frac{min}{shower} * \frac{shower}{days} * \frac{days}{year} * \frac{1}{\frac{F}{home}}} * CF$$

Table 39 lists inputs and assumptions used for calculating efficient showerhead savings. As with efficient aerators, Cadmus updated Ohio TRM assumptions for the average number of people per household using the ARP participant survey. Additionally, in calculating savings, Cadmus accounted for an electric water heater saturation of 48.29%, as determined from OEP's Family Home Installation Survey.

Cadmus also updated assumptions on the minutes-of-use per person, per shower, showers per day, and the assumed temperature of water used at the showerhead, based on a water metering study Cadmus conducted for Consumers Energy and DTE Energy in Michigan.[13]

Table 39. Efficient Showerhead Savings Calculation Inputs

Variable	Variable Definition	Input	Cadmus Source
ISR	ISR or fraction of units installed	20%	ARP participant survey.
GPM_{BASE}	Gallons per minute of baseline faucet	2.5	Minimum federal GPM allowed.
GPM_{LOW}	Gallons per minute of low-flow faucet	1.25	Showerhead 1.25 GPM Niagara N2912.
#people	Average number of people per household	2.31	ARP participant survey.
min/shower	Minutes of use per person per shower	7.83	Cadmus water metering study.
days/yr.	Days faucet used per year	365	Ohio TRM Assumption.
shower/day	Showers per day	0.61	Cadmus water metering study.
F/home	Average number of showers in the home	2.1	Ohio TRM Assumption.
8.33	Constant to convert gals to lbs.	8.33	Adjusted TRM Assumption.
1	Constant to convert lbs. and of water to BTU	1	Ohio TRM Assumption.
T_{FT}	Assumed temperature of water used	101	Cadmus water metering study.
T_{MAINS}	Assumed temperature of water entering house	57.7	Vectren's temperature data for Dayton, OH. Averaged monthly water main temperature calculated using the

[13] *Michigan Water Meter Study*. March 2013. Power Point presentation to Michigan Evaluation Working Group.

Variable	Variable Definition	Input	Cadmus Source
			Building America Research Benchmark Definition, updated December 2009. Pg.19-20. http://www.nrel.gov/docs/fy10osti/47246.pdf
1,000,000	Conversion	1,000,000	Assumed.
RE	Recovery Energy	0.98	Review of AHRI Directory.
0.003412	MMBtuh to kWh	0.003412	Ohio TRM Assumption.

Using the above inputs, Cadmus calculated per-unit, annual energy savings of 25.2 kWh, resulting in adjusted gross energy savings of 53,992 kWh. Cadmus used peak demand reduction calculations consistent with the Ohio TRM. Peak demand reduction equated to 0.0003 kW per unit installed, for a total demand reduction of 0.63 kW.

Kit Savings

Table 40 shows final inputs and savings estimated for measures distributed in the energy-saving kits. To highlight the large impact of low installation rates, the table includes savings with and without the ISR applied.

Table 40. Kit Savings

Measure	Ex Ante ISR	Ex Post ISR	Unadjusted by ISR		Adjusted by ISR	
			Adjusted Gross kWh Savings	Adjusted Gross kW Savings	Adjusted Gross kWh Savings	Adjusted Gross kW Savings
CFL Bulbs	77%	65%	178,886	18.92	119,721	12.35
Bathroom Aerator	47%	29%	48,705	6.63	15,867	2.11
Kitchen Aerator	55%	32%	242,164	4.83	78,892	1.53
Showerhead	55%	20%	267,504	3.39	55,355	0.69
Total			**737,260**	**34**	**269,835**	**17**

Part-Use Factor

To determine average, per-unit, gross energy savings for refrigerators and freezers, Cadmus applied the program's part-use factor, obtained from the 2014 and 2015 participant surveys; this accounted for participating appliances not plugged in year-round prior to participation. Retirement of appliances not previously in operation or operated for only a part of the year would not yield the full year of energy savings presented below in Table 41. Cadmus analyzed data from the 2014 and 2015 participant surveys to calculate part-use factors, used in the following three participant categories:

Participating units not used for at least one full year prior to recycling were assigned a part-use factor of 0. As the unit did not consume electricity, its retirement did not generate savings.

Recycled units operating the full year prior to participation were assigned a part-use factor of 1.

- To determine part-use factors for units used only a portion of the previous year, Cadmus divided the average number of months such units were used by 12. The part-use factor for these appliances ranged between 0 and 1.

Final, part-use, adjusted gross savings resulted from the weighted average of these three usage scenarios.

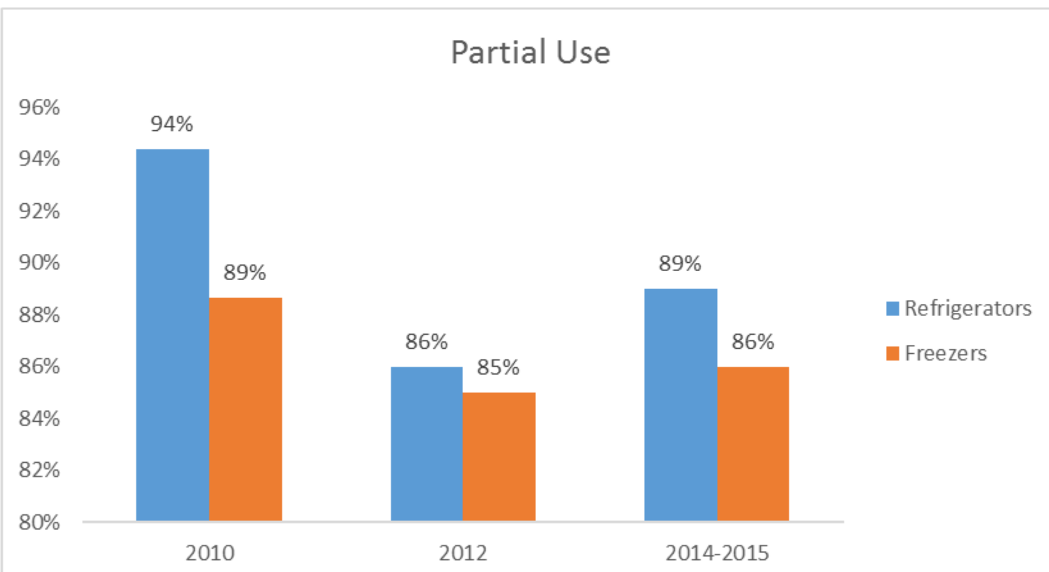
Table 41 illustrates how Cadmus applied part-use factors for each of the three categories to determine average, per-unit, gross, and annual energy savings for refrigerators and freezers.

Table 41. Part-Use Adjusted Gross Per-UES for Refrigerators and Freezers

Operational Status	Recycled Refrigerators			Recycled Freezers		
	Percent of Total Units	Average Part-Use Factor	Part-Use Adjusted Per UES (kWh/Year)	Percent of Total Units	Average Part-Use Factor	Part-Use Adjusted Per UES (kWh/Year)
Not Running	9%	0.00	0	13%	0.00	0
Running Part Time	4%	0.42	456	1%	0.33	284
Running All Time	88%	1.00	1095	85%	1.00	853
Per Unit Average		**0.89**	**976**		**0.86**	**731**

For the 2012 evaluation, Cadmus found part-use factors of 0.94 and 0.89 for refrigerators and freezers, respectively. Though slightly lower than the 2014–2015 findings, none of the part use factors showed statistically significant difference.

Figure 17. 2010, 2012, and 2014–2015 Part-Use Factors



Using the evaluation's findings, refrigerators and freezers exhibited part-use factors of 0.89 and 0.86, respectively.

Based on the part-use, adjusted, per-unit, gross, annual energy savings presented in Table 42 (for 2015), Cadmus determined program-wide, annual, gross energy savings generated by DP&L's participation in 2015 (also shown in Table 42).

Table 42. 2015 Adjusted, Part-Use, Gross, Annual Energy Savings

Appliance	Adjusted Gross Energy Savings Per Appliance (kWh/Year)	Adjusted Gross Demand Reduction Per Appliance (kW/Year)*	2015 Participation	Total Adjusted Gross Savings (kWh/Year)	Total Adjusted Gross Demand (kW/Year)	Precision at 90% Confidence
Refrigerator	976	0.16	2,979	3,261,620	477	± 10%
Freezer	731	0.12	713	607,979	86	± 28%
Total			**3,692**	**3,869,600**	**562**	**± 9.5%**

*Cadmus derived refrigerator and freezer summer coincident peak demand reduction by applying the Ohio TRM formula. Results from this evaluation determined the change in kWh input.

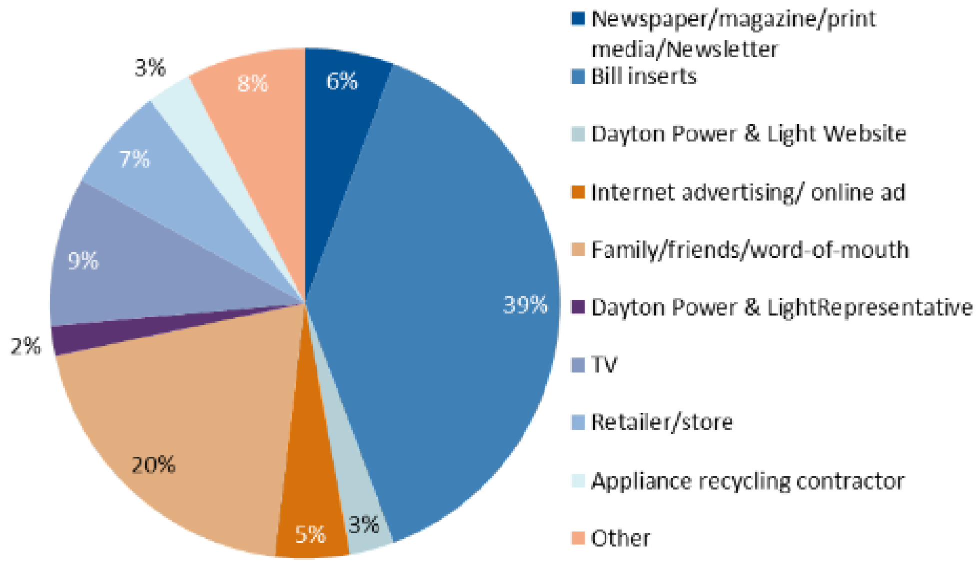
Participant Survey Analysis

DP&L and JACO marketed the ARP through an array of channels, including the following:

- Newspaper advertisements
- Television advertisements
- Online advertising
- A program website
- Customer information sheets
- Bill inserts
- Retailers (e.g., Sears)
- POP advertising

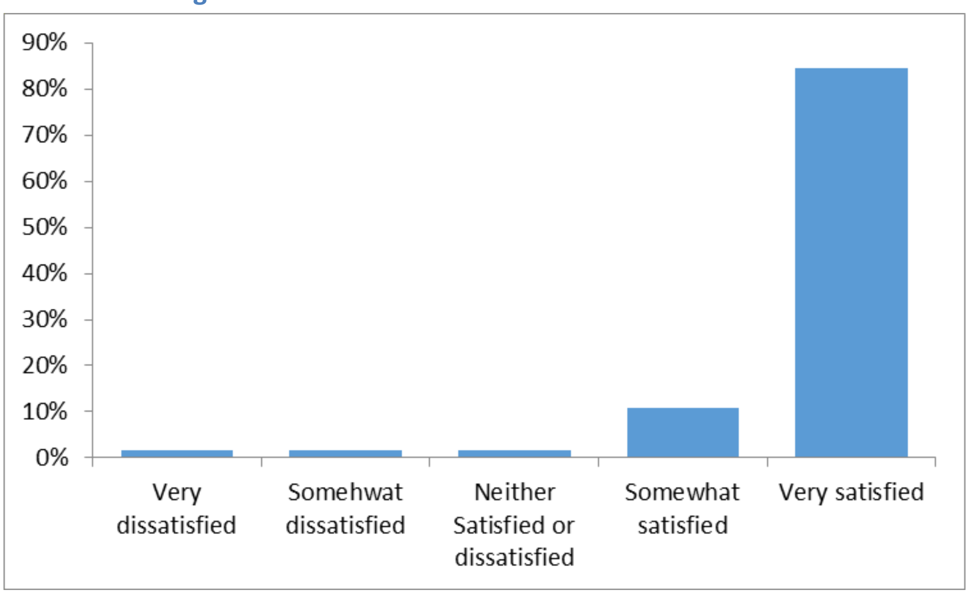
Survey data, shown in Figure 18, found participants primarily learned of the program through bill inserts or some other form of direct mail.

Figure 18. Participant Method for First Hearing About the Program



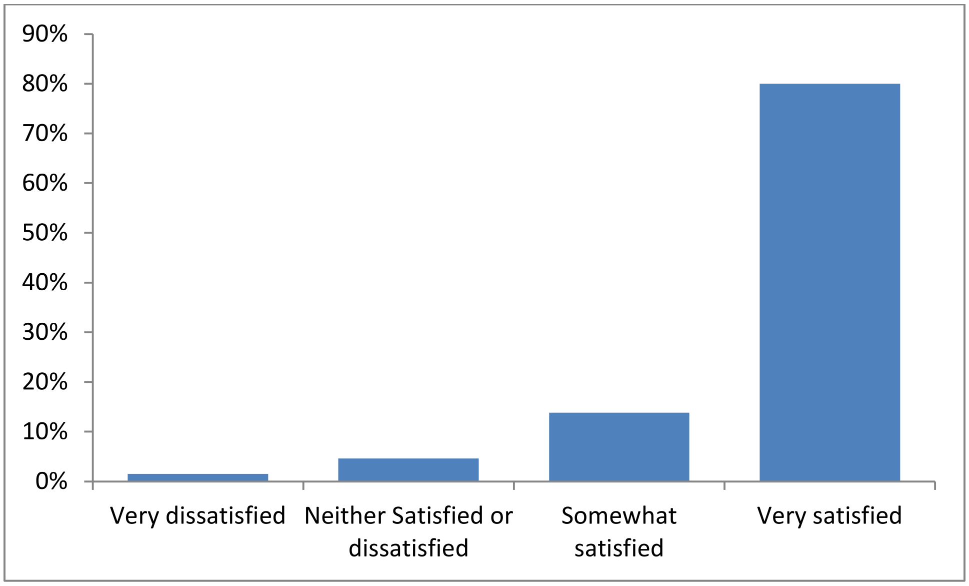
Customers remained satisfied with the incentive level, with 96% of surveyed participants satisfied or somewhat satisfied with the $40 rebate amount, as shown in Figure 19.

Figure 19. Overall Satisfaction with Rebate Amount



As shown in Figure 20, approximately 94% of participants reported being “very satisfied” or “satisfied” with the program, with 80% of all participants awarding it a “very satisfied” rating.

Figure 20. Overall Program Satisfaction



Recommendations

Drawing upon the preceding findings, Cadmus offers the following recommendations:

Although the program has been suspended, consider leveraging the ARP's popularity among past participants to solicit participation in other DP&L programs. DP&L can use lists of past participants to distribute information about new program offerings via direct mail or e-mail. For example, past participants might be enrolled in the appliance rebate program (provided that continues). Reaching out to this group could boost initial program participation as it would target a group of individuals that has shown some consciousness of energy efficiency (i.e., would be more likely to sign up), but historically has not participated in other programs.

Residential Low-Income Program (OPAE)

This chapter describes the evaluation approach, detailed findings, and conclusions and recommendations for the Residential Low-Income Program, implemented by the Ohio Partners for Affordable Energy (OPAE).

Evaluation Overview

Cadmus' evaluation of the 2015 Residential Low-Income Program implemented by OPAE followed researchable questions and evaluation activities outlined in the DP&L *2015 Evaluation, Measurement, and Verification Plan*. Table 43 identifies key researchable evaluation questions.

Table 43. Key Researchable Questions

Researchable Question	Activity Used to Address Question
Does the database accurately capture the key assumptions needed to evaluate savings? Are savings calculated accurately?	• Program database review
What are the estimated gross electric savings and demand reductions generated by the program?	• Engineering analysis • Billing analysis • Billing analysis data collection • Determine comprehensive list of measures in each home
Is this program cost-effective?	• Cost-effectiveness analysis

Detailed Evaluation Findings

DP&L surpassed its energy-savings goal of 1,083,240 kWh and 162 kW, by achieving 1,345,730 kWh and 170.4 kW in adjusted gross savings.

Upon applying results from the billing analysis, the program achieved adjusted gross savings realization rates of 87.6% against *ex ante*-claimed energy savings and demand reduction. DP&L requested that Cadmus calculate *ex ante* savings for the Low-Income program. Cadmus used the quantity and measure details from the program tracking database (CC-System) as inputs to calculate *ex ante* savings (rather than using the savings field from the database).

The following key findings relate to the impact and process evaluation activities:

- Table 44 presents program-level, *ex ante* claimed, verified gross, and adjusted gross savings for energy and demand. As adjusted savings use the billing-analysis, program-level realization rate, Table 44 presents the results at the program level. Appendix K provides measure-level *ex ante* and verified savings.

Table 44. Residential Low-Income Program Claimed and Achieved Energy Savings

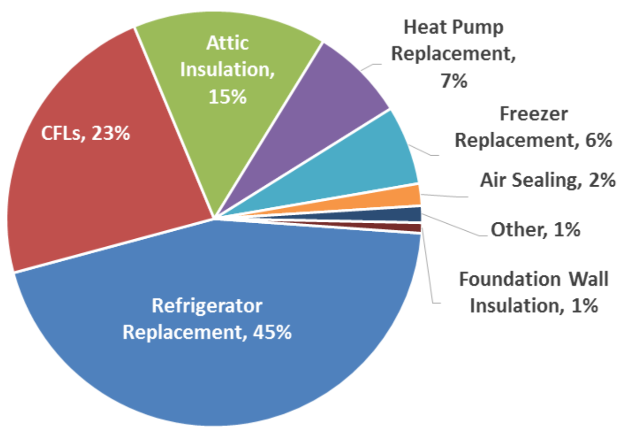
Measure	*Ex Ante* Claimed Savings		Verified Gross Savings		Adjusted Gross Savings		
	kWh	kW	kWh	kW	kWh	kW	Precision*
Program Savings	**1,536,221**	**195**	**1,536,221**	**195**	**1,345,730**	**170**	**± 19%**

* Precision at 90% confidence.

**Values in table may not sum to 100% exactly due to rounding.

- Cadmus calculated adjusted savings by means of a billing analysis, based on a final billing dataset of 471 customers that participated in the OPAE's Low-Income program between 2012 and 2015. The billing analysis employed a PRISM model to calculate the savings, analyzing weather-normalized pre- and post-installation annual usage for each account.
- Figure 21 shows how refrigerator replacement, CFLs, and attic insulation provided 83% of the program's *ex ante* energy savings. The freezer replacement and heat pump replacement also proved significant, contributing another 13% of energy savings.

Figure 21. *Ex Ante* Energy Savings Distribution



- Findings from the billing analysis indicate refrigerators, freezer, lighting, and HVAC *ex ante* savings estimates appeared accurate, while the air sealing, insulation, and water-heating billing analysis savings appeared high. Savings for water heater measures achieved a 68% realization rate while the building envelope measures, air sealing and insulation measures, achieved realization rates of 68% and 66% respectively. Ex ante savings were derived primarily from the Ohio TRM.
- Cadmus met with DP&L, FirstEnergy, and OPAE several times resulting in improvements to the CC-System throughout the year. After database updates had been implemented by First Energy on November 30, 2015, Cadmus identified the following improvements in the database:
  - No missing savings
  - Accurate inputs allowing for correct calculations for insulation and air sealing measures (e.g. minimum R-value for insulation measures and correct SEER values)

- Cadmus found database issues similar to those observed for the previous years' measures, including incorrect key assumptions for estimating savings and inaccurate savings calculations.
- Issues noted regarding program data tracking and reporting did not prove unique to DP&L: during a previous evaluation, interviews with DP&L and FirstEnergy (which administers the database) indicated these issues occurred across other low-income programs using this software.

Evaluation Data Collection Methods

To calculate program energy-saving impacts, Cadmus primarily relied on DP&L participant tracking data, along with savings algorithms provided in the Ohio TRM.

Billing Analysis

Cadmus worked with DP&L to collect billing data for Low-Income participants, starting in July 2014. A billing analysis requires two to four years of electric bills for each customer: the bills must cover pre-installation, installation, and post-installation periods for each home. As DP&L's billing data management system retains billing records for just two years, DP&L provided Cadmus with these records on a rolling basis; so Cadmus could gather more than two years' worth of electric bills for each home.

DP&L and Cadmus began this data collection in July 2014. Each month, DP&L provided electric billing records of participants that participated in the program for that specific month. In January 2016, DP&L provided billing data for all participants included in these monthly batches of billing records. This final dataset provided up-to-date billing information for billing records that had been collected each month.

Comprehensive List of Installed Measures

Cadmus reached out to OPAE to determine a comprehensive list of measures installed in each home. The DP&L program database captured measures DP&L funded, but did not include measures funded by other sources. A comprehensive list of measures would identify measures funded by other sources; so the billing analysis results would reflect DP&L-funded measures.

Database Review

Cadmus worked with DP&L, FirstEnergy Corp. (the database developer and host), and OPAE to review the program database at a measure level and to assess the following:

Does the database accurately and consistently collect key assumptions used in Ohio TRM savings algorithms?

Is the database consistent and accurate in calculating energy savings?

Specifically for the second item, Cadmus worked to address the following issues that arose during the 2012, 2013, and 2014 program evaluations:

- Electric savings were not calculated for homes that apparently should have received them.

- Savings were incorrectly calculated.

Cadmus met with DP&L, FirstEnergy, and OPAE on four occasions—twice in 2015 and twice in 2016—to discuss the above issues that affect savings in the CC-System. The meetings resulted in FirstEnergy implementing programming updates in the CC-System and OPAE providing updated guidance to the agencies entering information into the CC-System.

Impact Evaluation Methodology and Findings

Engineering Analysis

Cadmus used the methodologies and inputs prescribed by the Ohio TRM to calculate *ex ante* and verified savings. Some measures required updating the methodology and inputs for the following reasons:

- Inaccurate inputs provided by the CC-System database
- Outdated methodology and inputs

For air-sealing and insulation measures, Cadmus applied thresholds on specific input assumptions to limit unreasonably high savings. Specifically, this limited air-sealing improvements to 30% (i.e., some cases had leakage improvements greater than 50%). For attic and wall insulation measures, Cadmus set respective savings thresholds at 50% and 20% of total home heating energy usage. Adjustments to pre- and post-R-values accounted for the insulating effect of roof and wall structures, as shown in Table 45. These R-value adjustments drew upon modeling assumptions Cadmus used in the 2012 DP&L Potential Study.[14]

Table 45. R-Value Adjustments to Account for a Structure's Insulating Effect

Insulation	R-Value Adjustment
Ceiling	5.00
Wall	4.37
Foundation Wall	2.32

Table 46 summarizes additional updates and provides a complete source list for measure-level savings.

[14] The *2012 DP&L Potential Study* can be found in the *DP&L 2013–2015 Portfolio Plan Filing*.

Table 46. Savings Sources and Updates

Measure	Source and Update
CFLs	Residential Lighting program methodology: lumens equivalence and delayed EISA baselines based on 2015 shelf stocking study. 2013 Low-Income evaluation: ISR of 97%.
Energy-Efficient Showerhead	Cadmus 2012 Michigan water meter study: engineering algorithms and inputs.
Faucet Aerator	Cadmus 2012 Michigan water meter study: engineering algorithms and inputs.
LED Nightlight	2013 Indiana TRM: methodology and inputs.
Freezer Replacement	Cadmus replacement appliance savings calculator: ENERGY STAR UEC.
Refrigerator Replacement	Ohio TRM Joint Objections and Comments: updated existing UEC.
Water Heater Pipe Insulation	ACEEE Report Number E093, p. 117, April 2009: energy-savings factor.
Smart Strip	Mid-Atlantic TRM V5.0: installation rate.

Billing Analysis

Methodology

DPL provided billing data and tracking data for participants from 2012–2015 to perform billing analysis and to estimate OPAE energy savings overall, for measure groups and for "other" measure groups. Cadmus used the billing analysis results to establish the program's adjusted gross savings.

DP&L provided billing data for the OPAE program in various extracts. Tracking data included details about measures installed, installation dates, other program participation, and participant details. Cadmus populated the *ex ante* savings estimates based on engineering estimates for all measures installed through the program from previous program periods.[15]

Finally, Cadmus obtained earliest and latest participation dates for all measures installed, and combined this customer-level, measure category information with the billing data.

In conducting the billing analysis for the Residential Low-Income program, Cadmus completed the following steps:

- Matched measure data from the tracking database with electric billing data.
- Used zip code mapping to determine the nearest weather station for each zip code.
- Obtained daily average temperature weather data (July 2012 through January 2016) for six NOAA weather stations, representing all zip codes associated with participants.
- Used daily average temperatures to determine base 45–85 HDDs and CDDs for each station.
- Obtained typical meteorological year 3 (TMY3; 1991–2005) annual normal heating and CDDs to weather normalize the billing data.

[15] For the past several years, Cadmus has calculated *ex ante* savings on DP&L's behalf.

- Matched billing data periods with the CDDs and HDDs from the associated stations.

Data Screening

Cadmus removed the following elements from the analysis:

- Electric billing data monthly readings where usage fell below 1 kWh per day
- Participant and nonparticipant customers with fewer than 10 pre- and 10 post-installation months

This ensured pre- and post-installation periods remained well balanced and the PRISM models represented all seasons.

Energy Savings Summaries

Table 47 presents overall average savings, estimated by the PRISM models, realization rates, and associated standard errors around the savings estimates. Overall, the average OPAE program participant's usage changed by 1,533 kWh or 12% from the pre-period to the post-period. The nonparticipant group, however, experienced increased usage of 729 kWh over the same period (a 5% increase). As a result, net participant savings were 2,157 kWh. Compared to the 2,461 kWh *ex ante* savings estimate, this represents an 88% realization rate. With average pre-installation period usage of 12,700 kWh, savings represent a 17% reduction in home energy usage.

Table 47. OPAE Overall Billing Analysis Results

Group	n	Model Savings	*Ex Ante* Savings	Realization Rate	Relative Precision 90% Confidence Level	Pre Period NAC	Adjusted Gross % Savings	*Ex Ante* % Savings
Participant	471	1,533*	2,461	62%	11%	12,700	12.1%	19.4%
Nonparticipant	143	-729	-	-	52%	14,848	-4.9%	-
Participant Adjusted Gross	**471**	**2,157**	**2,461**	**88%**	**19%**	**12,700**	**17.0%**	**19.4%**

*As a check, the monthly, fixed-effects, CSA modeling approach yielded an identical result: 1,533 kWh savings with a 90% relative precision of 11%. As discussed, only PRISM estimates were used to derive model savings.

Although sample sizes did not permit obtaining measure-level savings estimates, Cadmus estimated measure group savings. Table 48 (below) provides the adjusted gross measure group results (i.e., adjusted for the nonparticipant group change in usage).

Most customers installed lighting measures and refrigerators and/or freezers. Though Cadmus could not obtain savings estimates for refrigerators and freezers separately due to small sample sizes (n=13), savings averaged 1,334 kWh (a 78% realization rate) compared to the 1,718 kWh *ex ante* estimate. This suggested lower refrigerator and freezer savings than expected. Customers that installed lighting measures, refrigerator/freezer measures, and HVAC measures, along with other measures, achieved close to the average realization rate, indicating the *ex ante* estimates for these measures remain fairly accurate.

Table 48 also shows that customers that received air sealing and insulation in addition to other measures achieved lower average realization rates (i.e., in the 66%–68% range). Thus, although the customers receiving air sealing and insulation measures saved a considerable amount (over 4,000 kWh), savings were not as high as the expected 6,000 kWh. Pre-period usage for customers receiving air sealing and insulation also nearly doubled the average, indicating electric heat usage. They did not, however, save in the expected 27% range—rather more in the 18% range. Similarly, it seems water-heating measures did not save as much as expected: customers expected to save 22% only achieved 15% savings, for a 68% realization rate.

Although not measure-specific results, these findings indicate refrigerators, freezer, lighting, and HVAC *ex ante* savings estimates appeared accurate, while the air sealing, insulation, and water-heating billing analysis savings appeared high.

Table 48. OPAE Adjusted Gross Measure Group Energy Savings from Billing Analysis

Measure Group	n	Model Savings	*Ex Ante* Savings	Realization Rate	Relative Precision 90% Confidence Level	Pre Period NAC	Modeled Percent Savings	*Ex Ante* Percent Savings
Overall	**471**	**2,157**	**2,461**	**88%**	**19%**	**12,700**	**17.0%**	**19.4%**
Refrigerators/Freezers	379	2,068	2,383	87%	20%	11,799	17.5%	20.2%
Refrigerators/Freezers Only	13	1,334	1,718	78%	80%	11,870	11.2%	14.5%
HVAC	1	4,104	3,921	105%	9%	16,749	24.5%	23.4%
Air Sealing	41	4,278	6,265	68%	19%	23,774	18.0%	26.4%
Insulation	46	4,064	6,196	66%	19%	22,375	18.2%	27.7%
Lighting	447	2,159	2,411	90%	19%	12,460	17.3%	19.4%
Water Heating	47	2,912	4,264	68%	28%	19,461	15.0%	21.9%
Other	3	456	1,372	33%	255%	16,803	2.7%	8.2%

Comprehensive List of Installed Measures

One task associated with the billing analysis included compiling a comprehensive list of measures installed in participant homes to better allocate billing analysis savings to DP&L-funded measures. After meeting with DP&L and OPAE, Cadmus determined compiling a comprehensive list of installed measures in participant homes could not be conducted in a straightforward manner: the information was not compiled in a single location and existed only on paper applications. Collecting this information for 1,000+ customers would have placed a significant burden on OPAE.

Alternatively, Cadmus employed an alternative method to accomplish a similar outcome to collecting a comprehensive list of installed measures. As discussed in the Engineering Analysis section, Cadmus identified a marker in the billing data denoting a customers' participation in Ohio's Home Weatherization Assistance Program (HWAP). Removing these customers from the billing analysis eliminated capturing some savings not funded by DP&L.

Database Review Findings

Cadmus reviewed the CC-System database and identified many elements that worked, along with issues related to data integrity and savings calculations. The review identified improvements that persisted from the previous year, including the following:

- Very few cases of homes without electric heating and/or central cooling received shell measures
- Most pertinent database fields were populated

The database review also identified several improvements in CC-System data tracking relative to the previous year, including the following:

- The new database field specifying the program year for tracking savings and costs
- Following database updates that First Energy implemented on November 30, 2015: no missing savings and accurate inputs allowing for correct calculations for insulation and air sealing measures (e.g. minimum R-value for insulation measures and correct SEER values)

Cadmus’ review of the CC-System, along with feedback from several meetings with FirstEnergy, OPAE, and DP&L, identified several database issues that could be addressed by updating the CC-System code or updating the way OPAE’s agencies input data into the system. The review focused on measures contributing significant savings to the program; it also reveals significant issues with the savings calculations (i.e., primarily air sealing and insulation measures [wall, attic and foundation wall insulation]).

This evaluation did not verify the implementation of proposed solutions (discussed further below). The following evaluation should verify whether or not the solutions have been implemented correctly and that the solutions have addressed the associated issues. While these issues affected DP&L program data tracking and reporting, they were not DP&L-specific. The same issues could affect other Ohio utility low-income weatherization programs using the same database system.

One identified issues is specific to cases where insulation measures are installed in homes using heat pumps: heat pump heating efficiencies have been input into the CC-System incorrectly. For insulation measures, the savings algorithm requires heating efficiencies in decimal units (e.g., 0.99) as opposed to units associated with the HSPF (e.g., HSPF = 6.8). Agencies typically assume heat pump heating efficiencies of 0.99, while typical heat pumps have efficiencies of 1.99 and higher. The heat pump heating efficiency may be calculated by dividing the HSPF by 3.412 and multiplying the result by 100 (e.g., for an HSPF of 6.8: 6.8 ÷ 3.412 x 100 = 199). OPAE plans to instruct agencies to input heat pump heating efficiencies correctly for insulation measures.

The review also identified that the CC-System calculates kW demand reduction incorrectly for insulation. The CC-System calculates kW demand reduction for insulation using heating and cooling savings, when the calculation should use only cooling savings. FirstEnergy plans to update the kW demand reduction calculation to be based solely on cooling savings.

The CC-System review identified cases of electrically heated homes receiving shell measures while the CC-System did not calculate electric savings. Meetings with FirstEnergy and OPAE revealed that if inputting "Job Type" into the CC-System as "Base Load" (rather than “Heating Customer”), the CC-System assumes the home has gas heat and does not calculate heating savings for shell measures. The review identified a small number of cases where this occurred, leading to the CC-System calculating zero for these homes.

The CC-System review also identified two overarching issues that manifest differently in the CC-System. Table 49 summarizes these issues, notes how they manifest in CC-System savings, and discusses how FirstEnergy and OPAE plan to address them.

Table 49. Reported Savings Issues and Solutions

Issue	Manifestation	Solution
A disconnect exists between the type of variable the CC-System expects and the type of variable input by the agencies.	For air-sealing and insulation measures, the CC-System was setup to receive heating efficiencies as decimal numbers (e.g., 0.99), and the agencies input heating efficiencies as whole numbers (e.g., 99), leading to the CC-System calculating savings too low by orders of magnitude (as the savings calculations divide by the heating efficiency).	FirstEnergy will update the CC-System calculation to divide the heating efficiency by 100.
	For insulation measures, the agencies input an initial R-value of 0 when no insulation existed in a home, leading to errors when the CC-System attempted to calculate savings (and resulting in zero savings for the measure). The OH TRM specifies using a minimum R-value of 5 to account for the insulating effect of building materials.	FirstEnergy will apply a constraint to the “Initial R-value” field in the CC-System, allowing only inputs of “5” or greater.
	For air-sealing and HVAC tune-up measures, the CC-System was setup to receive system capacities in units of “Btuh” (e.g., 24,000 Btuh) and the agencies input the system capacities in units of “Tons” (e.g., 2 tons), leading to the CC-System calculating savings too low by orders of magnitude (as the savings calculations multiply by the system capacity).	FirstEnergy will apply a constraint to the “System Capacity” field in the CC-System, allowing only inputs of “3,000” or greater.
The CC-System does not report savings for measures with deemed savings.	The smart strip measure appears in the CC-System as producing no reported savings.	FirstEnergy will update the CC-System to assign OH TRM savings of: 56.6 kWh and 0.0063 kW to 5-plug smart strips; and 102.8 kWh and 0.012 kW to smart strips with more than 5 plugs.
	The water heater temperature setback measure appears in the CC-System as producing no reported savings.	FirstEnergy will update the CC-System to assign savings of 92kWh and 0.11 kW, per the 2014 program evaluation for each installation.

Recommendations

Drawing upon the preceding findings, Cadmus offers the following recommendations:

- **The 2016 evaluation should verify that solutions identified and implemented during the 2015 evaluation have addressed the associated issues.** While the 2014 and 2015 evaluation identified several issues and appropriate solutions, implementation of all of these solutions could not be verified during the 2015 evaluation.
- **Implement CC-System updates so such updates apply to affected measures for the entire program year.** Updates implemented midyear could lead to inconsistent savings calculations in the CC-System and introduce challenges to effectively evaluating the data.
- **Continue to perform measure-by-measure reviews of the CC-System, in concert with the database administrator and the CAP agencies, to address all remaining database issues.** The 2015 program year review focused on measures that represented large portions of 2015 program savings. Issues may remain with measures achieving smaller portions of program savings (e.g., smart strips) and/or measures not installed in the 2015 program year (e.g., duct sealing).
- **Continue to collect monthly billing data for Low Income participants.** Continuing to collect these billing data will create a more robust dataset for a future billing analysis, including more participants and longer data periods for each participant. Performing a billing analysis in subsequent years using a more robust dataset will produce results with improved accuracy and precision.

Residential Low-Income Program (PWC)

This chapter describes the evaluation approach, detailed findings, and conclusions and recommendations for the Residential Low-Income Program, implemented by People Working Cooperatively (PWC). In 2015, DP&L launched this program as a pilot, operating independently from OPAE's Low-Income program. The program installs energy efficiency measures in customers' homes as part of a broader mission to help low-income, elderly, and disabled homeowners stay in their homes.

Evaluation Overview

Cadmus' evaluation of the 2015 Residential Low-Income Program, implemented by OPAE, followed researchable questions and evaluation activities outlined in the DP&L *2015 Evaluation, Measurement, and Verification Plan*. Table 50 identifies key researchable evaluation questions.

Table 50. Key Researchable Questions

Researchable Question	Activity Used to Address Question
What gross electric savings and demand reductions did the program generate?	• Program database review. • Engineering analysis.
What were the program's achievements and challenges?	• Stakeholder interviews.
Which aspects of the program design worked well and which can be improved?	• Stakeholder interviews.
Is the pilot study cost-effective?	• Cost-effectiveness analysis.

Detailed Evaluation Findings

As *ex ante* and adjusted savings are the same values, adjusted gross savings represent realization rates of 100% and 100% against *ex ante*-claimed energy savings and demand reduction, respectively. DP&L requested that Cadmus calculate *ex ante* savings for the Low-Income program. Because Cadmus used all current and available information to inform both the *ex ante* savings and adjusted gross savings, the two savings are equal.

The following key findings relate to the impact and process evaluation activities:

- Table 51 presents program *ex ante* claimed, verified gross, and adjusted gross savings for energy and demand.

Table 51. Residential Low-Income Program Claimed and Achieved Energy Savings

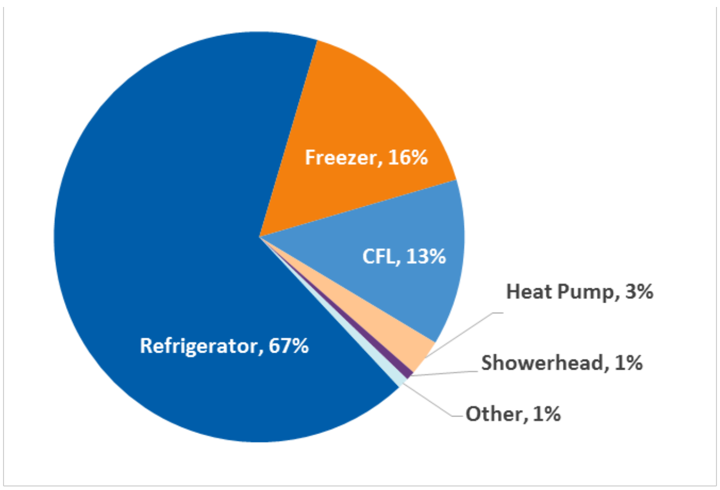
Measure	*Ex Ante* Claimed Savings		Verified Gross Savings		Adjusted Gross Savings		
	kWh	kW	kWh	kW	kWh	kW	Precision*
Central AC	477	0.314	477	0.314	477	0.314	± 10%
CFL	20,712	2.190	20,712	2.190	20,712	2.190	± 15%
Faucet Aerator	432	0.122	432	0.122	432	0.122	± 13%
Freezer	25,144	3.809	25,144	3.809	25,144	3.809	± 10%
Heat Pump	4,513	0.942	4,513	0.942	4,513	0.942	± 10%
Pipe Insulation	219	0.025	219	0.025	219	0.025	± 14%
Refrigerator	105,084	16.161	105,084	16.161	105,084	16.161	± 10%
Showerhead	1,137	0.084	1,137	0.084	1,137	0.084	± 16%
WH Wrap	255	0.029	255	0.029	255	0.029	± 12%
Total**	**157,974**	**24**	**157,974**	**24**	**157,974**	**24**	**± 7%**

* Precision at 90% confidence.

**Values in table may not sum to 100% exactly due to rounding.

- Figure 22 shows how the program focused on refrigerator replacements, CFLs, and freezer replacements for DP&L-funded measures in the homes of 175 participants. These measures provided the vast majority of savings: 96% of program kWh savings.

Figure 22. Energy Savings Distribution



- With guidance from DP&L and Cadmus, PWC built an Excel database to collect all data points necessary to evaluate measure savings. These three groups met several times during the evaluation to discuss database updates that improved the data quality and completeness of information collected. At the end of the evaluation period, Cadmus used the database to calculate *ex ante*, verified, and adjusted savings for the program.

Evaluation Data Collection Methods

Database Review

Cadmus worked with DP&L to review PWC's tracking database and to assess if that database accurately and consistently collected key assumptions used in Ohio TRM savings algorithms. At the beginning of the program, Cadmus provided PWC with a data collection guide that specified required data collection fields for each measure.[16] Twice during the evaluation period, PWC sent the latest, accumulated data to DP&L and Cadmus for review. Upon reviewing the collected data for comprehensiveness and completeness, Cadmus provided feedback to PWC during the evaluation period.

Stakeholder Interviews

Cadmus conducted two stakeholder interviews: one with two DP&L staff; and one with three PWC staff. These interviews explored program design and implementation, marketing and outreach, program successes and challenges, and data tracking.

Impact Evaluation Methodology and Findings

Database Review Findings

Cadmus reviewed PWC's data workbook several times during the evaluation period to assess if the dataset contained all information necessary to evaluate savings. Overall, the database included most of the critical information required. Cadmus identified the following issues:

- Duplicate records
- Data populated in incorrect fields (e.g., "INDOOR" input into "Qty Installed Outdoor" field)
- Unclear data fields and associated data (e.g., the "Yes" and "No" inputs in a field titled "AC Installed, Yes/No" did not clearly convey if a new A/C unit had been installed or was simply present at the home)
- Missing data

PWC made updates to the database and data collection process to address the feedback identified above. The final database contained all of the information Cadmus needed to calculate program savings.

Engineering Analysis

Cadmus used the same inputs and methods to calculate *ex ante*, verified, and adjusted gross savings for measures in the database. Whenever possible, these included methodologies and inputs prescribed by the Ohio TRM to calculate savings. Some measures required updating methodologies and inputs for the following reasons:

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[16] The data collection guide was based on the Low Income database field review completed for OPAE's Low-Income program as part of the 2013 Evaluation (Appendix E:, p. 170): http://dis.puc.state.oh.us/DocumentRecord.aspx?DocID=fb8f219b-4024-4694-9908-1b2731540eb5

- Inaccurate inputs provided by the CC-System database
- Outdated methodology and inputs

In all cases, Cadmus calculated *ex ante* and verified savings using methodologies and inputs consistent with the Low Income program implemented by OPAE. Table 52 summarizes all updates to the Ohio TRM methodologies:

Table 52. Savings Sources and Updates

Measure	Source and Update
CFLs	Residential Lighting program methodology: lumens equivalence and delayed EISA baselines, based on the shelf stocking study. 2013 Low Income Evaluation: ISR of 97%.
Energy-Efficient Showerhead	Cadmus 2012. Michigan water meter study: engineering algorithms and inputs.
Faucet Aerators	Cadmus 2012. Michigan water meter study: engineering algorithms and inputs.
Freezer Replacements	Cadmus replacement appliance savings calculator: ENERGY STAR UEC.
Refrigerator Replacements	Ohio TRM Joint Objections and Comments: updated existing UEC.
Water Heater Pipe Insulations	ACEEE Report Number E093, p. 117; April 2009: energy-savings factor.

Process Evaluation Findings

Stakeholder Interview Findings

Cadmus conducted two stakeholder interviews with DP&L and PWC to explore the pilot's design and implementation, program successes and challenges, data tracking, and program goals and outcomes.

Program Design and Implementation

In 2015, DP&L launched the pilot Residential Low-Income Weatherization Program through PWC. A nonprofit organization serving low-income, elderly, and disabled homeowners, PWC provides home repairs, weatherization, modification, and maintenance services to help residents safely stay in their homes.

Through the program, DP&L provides funding and administration support for PWC to provide weatherization services and to make energy efficiency upgrades as part of the existing program and home repair services it provides to customers. Participating customers receive a home audit to identify energy savings and home improvement opportunities. Through the program, customers may receive energy-saving measures such as window and door sealing, CFLs, faucet aerators, pipe wraps, and—in limited cases—equipment replacement (e.g., refrigerators, heat pumps).

According to the PWC interviewees, the organization typically reaches out to potentially eligible customers. PWC also conducts some outreach to other agencies providing low-income services within DP&L’s service territory, informing them of these energy-saving services. PWC interviewees said they primarily identified potential customers using two sources:

- PWC's database of existing clients receiving services through the organization
- Targeting DP&L customers who participate in the Percentage of Income Payment Plan Plus, an extended payment arrangement that helps customers maintain their natural gas and/or electric service.

PWC then works with DP&L to target services through identifying customers with high energy consumption. According to PWC interviewees, identifying eligible customers, with high energy consumption within DP&L service territory and using electric heat, has been one of the most significant barriers PWC faces with the program. To help overcome this challenge in the future, PWC interviewees requested that DP&L offer additional support in targeting customers. For example, PWC would prefer DP&L provide a list of customers with high energy use (i.e., customers that DP&L would like PWC to target) rather than PWC providing DP&L with customer lists and asking DP&L to look these up in the system to determine whether they can be considered high energy consumption households.

Program Goals and Outcomes

In 2015, the program sought to achieve the following goals:

- Complete 350 projects
- Achieve 525,000 kWh in energy savings

The program fell short of both goals, completing 175 projects and achieving 157,974 kWh in savings. DP&L and PWC stakeholder interviewees noted the program experienced a slow start. PWC interviewees explained they initially had difficulty in securing funds from other organizations for non-energy home repairs—funds which PWC needed for ramping up the program. They explained that the difficulty in identifying target customers also presented a barrier to achieving their project and energy-savings goals, but they believed assistance from DP&L in identifying target customers could help them reach more customers.

Recommendations

Drawing upon the preceding findings, Cadmus offers the following recommendations:

During the evaluation period, continue to hold meetings to discuss database and data collection, ensuring the quality and completeness of data. Though the final dataset used for the evaluation contained the information necessary for calculating savings, some of the database issues identified through the evaluation could resurface during the next evaluation period. Resolving such issues during the program period would be far simpler than doing so at the end.

Residential Heating and Cooling Rebate Program

This chapter describes Cadmus' evaluation approach, detailed findings, conclusions, and recommendations for the Residential Heating and Cooling Rebate Program.

Evaluation Overview

Cadmus' evaluation of the 2015 Residential Heating and Cooling Rebate Program followed researchable questions and evaluation activities outlined in the DP&L *2015 Evaluation, Measurement, and Verification Plans*. Table 53 identifies key researchable evaluation questions.

Table 53. Key Researchable Questions

Researchable Questions	Activity Used to Address Question
What are the program gross electric savings and peak demand reductions?	• Program database review. • Application of 2013 program billing analysis results for heat pumps, central air conditioners, and electronically commutated motor (ECM) measures. • Ohio TRM calculation and assumption review. • Perform billing analysis or engineering calculations for programmable thermostats. • Engineering calculations.
Is this program cost-effective?	• Cost-effectiveness analysis.

Consistent with impact methods employed in previous years, the 2015 impact evaluation focused on a regression analysis of billing data from 2009, 2010, 2011, and 2012 program participants. As the analyses considered all customers participating in the program since 2009, annual UES estimates fluctuated only slightly from year-to-year. As no significant program changes were planned for included measures for 2015 and to ensure efficient use of evaluation resources, Cadmus applied the UES estimates calculated as part of the 2013 program evaluation to the 2015 participant data.

Detailed Evaluation Findings

DP&L exceeded its energy savings goal of 8,814,339, achieving 9,490,639 kWh in adjusted savings. The 2015 program fell short of the demand reduction goal of 2,712 kW, achieving 1,619 kW in adjusted demand reduction. *Ex ante* savings were 9,602,721 kWh and 1,656 kW. Adjusted gross savings compared to *ex ante* savings represented realization rates of 99% for energy and 98% for demand reduction. The following key findings relate to the impact and process evaluation activities:

- Table 54 presents program *ex ante* claimed and adjusted gross savings and demand reduction.

Table 54. Residential Heating and Cooling 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*
ER AC 14/15 SEER	1,217,433	495	1,217,433	495	1,217,433	470	1.7%
ER AC 16+ SEER	1,198,245	487	1,198,245	487	1,198,245	474	1.6%

Measure	*Ex Ante* Claimed Savings		Verified Gross Savings		Adjusted Gross Savings		
	kWh	kW	kWh	kW	kWh	kW	Precision*
NC AC 14/15 SEER	7,065	4	7,065	4	10,450	4	10.0%
NC AC 16+ SEER	19,771	8	19,771	8	24,474	10	10.0%
RP AC 14/15 SEER	11,177	7	11,177	7	11,177	5	7.3%
RP AC 16+ SEER	9,798	4	9,798	4	10,317	4	10.0%
ER HP 14/15 SEER	1,685,861	219	1,685,861	219	1,685,861	206	2.9%
ER HP 16+ SEER	1,617,511	218	1,617,511	218	1,617,511	231	3.3%
NC HP 14/15 SEER	39,155	6	39,155	6	31,389	5	10.0%
NC HP 16+ SEER	37,091	5	37,091	5	50,229	6	10.0%
RP HP 14/15 SEER	33,724	5	33,724	5	25,216	3	10.0%
RP HP 16+ SEER	33,442	4	33,442	4	40,810	5	10.0%
ER GSHP 16/18 EER	475,142	24	475,142	24	486,696	22	10.0%
ER GSHP 19+ EER	602,754	40	602,754	40	762,588	40	10.0%
NC GSHP 16/18 EER	193,897	10	193,897	10	164,223	9	10.0%
NC GSHP 19+ SEER	146,102	11	146,102	11	135,312	9	10.0%
RP GSHP 16/18 EER	27,934	1	27,934	1	19,714	1	10.0%
RP GSHP 19+ EER	40,278	3	40,278	3	34,908	3	10.0%
NC MS AC 16+ SEER	1,170	1	1,170	1	1,381	1	10.0%
NC MS HP 14/15 SEER	6,769	0	6,769	0	9,193	1	39.2%
NC MS HP 16+ SEER	304,510	17	304,510	17	298,600	22	38.6%
ECM**	366,897	86	366,897	86	366,897	86	12.6%
ECM with New AC	670,873	0	670,873	0	670,873	0	19.2%
ECM with New HP	39,045	0	39,045	0	0	0	0%
Programmable Thermostat with AC	215,149	0	215,149	0	337,512	0	10.0%
Programmable Thermostat with HP	497,491	0	497,491	0	228,096	0	10.0%
Programmable Thermostat with GSHP	95,079	0	95,079	0	41,319	0	10.0%
Smart Thermostat with AC	2,681	0	2,681	0	4,168	0	10.0%
Smart Thermostat with HP or GSHP	1,492	0	1,492	0	858	0	10.0%
Heat Pump Water Heater - Electric Home	5,188	1	5,188	1	5,188	1	10.0%
Total* **	**9,602,721**	**1,656**	**9,602,721**	**1,656**	**9,490,639**	**1,619**	**2.32%**

* Precision at 90% confidence.

** Electronically commutated motor.

*** Values in table may not sum exactly to total due to rounding.

- Adjusted gross savings for 2015 exceed the 2014 level by 1,468,674 kWh—an increase of 18.3%. The jump in savings results from increases in participation in several measures, including high-efficiency central air conditioners (CACs) and air-source heat pumps and ECM fan motors for furnaces, CACs, and air source heat pumps. The addition of thermostat measures also contributed significantly.
- Demand reduction increased only slightly over 2014 levels: by 20 kW (just over 1%). Thermostat measures could be a reason that savings increased at a higher percentage than demand reduction: these measures contributed 612,053 in adjusted gross kWh savings, but did not reduce peak demand. Another factor was a trend towards somewhat higher replacement-system energy-efficiency rating (EER) values for CAC and air-source heat pump systems, in effect lowering unit demand reduction.
- The program's 99% realization rate for energy savings resulted largely from the application of the billing analysis results to determine *ex ante* and adjusted savings. Measures where UES were deemed from billing analysis results—CACs, air source heat pumps, and ECM furnace fans—resulted in more than 70% of program savings; all of these measures achieved a 100% realization rate.
- Demand reduction's 98% program realization rate reflected overall close tracking between *ex ante* and adjusted savings. Differences between *ex ante* and adjusted demand reduction for specific measures often resulted from differences in identified EERs for CAC, air-source heat pump, and ground-source heat pump measures. For the *ex ante* savings estimates, demand savings were based on unit savings from the 2013 Cadmus evaluation, which were calculated using EER values somewhat different than average EER values of existing units identified in the 2015 data.

Evaluation Data Collection Methods

In evaluating the 2015 program, Cadmus used the approaches detailed below.

Program Participant Utility Bill Regression Analysis and Engineering Review

Cadmus used billing results from the 2013 program evaluation, as significant changes did not occur between the 2009 and 2015 program years regarding program delivery, customers targeted, or required efficiency levels for all applicable measure types. The evaluation compared the equipment characteristics of the billing analysis sample against the 2015 program data and found good agreement between the two. Cadmus used the billing analysis results to evaluate measure-level kWh estimates.

Where billing analysis results proved unavailable, Cadmus performed an engineering review based on the Ohio TRM. The evaluation team included additional primary and secondary sources as needed to supplement the TRM guidelines. Cadmus used engineering calculations to help evaluate measure-level kWh savings for ground-source heat pumps, mini-split heat pumps, ECM measures, and thermostat measures. The evaluation also relied on engineering calculations in evaluating measure-level kW savings for all measures.

Data Tracking System Review

Cadmus reviewed the final 2015 program tracking database for input, accuracy, and completeness of data tracked. The review determined whether the tracking database contained the following:

- Data necessary to calculate the collected savings
- Reported savings estimates matching the measure types
- Existing and installed equipment types meeting the measure requirements

As previous evaluation efforts identified few tracking data issues for this program, Cadmus only conducted a brief review of tracking data elements that did not directly inform savings calculations in 2015.

Programmable Thermostat Customer Survey

Cadmus conducted a phone survey with 70 DP&L customers who received rebates for purchasing a programmable or smart thermostats through the Residential Programs' Heating Rebates component. This survey provided detailed information on customers' motivations for purchasing new programmable thermostats, usage patterns of old and new thermostats, types of heating and cooling equipment in customers' homes, and customers' demographic characteristics.

Impact Evaluation Methodology and Findings

For the Residential Heating and Cooling Rebate Program, this report first presents energy savings, with results for the various measures organized by the evaluation method used. Discussion of demand reduction follows, also organized by evaluation method.

Participant Utility Bill Regression Analysis UES Estimates

Table 55 summarizes UES estimates (with acceptable precision levels) calculated through the participant billing analysis.[17] Generally, per-unit, adjusted, gross savings estimates matched *ex ante* estimates provided by DP&L and the program implementer. Cadmus used engineering calculations to quantify savings for ECM measures.

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[17] Consistent with the previous evaluation, Cadmus used a pre- and post-fixed effects modeling approach. Cadmus Evaluation 2013 *EM&V Report*, filed May 15, 2014, Case No. 14-738-EL-POR: http://dis.puc.state.oh.us/DocumentRecord.aspx?DocID=fb8f219b-4024-4694-9908-1b2731540eb5

Table 55. Measure Savings Estimates (kWh)

Measure	Accounts in Analysis	*Ex Ante* UES Estimate	Adjusted Gross UES Estimate	Realization Rate
ER AC 14/15 SEER	3,315	1,089	1,089	100%
ER AC 16+ SEER	2,287	1,246	1,246	100%
RP AC 14/15 SEER	117	196	196	100%
ER HP 14/15 SEER	1,152	3,093	3,093	100%
ER HP 16+ SEER	793	3,301	3,301	100%
ECM	205	758	758	100%
ECM with New AC	205	417	417	100%

When applying results from the participant billing analysis for ECM measures, Cadmus only included heating savings for ECMs installed with new CACs, as the system's AHRI SEER rating should account for ECM savings in cooling mode. The Cadmus 2012 *EM&V Report*[18] discusses this issue more thoroughly. Similarly, Cadmus did not include savings in heating or cooling modes for ECMs installed with heat pumps as savings for cooling and heating should be accounted for in the system's AHRI SEER and HSPF ratings.

To verify that including participants from previous program years did not introduce bias and that the billing analysis sample population remained comparable to the overall 2015 program population for these measure categories, Cadmus used the following areas in comparing the two groups:

- Average SEER rating of incented equipment
- Average size (tons) of incented equipment
- Average SEER rating of replaced equipment
- Average size (tons) of replaced equipment

Table 56 and Table 57 compare these populations.

Table 56. Comparison of Billing Analysis Sample to Program Population: Incented Equipment

Measure	Average SEER		Average Size (Tons)	
	Sample	Population	Sample	Population
ER AC 14/15 SEER	14.4	14.6	2.7	2.7
ER AC 16+ SEER	16.2	16.5	2.7	2.8
RP AC 14/15 SEER	14.4	14.4	2.7	2.8
ER HP 14/15 SEER	15.0	14.7	2.7	2.7
ER HP 16+ SEER	16.7	17.1	2.9	3.0

18 Cadmus. *2012 EM&V Report.* Filed May 15, 2013, under docket number 13-1140-EL-POR.

Table 57. Comparison of Billing Analysis Sample to Program Population: Replaced Equipment

Measure	Average SEER		Average Size (Tons)	
	Sample	Population	Sample	Population
ER AC 14/15 SEER	9.6	10.1	2.7	2.6
ER AC 16+ SEER	9.7	10.3	2.6	2.7
RP AC 14/15 SEER	9.3	9.8	2.8	2.7
ER HP 14/15 SEER	10.5	10.5	2.6	2.6
ER HP 16+ SEER	10.5	11.0	2.7	2.8

This comparison revealed several minor differences in the characteristics of incented and replaced equipment. While some of these differences proved statistically significant, they tended to be small, with limited impacts on the UES estimates. Therefore, Cadmus concluded that the populations proved sufficiently similar to justify applying UES estimates (identified through the billing analysis) to the 2015 population.

An analysis of year-over-year characteristics indicated, however, that the population of incented and replaced equipment has started to deviate from the billing analysis sample. For example, the average SEERs and capacities of replaced equipment have become more efficient and larger, respectively. This holds true for incented equipment. Given this upward trend in replaced and incented equipment, Cadmus recommends conducting an updated billing analysis for the 2016 program year evaluation.

Cadmus applied the UES estimates to the program population to derive adjusted gross savings for the selected measures, with the results shown in Table 58.

Table 58. Adjusted Gross Energy Savings (kWh) from Participant Billing Analysis

Measure	Incented Measures	Adjusted Gross UES Estimate	Total Adjusted Gross Savings
ER AC 14/15 SEER	1,118	1,089	1,217,433
ER AC 16+ SEER	962	1,246	1,198,245
RP AC 14/15 SEER	57	196	11,177
ER HP 14/15 SEER	545	3,093	1,685,861
ER HP 16+ SEER	490	3,301	1,617,511
ECM	484	758	366,897
ECM with New AC	1,609	417	670,873
Total*	**5,265**		**6,767,996**

*Values in table may not sum exactly to total due to rounding.

UES Estimates from Ohio TRM Calculations

Cadmus deferred to the Ohio TRM when calculating adjusted gross UES estimates for all measures, except for the following:

Heating savings from mini-split air-source heat pumps (not included in the TRM)

Programmable and smart thermostats (not included in the TRM)

Measures included in the participant billing analysis (shown in Table 58)

Though the Ohio TRM did not address some variations in common measures (specifically, early replacement heat pumps), savings calculations and assumptions for these measures could be adapted using information provided for similar measures.

Cadmus applied the Ohio TRM energy savings equations and assumptions to 2015 program participants, resulting in the annual energy-savings estimates shown in Table 59.

Table 59. Adjusted Gross Energy Savings from Ohio TRM Calculations

Measure	Incented Measures	Adjusted Gross UES Estimate (kWh)	Total Adjusted Gross Savings (kWh)*
NC AC 14/15 SEER	44	238	10,450
NC AC 16+ SEER	44	556	24,474
RP AC 16+ SEER	19	543	10,317
NC HP 14/15 SEER	44	713	31,389
NC HP 16+ SEER	26	1,932	50,229
RP HP 14/15 SEER	35	720	25,216
RP HP 16+ SEER	23	1,774	40,810
ER GSHP 16/18 EER	67	7,264	486,696
ER GSHP 19+ EER	89	8,568	762,588
NC GSHP 16/18 EER	31	5,298	164,223
NC GSHP 19+ SEER	23	5,883	135,312
RP GSHP 16/18 EER	4	4,929	19,714
RP GSHP 19+ EER	6	5,818	34,908
NC MS AC 16+ SEER	13	106	1,381
Heat Pump Water Heater - Electric Home	4	1,297	5,188
Total	**472**		**1,802,895**

*Values in table may not sum exactly to total due to rounding.

When calculating energy savings, Cadmus adhered to all savings equations and assumptions articulated in the Ohio TRM, with the exceptions discussed below.

CAC and Air-Source Heat Pump

The Ohio TRM listed 631 as full-load cooling hours for the Dayton, OH, area. This estimate includes a 33% reduction for oversizing newly installed equipment. Cadmus found this oversizing correction not applicable for this program, based on discussions with participating contractors and program staff. Therefore, the evaluation used full-load cooling hours from the ENERGY STAR Calculator (947). Participant customer billing analysis supported this decision.

The Ohio TRM did not include early-replacement, air-source heat pump measures. To calculate energy savings and demand reductions for these measures, Cadmus adapted the appropriate time-of-sale, air-source heat pump calculations to include the size and efficiency of the replaced equipment.

Program tracking data lacked the SEER rating of the replaced equipment for seven early-replacement CACs and six early-replacement air-source heat pump measures. When calculating savings for these measures, the evaluation used proxies: average-sized SEER ratings for equipment replaced from the same incented measure category.

Ground-Source Heat Pump

According to program tracking data and the AHRI-certified products directory, in 2015, approximately 50% of ground-source heat pumps incented through the DP&L Residential Heating and Cooling program were multistage units. Therefore, consistent with the previous evaluation, Cadmus adapted the algorithm provided in the Ohio TRM to capture savings from part- and full-load equipment operations.

Cadmus also deviated from the Ohio TRM in the following areas:

- As with the CAC and air-source heat pump calculations described above, Cadmus used full-load cooling hours from the ENERGY STAR Calculator (947).
- The Ohio TRM did not include early-replacement, ground-source heat pump measures. To calculate energy savings and demand reductions, Cadmus adapted the appropriate ground-source heat pump and time-of-sale calculations to include the size and efficiency of the replaced equipment.
- The Ohio TRM energy-savings algorithm for replace-on-burnout, ground-source heat pump measures lacked the equation's "/1,000" component, which the gross savings calculations included.
- Cadmus assumed the federal minimum standard HSPF between 1992 and 2006 (included in the footnote on page 28 of the Ohio TRM, in the Residential HVAC Diagnostic and Tune-Up section), due to the low data collection rate in the program tracking database.
- The program tracking database contained only five entries for the coefficient of performance (COP) of the existing unit (out of 166 incented early replacement or replacement units). Therefore, Cadmus used proxies: the HSPF value from page 28 of the Ohio TRM and the HSPF-to-COP conversion factor from page 84.
- Ground-source heat pumps tend to be sized for heating rather than cooling. In an area such as Dayton, OH, this generally leads to oversized equipment on the cooling side. Ohio TRM savings equations used a unit's overall capacity to determine savings. This could overstate cooling savings for a unit. To correct for oversizing when calculating cooling savings for early-replacement and replace-on-burnout units, Cadmus used the capacity of the replaced unit. As this adjustment could not be made for new construction, analysis reverted to the capacity of the newly installed unit.

Mini-Split ACs

The Ohio TRM did not provide savings equations or assumptions for mini-split ACs, and too few participants could be included in the billing analysis to provide precise savings estimates. However, a review of 2013 participant customer survey data and interviews with implementation staff confirmed most of these measures were used for space cooling—much like a window or portable AC. Therefore, Cadmus applied the Ohio TRM energy savings equation and assumptions for time-of-sale, ENERGY STAR, room ACs to the 2015 program participants.

Heat Pump Water Heaters

Due to the very small number of heat pump water heaters incented (n=4), Cadmus employed the same methodology used to calculate *ex ante* savings. Measure data did not indicate the type of electrical heating system in a home. As with *ex ante* estimates, Cadmus assumed air-source heat pumps heated these homes.

UES Estimates from Ohio TRM and Engineering Calculations

Mini-Split Heat Pumps

Due to the very small number of heat pump water heaters incented (n=4), Cadmus employed the same methodology used to calculate *ex ante* savings (see Heat Pump Water Heaters, above). Measure data did not indicate the type of electrical heating in a home.

As with mini-split ACs, the Ohio TRM did not provide savings equations and assumptions for mini-split heat pumps, and too few participants could be included in the billing analysis to provide precise savings estimates. Therefore, to determine adjusted gross energy savings for these measures, Cadmus followed the same approach used for 2010 through 2014: relying on engineering calculations informed by the Ohio TRM and on primary and secondary source data.

To determine energy savings these measures achieved while cooling, Cadmus applied the Ohio TRM energy-savings equation and assumptions for time-of-sale, ENERGY STAR, room ACs to 2013 program participants. To calculate energy savings produced by air-source heat pump, mini-split measures used for heating, Cadmus utilized the following equation and assumptions:

$$\Delta kWh = Hcap * \left(\frac{1}{3.413} - \frac{1}{Installed\ HSPF}\right) * \frac{1}{A} * \ Heating\ Savings * Adjustment\ Factor$$

Where:

Hcap = Size of the installed unit in tons, multiplied by 12

A = 0.171 (identified in KEMA's mini-split study)[19]

Heating Savings = 135.0 (identified in KEMA's mini-split study)[20]

Adjustment Factor = 69.7%[21]

Table 60 presents annual savings estimates produced using this approach.

Table 60. Adjusted Gross Energy Savings from Engineering Calculations Based on Secondary Sources

Measure	Incented Measures	Adjusted Gross UES Estimate	Total Adjusted Gross Savings
NC MS HP 14/15 SEER	3	3,064	9,193
NC MS HP 16+ SEER	137	2,180	298,600
Total	**140**		**307,793**

Programmable and Smart Thermostats

The Ohio TRM did not provide savings values or equations for programmable and smart thermostats, which were added to the Residential Heating and Cooling Rebate Program for 2015. Cadmus based savings calculations on the equations and assumptions discussed below. Each equation has been designed to calculate estimated energy use for heating or cooling and then to apply the appropriate Energy Savings Factor (ESF) to estimate savings. Based on empirical data, the ESF represented the percentage of heating or cooling energy use the thermostat would be expected to save.

Electric Heating Savings

Cadmus calculated electric heating savings using the following equation:

$$\Delta kWh = FLHheating * \frac{Hcap}{HSPF * 3.412} ESFheating$$

19 KEMA. 2009. *Ductless Mini Pilot Study.* Available online: http://www.env.state.ma.us/dpu/docs/electric/0964/12409nstrd2ac.pdf

20 Ibid.

21 Cadmus determined the percentage of mini-split heat pumps installed to replace electric-resistance space heating using survey results with mini-split, air-source heat pump participants, conducted by CSG staff in 2010 and Cadmus in 2013.

Where:

FLHheating = full-load heating hours for Dayton, from the Ohio TRM (1,438)

Hcap = heating capacity of system, in MBtuH

HSPF = HSPF of heating system

ESFheating = heating energy savings factor for the type of thermostat upgrade

Cooling Savings

Cadmus calculated cooling using the following equation:

$$\Delta kWh = \frac{1}{SEER} * FLHcooling * Ccap * ESFcooling$$

Where:

SEER = SEER of the cooling system

FLHcooling = full-load cooling hour (Cadmus used the ENERGY STAR calculator value of 947))

Ccap = cooling capacity of system, in MBtuH

ESFcooling = cooling energy savings factor for type of thermostat upgrade

Energy Savings Factor Values

Cadmus used the ESF values shown in Table 61; these were based on billing analysis, metering, and participant surveys Cadmus conducted outside of its work for DP&L. For upgrades from manual to programmable thermostats, Cadmus used an average of the two ESF heating values.

Table 61. ESF Values for Programmable and Smart Thermostats

Thermostat Replacement Type	$ESF_{HEATING}$	$ESF_{COOLING}$
Manual to Smart*	13.40%	16.10%
Manual to Programmable*	7.80%	15.00%
Manual to Programmable**	6.80%	N/A
Averaged Manual to Programmable	7.30%	15.00%
Programmable to Smart*	6.60%	1.30%

*Per Cadmus' report *Evaluation of the 2013-2014 Programmable and Smart Thermostat Program*, prepared for Northern Indiana Public Service Company: January 22, 2015.

**RLW Analytics. *Validating the Impact of Programmable Thermostats*, prepared for GasNetworks: January 2007.

The DP&L measure code identified the type of thermostat installed—programmable or smart—and the type of system this controlled: CAC, air-source heat pump, or ground-source heat pump. To determine the thermostat type participants used before installing the new thermostats, Cadmus conducted a survey of program participants, described in the *Programmable Thermostat Customer Survey* section below.

Of 70 survey participants, 45 reported previously using a manual thermostat and 16 reported using a programmable thermostat. The other nine participants reported that they did not know the type of thermostat they used before installing their new system or did not previously use a thermostat (presumably because they heated with something other than a central furnace or heat pump).

Based on these results, Cadmus estimated that 74% of thermostat program participants upgraded from a manual thermostat and that 26% replaced a programmable thermostat. The evaluation applied these percentages when calculating a weighted ESF for each thermostat measure. As all thermostats were installed with new systems, Cadmus assumed these percentages applied to installations of both programmable and smart thermostats. The calculations weighted ESFs to ensure savings would not be calculated for participants replacing a programmable thermostat with another programmable thermostat.

The thermostat measure participants' survey also collected data about how participants used their old and new thermostats. These results showed patterns similar to research leading to the ESF values discussed above. For example, only 27% of respondents reported relying on their new thermostats to adjust temperature settings based on a programmed schedule—results nearly identical to those of the other study. In short, the survey strongly supports the validity of using the ESF values to estimate thermostat measure savings. These ESF values accounted for the relatively low use of a programmed scheduled with programmable thermostats, both with existing and new programmable thermostats.

Table 62 provides adjusted gross savings calculated using this approach. These savings show good general agreement with thermostat savings identified by several studies throughout the United States. For example, studies of savings achieved through Nest and other smart or communicating thermostats have shown annual savings of roughly 440 kWh (though one study reported much higher results and another showed much lower results). For the Ecobee thermostat, studies have shown savings of 140 kWh when upgrading from programmable thermostats and 217 kWh when upgrading from manual thermostats. Annual savings for installing programmable thermostats are thought to be roughly 320 kWh.

Table 62. Adjusted Gross Energy Savings (kWh) from Engineering Calculations Based on Secondary Sources

Measure	Incented Measures	Adjusted Gross UES Estimate	Total Adjusted Gross Savings
Programmable Thermostat with AC	1,520	222	337,512
Programmable Thermostat with HP	743	307	228,096
Programmable Thermostat with GSHP	142	291	41,319
Smart Thermostat with AC	17	245	4,168
Smart Thermostat with HP or GSHP	2	429	858
Total	**2,422**	**-**	**611,096**

Demand Reduction Estimates from Ohio TRM Calculations

Cadmus used the Ohio TRM to calculate adjusted, gross, demand reduction estimates for all measures in the 2015 participant database, except ECM and thermostat measures. This did not deviate from the Ohio TRM equations or assumptions for these measures, except for the following:

- To determine EER ratings for all incented and replaced equipment, Cadmus identified equipment in the AHRI-certified products directory using AHRI-certified reference numbers (provided in program tracking data). If a measure could not be located in the directory, Cadmus applied the following algorithm to the measure's SEER rating:[22]
  - $EER = -0.02 \times SEER^2 + 1.12 \times SEER$
- The program tracking database did not include the existing EER ratings for 47 ground-source heat pump measures. Therefore, Cadmus used the average EER rating of existing ground-source heat pumps (identified in the tracking data) as proxies for the missing data.
- The Ohio TRM did not include early replacement, air- or ground-source heat pump measures. To calculate energy savings and demand reductions for these measures, the evaluation adapted the appropriate time-of-sale calculations to include the size and efficiency of replaced equipment.
- To calculate demand reductions for mini-split ACs or air-source heat pumps, Cadmus applied the Ohio TRM demand reduction equation and assumptions for time-of-sale, ENERGY STAR, room ACs to 2014 program participants.

Table 63 provides the resulting annual demand reduction, identified using Ohio TRM algorithms and assumptions.

Table 63. Adjusted Gross Demand Reduction (kW) from Ohio TRM Calculations

Measure	Incented Measures	Adjusted Gross UDR Estimate	Total Adjusted Gross Demand Reduction
ER AC 14/15 SEER	1,118	0.42	470.25
ER AC 16+ SEER	962	0.49	474.27
NC AC 14/15 SEER	44	0.10	4.39
NC AC 16+ SEER	44	0.22	9.68
RP AC 14/15 SEER	57	0.10	5.42
RP AC 16+ SEER	19	0.22	4.25
ER HP 14/15 SEER	545	0.38	206.30
ER HP 16+ SEER	490	0.47	230.66
NC HP 14/15 SEER	44	0.10	4.55
NC HP 16+ SEER	26	0.22	5.80
RP HP 14/15 SEER	35	0.10	3.47
RP HP 16+ SEER	23	0.23	5.19

[22] U.S. DoE Building America House Simulation Protocols, P. 31: http://www.nrel.gov/docs/fy11osti/49246.pdf

Measure	Incented Measures	Adjusted Gross UDR Estimate	Total Adjusted Gross Demand Reduction
ER GSHP 16/18 EER	67	0.33	21.93
ER GSHP 19+ EER	89	0.45	40.37
NC GSHP 16/18 EER	31	0.30	9.24
NC GSHP 19+ SEER	23	0.39	8.92
RP GSHP 16/18 EER	4	0.34	1.36
RP GSHP 19+ EER	6	0.45	2.73
NC MS AC 16+ SEER	13	0.11	1.41
NC MS HP 14/15 SEER	3	0.18	0.54
NC MS HP 16+ SEER	137	0.16	21.85
Heat Pump Water Heater - Electric Home	4	0.18	0.72
Total*	**3,784**		**1,533.30**

*Values in table may not sum exactly to total due to rounding.

Demand Reduction from Engineering Estimates

To calculate demand reductions for ECM measures, Cadmus divided cooling energy savings (kWh), identified through the billing analysis (discussed above), by the full-load cooling hours for the Dayton, OH, area, listed in the ENERGY STAR calculator (947) and multiplied by the result of the 0.5 peak CF, identified in the Ohio TRM.

Demand reduction for ECMs with New ACs measures should be accounted for in savings associated with the SEER rating

Table 64. Adjusted Gross Demand Reduction (kW) from Engineering Estimates

Measure	Incented Measures	Adjusted Gross Unit Demand Reduction Estimate	Total Adjusted Gross Demand Reduction
ECM	484	0.18	85.81
ECM with New AC	1609	0.00	0.00
Total	**4,517**		**85.81**

In the absence of demand-response programs, programmable and smart thermostats do not generate easily quantified or verified reductions in peak demand.

Programmable Thermostat Survey

In February 2016, Cadmus conducted a phone survey with 70 DP&L customers who received a rebate for purchasing a programmable and smart thermostat through the Heating Rebates component of DP&L's Residential Programs. The survey assessed topics such as the following:

- Reasons for purchasing a new thermostat
- Details on installation of the new thermostat
- How customers used their old and new thermostats

- Types of heating and cooling equipment in the home
- Demographic characteristics of respondents' homes

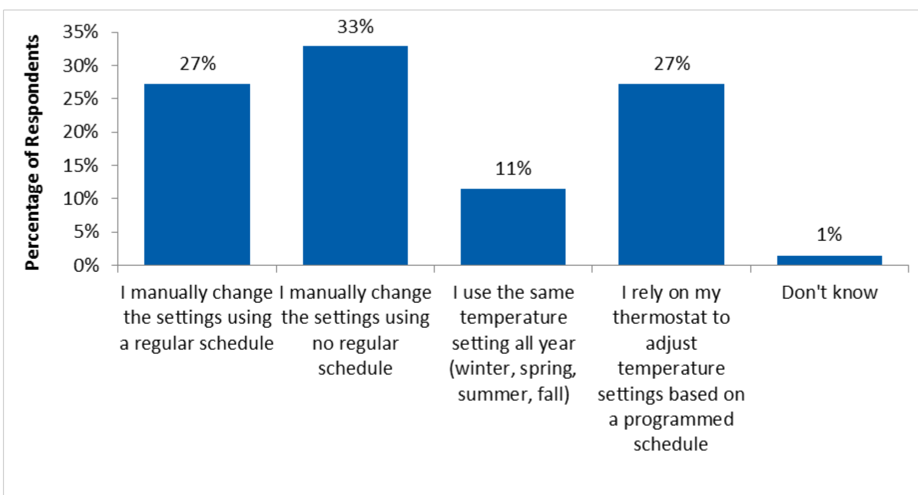
From the population of DP&L HVAC Program participants, Cadmus selected a sample of 2,000. Survey implementation realized 70 completes, meeting the sampling targets for results with 90% confidence and 10% precision.

New Thermostat Use and Programming

When asked about their primary reasons for purchasing a new thermostat, 40% of respondents said "to replace old or outdated equipment," and 13% said "to replace failed equipment" (n=70). Another 13% purchased the thermostat as part of an overall HVAC system upgrade. Nearly all (99%) respondents had contractors install their new thermostats. Over half (53%) said someone in their household programmed the thermostat. Nearly all respondents (97%) lived year-round in the home where the new thermostat was installed.

When Cadmus asked how respondents used their new thermostats, responses exhibited a range of use patterns. The majority (60%) manually changed the settings on their new thermostat: 27% did so using a regular schedule; and 33% did so without using a regular schedule. Another 27% relied on their thermostats to adjust temperature settings, based on a programmed schedule. Eleven percent used the same temperature setting all year. Figure **23** shows the survey results.

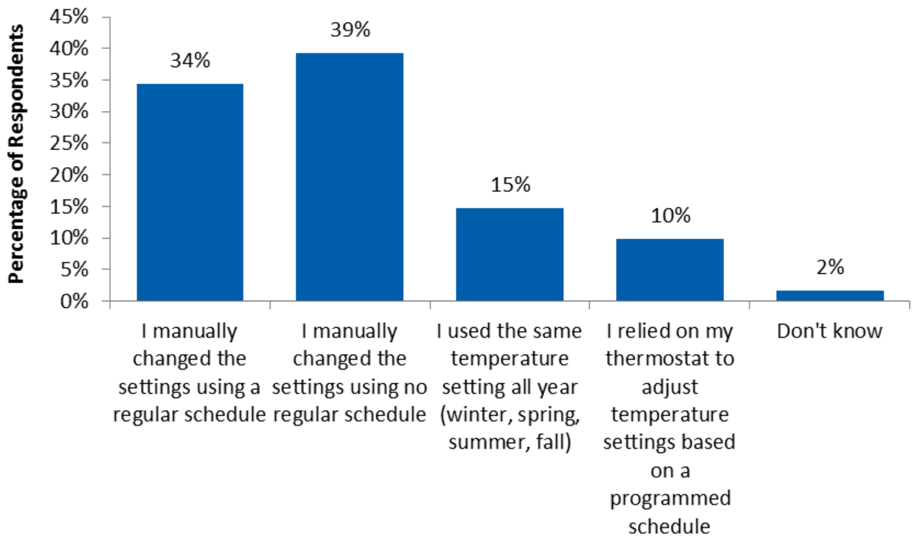
Figure 23. Which of the Following Best Describes How You Use Your New Thermostat?



Old Thermostat Use and Programming

Almost all respondents (64%) previously used a manual thermostat, and 23% used a programmable thermostat. None reported using a smart or Wi-Fi-enabled thermostat. Of respondents reporting they previously owned a thermostat (n=61), 34% manually changed the settings using a regular schedule, and 39% manually changed the settings using no regular schedule, as shown in Figure 24.

Figure 24. Which of the Following Best Describes How You Used Your Old Thermostat?



Survey findings also indicated that respondents used the programmable capacities of new thermostats more than those of their old thermostats. As shown in Table 65, use of the programmable schedule reportedly increased by 17%.

Table 65. Differences between New and Old Thermostat Use*

How Customers Uses Thermostat	Old Thermostat	New Thermostat	% Change
Manually change settings using a regular schedule	34%	27%	-7%
Manually change settings using no regular schedule	39%	33%	-6%
I use the same temperature setting all year	15%	11%	-4%
I rely on my thermostat to adjust temperature settings based on a programmed schedule	10%	27%	17%

*Percentages may not add up to 100% due to rounding.

Customer Demographics

The survey asked respondents a few demographic questions to help Cadmus understand the characteristics of customers participating in the programmable thermostat rebate program. In future years, this information can be used to identify whether changes in program design and marketing can attract different market segments.

Over half of customers (53%) primarily used natural gas to heat their homes, and 50 respondents (71%) had central, forced-air furnaces as their main type of heating system (n=70). Figure 25 and Figure 26 show detailed results. Before installing their programmable thermostats, 38 respondents (62%) used central, forced-air furnace systems as their home's primary heating system (n=61). Eight respondents reported switching to a central, forced-air furnace from another specified heating system when installing the programmable thermostat.

Figure 25. What Fuel do You Use Primarily to Heat Your Home?

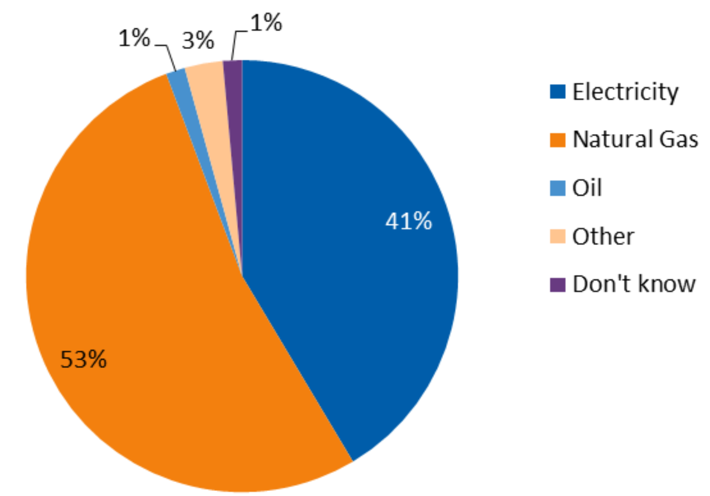
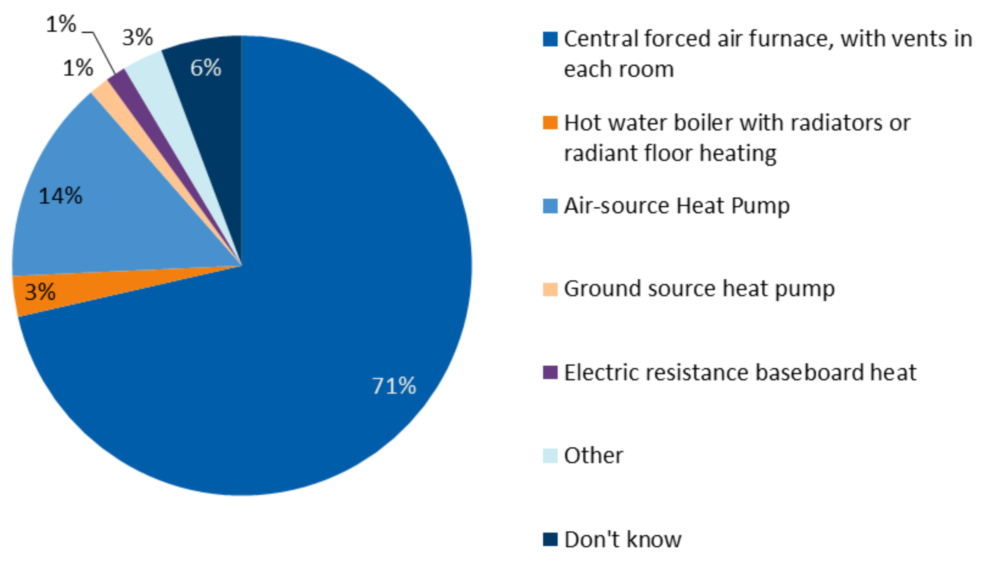


Figure 26. What is the Main Type of Heating System in Your Home?



When asked about the main types of cooling systems in their homes, 76% of respondents reported using CACs, a result 8% higher than the 68% of respondents using CACs before installing their programmable thermostats.

As shown in Table 66, almost all respondents (86%) resided in single-family, detached houses, though a few lived in attached homes or multifamily apartments. Sixty-three percent of customers' homes fell within a 1,000–2,500 square foot range. Regarding residency, about 16% had one full-time occupant, 49% had two full-time occupants, and 17% had three full-time occupants.

Table 66. Which of the Following Types of Housing Units Would You Say Best Describes Your Home?

Housing Type	Number (n=70)	Percentage
Single-family detached house	60	86%
Single-family attached house (e.g., duplex, townhouse)	3	4%
Condo or apartment	3	4%
Don't know	3	4%
Refused	1	1%

Recommendations

Drawn from the preceding findings, Cadmus offers the following recommendations:

Continue promoting new program measure offerings. The program exceeded its kWh goal, partly due to new program offerings, such as thermostat measures. The new thermostat measures provide substantial contributions to program savings. Survey results indicated an improvement that could increase actual thermostat savings: ensuring more contractors program thermostats for participants. Only 27% of survey participants reported relying on their new programmable thermostat to change temperatures, based on a programmed schedule. While the program is not designed to ensure every thermostat is properly programmed, additional training and education of contractors may help reduce the number of thermostats not installed.

Increase promotion of smart thermostats. Programmable thermostats generated the majority of thermostat savings due to the much larger number of programmable thermostats installed: 2,405 vs. 19. Yet smart thermostats offer a wider range of benefits than programmable models and often generate greater savings, partly through an ability to provide savings even if the installer or participant does not create a programmed schedule. Smart thermostats may also help maintain customer relationships by providing communication opportunities via e-mail and the device itself; further, it may provide data that offer new EM&V opportunities. Some smart thermostat vendors provide additional program opportunities, such as the Nest Seasonal Savings.[23] Cadmus recommends examining ways to increase promotions of smart thermostats and, ultimately, increasing their share of the thermostat measure category. Moving to smart thermostats likely would work well with appliance pilot offerings and retailer venues.

Conduct updated billing analysis in the 2016 program year. A billing analysis has not been conducted since 2013. Given efficiency levels and size of replaced and incented units has steadily increased for most equipment measure categories, Cadmus recommends conducting a billing analysis during the next evaluation cycle to update savings estimates. This should include billing analysis for new program offerings, such as thermostats.

[23] Nest Labs information about Nest Season Savings available at: https://nest.com/support/article/What-is-Seasonal-Savings

Residential Energy Education (Be E^3 Smart) Program

This chapter describes the evaluation approach, detailed findings, and conclusions and recommendations for the Residential Energy Education Program (Be E^3 Smart).

Evaluation Overview

Cadmus' evaluation of the 2015 Be E^3 Smart program followed researchable questions and evaluation activities outlined in DP&L's *2015 Evaluation, Measurement, and Verification Plans*. Table 67 identifies key researchable evaluation questions, and Table 68 lists evaluated measures included in the Be E^3 Smart Home Energy Efficiency kit.

Table 67. Key Researchable Questions

Researchable Questions	Activity Used to Address Question
How many schools, teachers, and students participated in the program?	• Review of database and documentation.
What were the program's achievements and challenges?	• Stakeholder interviews.
What are the program's gross savings?	• Analysis of student-returned survey. • Engineering analysis. • Follow-up parent survey.
Which program kit measures proved useful? Which measures proved less useful?	• Stakeholder interviews. • Follow-up parent survey. • Teacher survey.
How long do participants wait to install measures? What is the removal rate for kit measures?	• Student survey. • Follow-up parent survey.
Do parents of children participating in the Be E^3 Smart program express greater satisfaction with DP&L's service? Are they more likely to participate in other programs?	• Student survey. • Follow-up parent survey.
What are the sources of satisfaction and dissatisfaction with the program? Have they changed in recent years?	• Stakeholder interviews. • Student survey. • Follow-up parent survey. • Teacher survey.
Is the program cost-effective?	• Cost-effectiveness analysis.

Table 68. Be E^3 Smart Evaluated Kit Measures

Kit Measures	Quantity in Kit
13W CFL	4
LED Night Light	1
Bathroom Faucet Aerator	2
Kitchen Aerator	1
Energy-Efficient Showerhead	1

Though Cadmus did not evaluate them, the kit contained other measures for educational purposes: weather stripping, a door sweep, and a furnace filter whistle. DP&L did not claim savings for these measures.

Detailed Evaluation Findings

With 9,298 kits distributed, DP&L surpassed its participation goal of distributing 9,000 Home Energy Efficiency Kits. The program exceeded its savings goals of 2,376,762 kWh and 20 kW by achieving 4,162,367 kWh in adjusted savings and 281 kW in adjusted demand reduction. Adjusted gross savings represented 99% realization rates for *ex ante* claimed energy savings and 98% realization rates for demand reduction. Overall, per-kit savings increased from 2014, mainly due to the addition of two CFL bulbs. Although CFLs produced higher per-unit savings in 2014 (49 kWh per bulb) than in 2015 (38 kWh per bulb) due to EISA regulation effects, the larger number of units distributed resulted in much larger adjusted gross savings for CFL bulbs (1,213,019 kWh in 2015 versus 821,153 kWh in 2014).

- Table 69 presents program *ex ante* claimed and adjusted gross savings and demand reduction.

Table 69. Residential Be E^3 Smart Program Claimed and Achieved Energy Savings

Measure	*Ex Ante* Claimed Savings		Verified Gross Savings		Adjusted Gross Savings		
	kWh	kW	kWh	kW	kWh	kW	Precision*
13W CFL	1,255,089	134	1,255,089	134	1,213,019	128	± 16.0%
LED Night Light	48,947	0	48,947	0	48,947	0	± 12.4%
Bathroom Faucet Aerator	364,800	50	364,800	50	364,800	50	± 37.1%
Kitchen Faucet Aerator	865,583	19	865,583	19	865,583	19	± 27.0%
Efficient Showerhead	1,670,018	84	1,670,018	84	1,670,018	84	± 22.4%
Total**	**4,204,437**	**287**	**4,204,437**	**287**	**4,162,367**	**281**	**± 16.1%**

*Precision at 90% confidence.

**Values in table may not sum to exactly 100% due to rounding.

- The 2015 follow-up parent survey reported higher installation rates for LED night lights and efficient showerheads than in the 2014 parent survey. Few customers removed lighting measures after installation, and 2015 produced higher persistence rates than in 2014 for all measures except for kitchen faucet aerators.
- Overall, DP&L met its four program objectives:
  - Promoting energy education
  - Cultivating customer satisfaction
  - Helping families save energy
  - Promoting awareness of DP&L’s energy efficiency programs
- The follow-up parent survey (n = 70) showed a majority of participants (74%) were highly satisfied with the kit measures and the program as a whole. Participant survey results strongly indicated that student involvement in the program significantly increased energy-related

conversations in participating households: 51% of respondents discussed energy topics once a week or more, as much as six to 12 months after program completion (a decline from 70% in 2014).

- In terms of energy saved, approximately 34% of surveyed participants reported decreases in their electric bills following kit measure installations, and 44% reported becoming more aware of their energy usage and waste. Table 69 provides program *ex ante* claimed and adjusted gross savings and demand reduction.

Evaluation Data Collection Methods

In evaluating the 2015 program, Cadmus used the approaches detailed below.

Program Database Review

The program relied on student take-home survey responses (known as the family home installation survey) to estimate the number of measures installed from kits provided by OEP.[24] After presenting the energy education lesson, teachers provided students with instructions on how to complete an online survey and encouraged them to complete the survey after one to two weeks.

Through the survey, students reported how many kit measures they installed and whether they adopted recommended behavioral changes (e.g., adjusting thermostat settings) since receiving the kits and lesson. The survey also collected basic household and demographic information, such as heating and cooling system types, family size, and type of home (e.g., single-family, multifamily). The survey achieved a very high response rate of 85%, with 7,866 of the participating 9,298 households completing the online version.

For comparison, benchmarking research showed response rates at five peer Midwest utilities ranged from 34% to 75%. DP&L and OEP attributed this high response rate to OEP's strong relationships with participating teachers as well the online data entry portal making it easier for teachers to have students input their survey data during class.

Stakeholder Interviews

In October 2015, Cadmus interviewed DP&L program staff members and OEP implementers. The interviews highlighted successes and challenges from the 2014–2015 program year, program design and administration changes, outreach efforts, and future plans for the program.

Parent Follow-Up Telephone Survey

To evaluate measure installation lags and persistence, Cadmus fielded a follow-up parent survey with a sample of 70 parents of participating students. Completed in October 2015, the survey occurred six to 12 months after students completed the online family home installation survey. In addition to measure

24 Program implementer.

installation, the follow-up survey included questions addressing parents' experiences and satisfaction with the program and exploring general household demographics.

Of participants completing the online family home installation survey, 1,157 provided their phone numbers for the follow-up parent survey. The $20 gift cards offered for the follow-up survey likely contributed to the large number of participants willing to participate. Cadmus completed 70 surveys with the parents or guardians of participating students, meeting the sampling targets with 90% confidence and 10% precision.

Teacher Survey

The teacher survey sought to gather information on program design, delivery, satisfaction, and recommendations for program improvements the program. After Cadmus designed and programmed the online survey, OEP sent e-mails asking for teachers' feedback (and providing the survey link) to participating and nonparticipating teachers (i.e., those previously participating but opting out for the 2015 program year). As an incentive to complete the survey, Cadmus offered teachers a chance to win one of four $100 VISA check cards.

Of 129 participating and 25 nonparticipating teachers e-mailed, 61 teachers completed the online survey (57 participating and four nonparticipating teachers).

Impact Evaluation Methodology and Findings

DP&L requested that Cadmus calculate *ex ante* claimed savings alongside verified and adjusted gross savings. The *ex ante* and verified savings calculations primarily relied on the following:

- The Ohio TRM's current program year Be E^3 family home installation survey
- Parent follow-up survey results
- Engineering algorithms from other Cadmus evaluation work.

Cadmus applied an additional update to the TRM inputs to calculate adjusted gross savings; this used findings from the Residential Lighting Program and updated the delta watts factor for CFLs.

Table 70 summarizes adjusted gross savings components. Cadmus calculated adjusted gross savings by multiplying the total number of units installed by the share of units applied to electric end uses and by the per-unit savings. On average, Cadmus calculated that each kit saved 448 kWh/0.030 kW.

Table 70. Adjusted Gross Savings

Measure	Units Distributed	Installation Rate	Percent Electric*	Per-Unit Savings**		Adjusted Gross Savings	
				kWh	kW	kWh	kW
13W CFL	37,192	86%	100%	38	0.004	1,213,019	128
LED Night Light	9,298	39%	100%	14	0.000	48,947	0
Bathroom Faucet Aerator	18,596	42%	48%	97	0.013	364,800	50
Kitchen Faucet Aerator	9,298	43%	48%	447	0.010	865,583	19
Showerhead	9,298	63%	48%	593	0.030	1,670,018	84
Total	**83,682**	**n/a**	**n/a**	**448**	**0.030**	**4,162,367**	**281**

*For aerators and showerheads, this represented the saturation of electric water heaters, as indicated by OEP's family home installation survey.

**Per-unit savings do not sum to per-kit savings as the unit savings listed were not adjusted for installation rates or electric fuel types. (Per-kit savings are generated by dividing the total adjusted savings by the number of kits distributed.)

Measure Installation Rates

Follow-Up Survey

Cadmus verified ISRs for CFLs, night lights, aerators, and showerheads using results from the follow-up parent survey (administered by phone to participants six to 12 months after they received their kits). By surveying participants several months after the measure installations, Cadmus captured installations occurring *after* participants completed the family home installation survey (typically completed shortly after the family receives the kit, allowing but a short time to install the kit items). In addition, the follow-up parent survey captured data on measure persistence and on participants removing a measure after initially installing it. Table 71 compares installation rates calculated from the family home installation survey and the follow-up parent survey.

Table 71. Comparison of ISRs from the Online Family Survey and Follow-Up Parent Survey

Measure	Family Home Installation Survey Installation Rate (n = 7,866)*	Follow-Up Parent Survey Installation Rate (n = 70)	% Increase: Family Home to Follow-up Parent Survey
CFLs	48%	86%	79%
LED Night Light	31%	39%	25%
Bathroom Faucet Aerators	31%	42%	37%
Kitchen Faucet Aerator	37%	43%	16%
Efficient Showerhead	39%	63%	61%

*This installation rate, only shown for comparison purposes, was not used to determine 2014 savings.

As shown, Cadmus observed higher calculated ISRs from the follow-up parent survey than for the online family home installation surveys (addressing all measures). Cadmus attributed these results to additional time families received to install measures after receiving the kit.

ISRs differed the most for CFLs (79% higher on the follow-up parent survey), efficient showerheads (61% higher), and bathroom faucet aerators (37% higher). Kitchen faucet aerators and LED night lights exhibited more modest differences. Cadmus found similar results during the past three years of conducting the follow-up parent survey.

Comparison of Installation Rates

Cadmus compared ISRs for each measure to ISRs from past program evaluations and to results from evaluations of similar utility-sponsored programs. Figure 27 compares ISRs from the past four DP&L evaluations, while Figure 28 presents installation rate benchmarking results.

Figure 27. DP&L ISR Comparisons 2012–2015

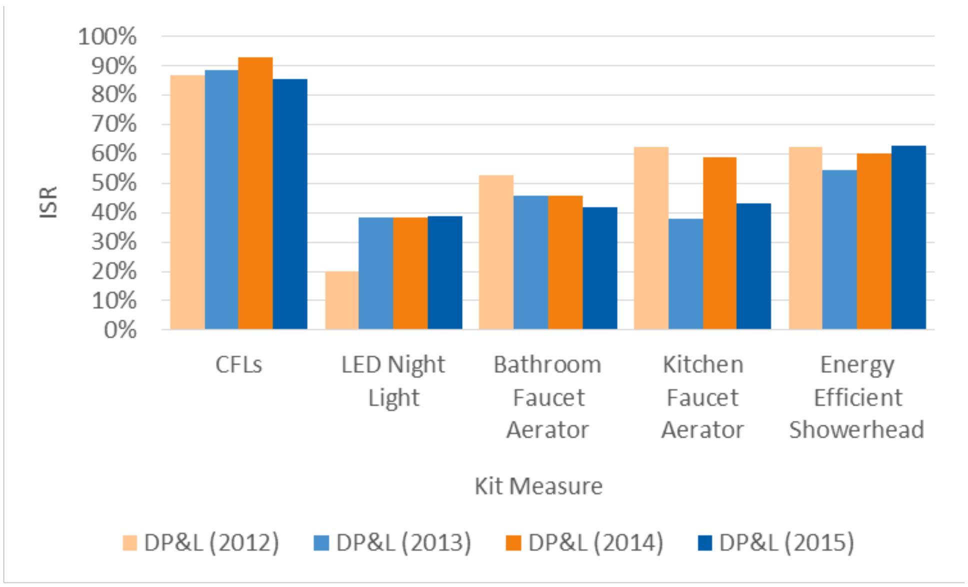


Figure 28. ISR Benchmarking

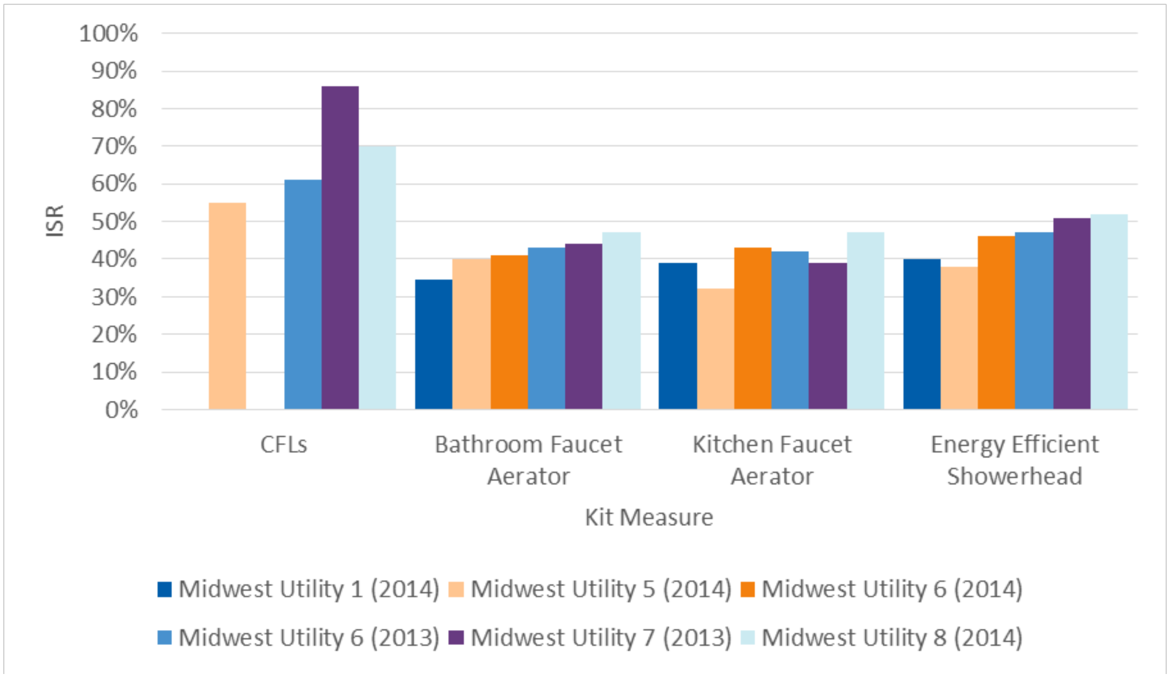


Table 72 shows the ISRs' percentage difference between the 2014 and 2015 evaluation years.

Table 72. DP&L's 2014 and 2015 ISR Comparison

Measure	DP&L 2014 Evaluation Year	DP&L 2015 Evaluation Year	% Difference
CFLs	93%	86%	-8%
LED Night Light	38%	39%	1%
Bathroom Faucet Aerators	46%	42%	-8%
Kitchen Faucet Aerator	59%	43%	-26%
Efficient Showerhead	60%	63%	4%

In 2015, the CFL installation rate decreased modestly, from 93% to 86%, likely due to adding two CFLs to the kits. This tended to lower the overall ISR for all four bulbs. The 2012–2015 DP&L CFL ISR produced results higher than or equal to other comparative Midwest programs (which ranged from 55% to 86%). Installation rates for efficient showerheads increased the most of all measures (4%), while rates for kitchen faucet aerators decreased by 26% between 2014 and 2015. Among survey respondents, 53% did not install the kitchen faucet aerator, primarily for two reasons:

- The respondent already had equipment of the same efficiency (or higher) installed (11% of respondents)
- The equipment did not fit (10% of respondents)

Nevertheless, this measure received a high satisfaction rating: 8.9.

TRM Deemed Savings Review

Cadmus reviewed TRM-deemed savings algorithms and inputs for each kit measure. The following sections describe deemed savings used in Cadmus' adjusted gross calculations.

CFLs

Cadmus used savings calculations outlined in the Ohio TRM and the following assumptions to calculate adjusted, gross energy savings and demand reduction for CFLs:

$$\Delta kWh = \frac{\Delta Watts * ISR * HOURS * WHFe}{1{,}000}$$

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

Table 73 shows inputs and assumptions for the 13-watt CFL calculation. Using these inputs, Cadmus determined that each CFL saved 38.1 kWh/unit and 0.004 kW/unit annually. Cadmus estimated 31,802 installations of 13-watt CFLs, leading to savings of 1,213,019 kWh and summer coincident peak savings of 128 kW.

Table 73. CFL Energy Savings and Demand Reduction Calculation

Input	Assumption	Source
Δ Watts Multiplier	2.75	Lighting stocking study and phone surveys calculated an average baseline of 47.6W for the 13W equivalent bulb during the program's duration (2013 Q3 & Q4 and 2014 Q1 & Q2) [(47.6W-13W)/13W] = 2.66.
Δ Watts	35.8	Ohio TRM. Calculated as bulb wattage multiplied by delta watts of 2.66.
ISR	86%	Parent follow-up survey.
Hours	1,040	Ohio TRM.
WHF_e	1.06	Ohio TRM. Adjustment made for outdoor installations.
WHF_d	1.06	Ohio TRM. Adjustment made for outdoor installations.
Summer Peak CF	0.11	Ohio TRM.

LED Night Lights

Cadmus used savings calculations outlined in the Ohio TRM and the following assumptions to calculate adjusted gross energy savings and demand reduction for LED night lights:

$$\Delta kWh = \frac{ISR * (Demand_{base} - Demand_{LED}) * HOURS}{1{,}000}$$

Table 74 lists inputs and assumptions used in LED night light savings calculations.

Table 74. LED Night Light Deemed Savings Calculation Inputs

Input	Assumption	Source
$\text{Demand}_{\text{base}}$ (watts)	5	Ohio TRM, typical C7 lamp
$\text{Demand}_{\text{LED}}$ (watts)	0.33	Ohio TRM
ISR	39%	Parent follow-up survey
Hours	2,920	Ohio TRM, on 8hrs/day 365 days/yr

Using these inputs, Cadmus determined that each LED night light saved 13.6 kWh/unit annually. Cadmus estimated installations of 3,589 LED night lights (which replaced existing night lights), with adjusted gross energy savings of 48,947 kWh. LED night lights did not produce demand reductions as operation hours did not coincide with Ohio's definition of peak hours.

Bathroom and Kitchen Faucet Aerator

Cadmus used the following approach to calculate energy savings and demand reductions for faucet aerators:

$$\Delta kWh = (GPM_{Base} - GPM_{Low}) * \frac{People}{Home} * \frac{min}{day} * \frac{days}{year} * \frac{1}{\frac{F}{home}} * 8.33 * (T_{FT} - T_{MAINS}) * \frac{1}{1{,}000{,}000} * \frac{1}{EF} * \frac{1}{0.003412}$$

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

Table 75 (below) lists inputs used to calculate adjusted gross savings for bathroom and kitchen faucet aerators.

Using these inputs, Cadmus determined that bathroom faucet aerators saved 97.1 kWh/unit annually and kitchen faucet aerators saved 447.2 kWh/unit annually, before adjusting for installation rates and water-heater fuel types. Cadmus used the Ohio TRM algorithm to calculate peak savings, which equated to 0.013 kW per bathroom faucet aerator installed and 0.010 kW per kitchen faucet aerator installed. After applying ISRs and electric fuel-type saturations to the total number of aerators distributed, bathroom faucet aerators achieved 364,800 kWh/50 kW in savings, and kitchen faucet aerators achieved 865,583 kWh/19 kW in savings.

Cadmus updated Ohio TRM assumptions for the average number of people per household (using self-reported household sizes from the program's family home installation survey). In addition, Cadmus used the follow-up parent survey to revise the number of bathroom faucets in the homes. A water metering study Cadmus conducted for Consumers Energy and DTE Energy in Michigan allowed the evaluation team to update assumptions on the minutes-of-use per person, per day, and the assumed water temperatures used by faucets.[25]

[25] *Michigan Water Meter Study*. March 2013. Power Point presentation to Michigan Evaluation Working Group.

Table 75. Bathroom and Kitchen Faucet Aerator Savings Calculation Inputs

Variable	Variable Definition	Bathroom Faucet Aerator	Kitchen Faucet Aerator	Source
GPM_{BASE}	GPM of baseline faucet	2.2	2.2	Cadmus water metering study.
GPM_{LOW}	GPM of low-flow faucet	1	1.5	Bathroom sink aerator, 1.0 GPM, Niagara N3210N; kitchen sink aerator, 1.5 GPM, Niagara N3115.
#people	Average number of people per household	4.42	4.42	Family home installation survey.
min/day	Minutes of use per person, per day	1.65	4.51	Cadmus water metering study.
days/yr	Days faucet used per year	365	365	Ohio TRM assumption.
F/home	Average number of faucets in the home	2.31	1.00	Follow-up parent survey; assumed for kitchen.
8.33	Constant to convert gals. to lbs.	8.33	8.33	Adjusted TRM assumption.
1	Constant to convert lbs. of water to BTU	1	1	Ohio TRM assumption.
T_{FT}	Assumed temperature of water faucets use	86	93	Cadmus water metering study.
T_{MAINS}	Assumed temperature of water entering house	57.7	57.7	Temperature data for Dayton, OH. Averaged monthly water main temperature calculated using the methodology provided in *Building America Research Benchmark Definition*, updated December 2009. Pp.19–20. http://www.nrel.gov/docs/fy10osti/47246.pdf
1,000,000	Unit conversion	1,000,000	1,000,000	Assumed.
Efficiency Factor	Recovery efficiency of electric hot water heater	0.98	0.98	Electric water heaters have a 98% recovery efficiency (OH TRM).
0.003412	MMBtuh to kWh	0.003412	0.003412	Ohio TRM assumption.
Hours	Average number of hours per year spent using faucet	19.2	121.2	(#people*min/day*365)/60/F/home
CF	Summer Peak CF	0.00262	0.00262	Ohio TRM assumption.

Efficient Showerheads

Cadmus used the following approach to calculate adjusted gross energy savings and demand reductions for showerheads:

$$\Delta kWh = (GPM_{Base} - GPM_{Low}) * \frac{People}{Home} * \frac{min}{shower} * \frac{shower}{days} * \frac{days}{year} * \frac{1}{\frac{F}{home}} * 8.33 * (T_{FT} - T_{MAINS}) * \frac{1}{1{,}000{,}000} * \frac{1}{EF} * \frac{1}{0.003412}$$

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

Table 76 (below) lists inputs and assumptions used for calculating efficient showerhead savings. As with efficient aerators, Cadmus updated Ohio TRM assumptions for the average number of people per household, using self-reported household sizes from the program's family home installation survey. With these inputs, Cadmus calculated per-unit, annual, energy savings of 592.9 kWh before adjustments for installation rates and water-heater fuel types; this resulted in adjusted gross energy savings of 1,670,018 kWh (after applying an installation rate and electric fuel-type saturation).

Cadmus used peak demand reduction calculations, consistent with the Ohio TRM, with peak demand reduction equating to 0.030 kW per unit installed and a total demand reduction of 84 kW (again, after applying an installation rate and electric fuel-type saturation).

Using a water-metering study Cadmus conducted for Consumers Energy and DTE Energy in Michigan, the evaluation team updated assumptions on minutes-of-use per person, per shower; showers per day; and the assumed temperature of water used at the showerhead.[26]

Table 76. Efficient Showerhead Savings Calculation Inputs

Variable	Variable Definition	Input	Cadmus Source
GPM_{BASE}	GPM of baseline faucet	2.5	Minimum federal GPM allowed.
GPM_{LOW}	GPM of low-flow faucet	1.25	Showerhead 1.25 GPM, Niagara N2912.
#people	Average number of people per household	4.42	Family home installation survey.
min/shower	Minutes of use per person per shower	7.83	Cadmus water metering study.
days/yr.	Days faucet used per year	365	Ohio TRM assumption.
shower/day	Showers per day	0.61	Cadmus water metering study.
F/home	Average number of showers in the home	1.75	Follow-up parent survey.
8.33	Constant to convert gals. to lbs.	8.33	Adjusted TRM assumption.
1	Constant to convert lbs. of water to BTU	1	Ohio TRM assumption.
T_{FT}	Assumed temperature of water used	101	Cadmus water metering study.
T_{MAINS}	Assumed temperature of water entering house	57.7	Used Vectren's temperature data for Dayton, OH. Averaged monthly water main temperature calculated using the methodology in *Building America*

26 *Michigan Water Meter Study*. March 2013. Power Point presentation to Michigan Evaluation Working Group.

Variable	Variable Definition	Input	Cadmus Source
			Research Benchmark Definition, updated December 2009. Pp.19–20. http://www.nrel.gov/docs/fy10osti/47246.pdf
1,000,000	Conversion	1,000,000	Assumed.
Efficiency Factor	Recovery efficiency of electric hot water heater	0.98	Electric water heaters have a recovery efficiency of 98% (OH TRM).
0.003412	MMBtuh to kWh	0.003412	Ohio TRM assumption.
Hours	Average number of hours per year spent using showerhead	73.4	(#people*min/day*365)/60/F/home
CF	Summer Peak CF	0.00371	Ohio TRM assumption.

Process Evaluation Methodology and Findings

The education program process analysis detailed in this chapter derived from the following evaluation activities, conducted during the 2015 evaluation:

- Program staff member and implementer interviews
- Online teacher survey
- Follow-up parent survey

Program Staff Member and Implementer Interviews

In fall 2015, Cadmus interviewed DP&L and OEP program staff. The interviews highlighted successes and challenges from the 2015 program year, program design and administration changes, outreach efforts, and future program plans.

DP&L and OEP staff expected to distribute approximately 9,000 kits each school year for the near future. Representatives from both organizations anticipated this goal will be easy to meet and had no plans to make adjustments. All schools and districts within DP&L's territory qualified for Be E^3 Smart, and no metric existed for reaching a certain type of community (e.g., low-income participants). However, districts with lower participation levels were targeted during recruitment. As dual administrators of the program, DP&L and Vectren Ohio screened customers to ensure they fell within both utilities' service areas.

DP&L and OEP have managed the program smoothly for multiple years, with DP&L responsible for the scope of work and contract details, and OEP handling recruitment and communication with teachers. OEP also planned and implemented the teacher training sessions. Program objectives have not changed since the program's inception.

According to interviews with DP&L and OEP representatives, teachers who chose not to continue participating did so due to lack of time or having participated in the past (i.e., they had the materials and curriculum and did not want to participate in kit distribution again, although they continued to use the materials).

OEP interviewees reported that word-of-mouth and networking provided the most valuable tactics for marketing the Be E^3 Smart program, especially given alumni teachers (i.e., participating in the program in the past) were allowed (and encouraged) to sign up again. OEP's strong relationship with schools and teachers allowed them to recruit new teachers through alumni teachers and events such as summer conferences. Insofar as employing marketing materials, postcards, brochures, and social media were most commonly used to disseminate program information. The majority of teachers signed up for the program online, but OEP also provided hard copies of applications.

For the 2015 school year, kit contents only changed through the addition of two CFLs. While in previous years, CFLs were sent separately from the rest of the kit components, in 2015, CFLs were prepackaged in separate bags and included inside the kit. This addressed teachers' concerns that they would not receive their bulbs or that they would be damaged upon arrival. OEP reported that kit delivery proved seamless this year. For the 2016 school year, the Be E^3 Smart program plans to replace one kit CFL bulb with an LED bulb.

In addition to distributing home energy efficiency kits, Be E^3 Smart offers several more programs, listed below. OEP coordinates the Energy Tour, Energy Fair, and Activating and Energizing Girls in Science; DP&L handles media and provides sponsorship:

- **The Energy Sources Tour:** For Ohio educators, a three-day bus tour of energy sites, conducted by energy professionals.
- **The Energy Blitz:** A one-day tour in northeastern Ohio.
- **Activating and Energizing Girls in Science:** A program that selects five middle schools for participation in an energy bike building program during summer. In 2015, 20 middle-school girls participated in building a bike to learn about energy science and technology.
- **The Youth Energy Summit:** Promotes student leadership for high-school students, teaching them energy lessons and activities which they can then present to younger students at an energy workshop or fair within their community. DP&L employees also teach high-school students about career paths in the energy sector.
- **The Energy Fair:** For elementary and middle-school teachers and students, high-school leaders facilitate and teach energy-related activities.

Though the program's general design has not changed since its inception, Be E^3 Smart made the following changes to student engagement and teacher activities:

- Due to very high demand (receiving over 600 students), OEP capped attendance to the Energy Fair and limited participation to two elementary classrooms per district.
- Two dates were introduced for high-school students to avoid limiting how many high-school teams could participate.

- Attendance for high-school training increased so much that OEP suggested dividing the training into two days and holding it off-site at the Montgomery County recycling center. OEP reported this made the training much easier to conduct in terms of logistics.

Program staff reported encountering one obstacle during the year: only five schools participated in Activating and Energizing Girls in Science, and the number of applicants has dwindled over the past few years. DP&L program staff believe this has occurred as most teachers have already participated, and DP&L interviewees spoke of potentially and/or temporarily discontinuing or revamping the program.

Online Teacher Survey

Cadmus conducted an online survey with participating teachers and nonparticipating teachers (identified by OEP as teachers that had participated in the past, but chose not to participate in the 2015 program year). Survey results provided a deeper understanding of program performance aspects:

- Teachers' opinions on program design and delivery
- Their satisfaction with the program
- Key recommendations for program improvement.

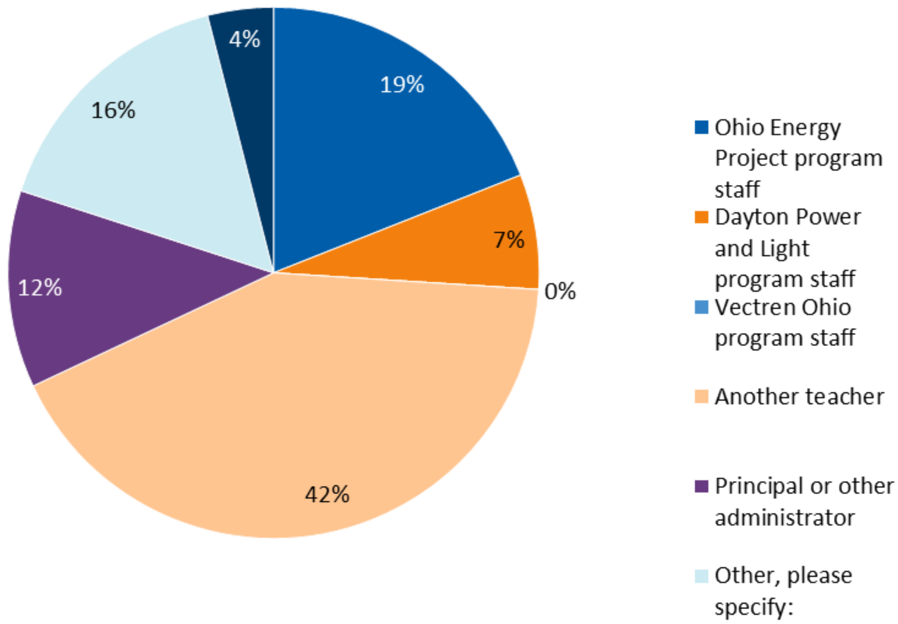
Nonparticipant teacher surveys provided teachers with an avenue to explain why they ceased to participate and to provide information on program challenges. Such information should help program and implementation staff better plan for upcoming years.

Participating Teachers

Program Marketing

OEP interviewees reported that teachers predominantly learned of the program through other teachers, as confirmed in the teacher survey, shown in Figure 29.

Figure 29. Ways Teachers First Learned About the Be E^3 SMART Program



Participant Satisfaction

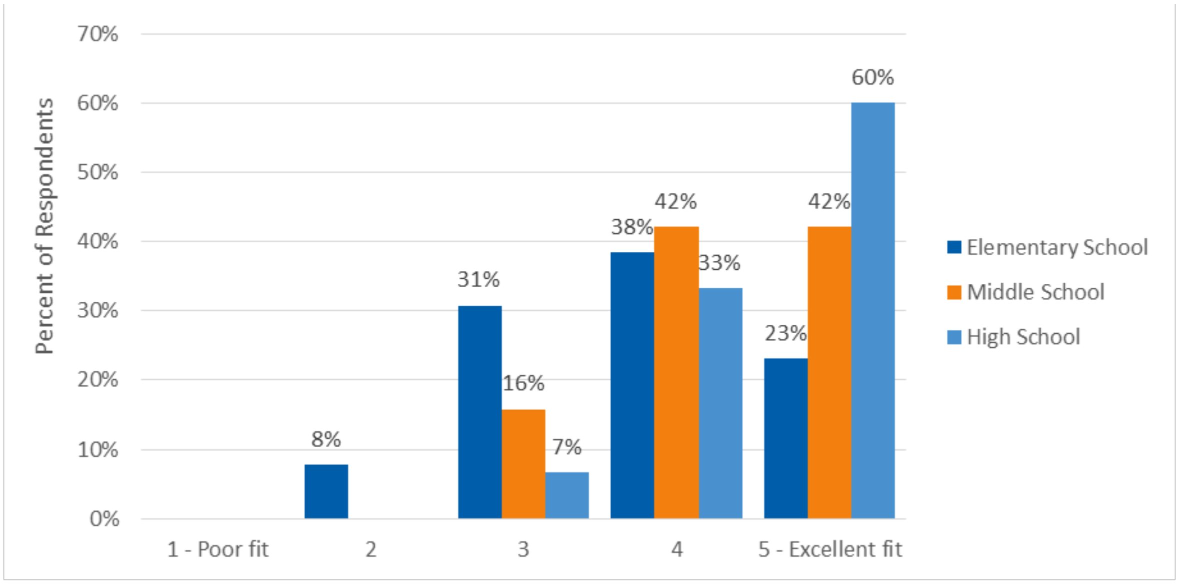
Participating teachers expressed high overall satisfaction levels during the 2015 program year: 93% were highly satisfied, and 7% were somewhat satisfied.

Teachers provided other indicators of high satisfaction levels, including the following responses:

- Nearly half of teachers (47%) reported that free energy-savings products for students and families, overall, presented the most beneficial part of the program.
- All teachers reported that they would recommend—or had already recommended—the program to other teachers (19% and 81%, respectively).
- The majority (86%) of teachers rated an "excellent" to curriculum training they received from OEP program staff.
- The majority (84%) of teachers agreed with the statement: "My students seemed to understand the lessons/curriculum." (Ratings of 4 or 5 on a scale of 1 to 5, where 1 was strongly disagree and 5 was strongly agree.)
- The majority (84%) of teachers agreed with the statement: "My students seemed engaged in the lesson." (Ratings of 4 or 5 on a scale of 1 to 5, where 1 was strongly disagree and 5 was strongly agree).

About half (47%) of participating teachers would have taught students about energy conservation in the Be E^3 SMART program's absence, indicating they strongly support the curriculum. Overall, as shown in Figure 30, 23% of elementary school teachers, 42% of middle school teachers, and 60% of high school teachers believed the program's lesson plans fit very well with Ohio's curriculum standards (ratings of 4 or 5 on a scale of 1 to 5, where 1 was poor fit and 5 was excellent fit). No teachers reported the lowest satisfaction level of 1.

Figure 30. Fit Between Be E^3 SMART Lesson Plans and Ohio's Curriculum Standards



Recommendations for Improvements

The survey asked teachers about the program's suitability for younger students (grades four through six); for those in grades 10–12; and whether teachers had suggestions for tailoring the program to these ages. When asked if they would change anything about the program to make it more suitable for lower grade levels, 78% of teachers who work with this age group would not make changes. Those who would make changes (22%) provided the following suggestions for improvements:

- "Providing more videos for fifth graders."
- "Lower-level activity pages to go with each lesson. The ones we have are a bit difficult and wordy for third and fourth grade students."
- "I feel like the reading level in several activities is just too high for grades four through six. [Include] shorter activities that can be used as quick formative assessments."

When asked whether they would change the program to make it more suitable for older students, 71% of teachers working with this age group said they would not make changes. Teachers who would make changes (29%) suggested more challenging material in the kits:

- "Make it more challenging in terms of the labs that they do rather than the discussion questions…some of the activities are aimed for a younger audience."

- “More independent and open inquiry.”
- “More complex mathematics and explanations of the chemistry world make it more relevant.”

Nonparticipating Teachers

OEP identified nonparticipating teachers as those participating in the past, but choosing not to participate in the 2015 program year. OEP identified 15 teachers for this sample, and four completed the survey. Due to the low number of responses, Cadmus provides responses anecdotally; they should not be used to extrapolate substantial conclusions about the program.

The survey focused on the primary reasons teachers chose not to participate in the program for the 2015 program year. Responses revealed that most chose not to return to the program as it proved, for various reasons, an imperfect fit for the teachers and their students. In particular, teachers reported that the curriculum did not align with grade-level standards.

Recruitment Challenges

Nonparticipating teachers cited the following reasons for not signing up for the 2015 program year (n = 1 for each):

- The content of the curriculum did not fit with existing lesson plans
- Insufficient time to participate in teacher trainings
- Program did not align with mandatory educational standards
- Participated in the Be E3 SMART program in the past and continue to use the curriculum, but did not want to receive the kits

Recommendations for Improvement

The nonparticipating teachers offered the following suggestions for improvements:

- “Please align more with fifth-grade standards if possible.”
- “For the fifth grade level, while we enjoyed the sessions very much, it was not aligned with the standards we need to teach for fifth-grade science. Unfortunately, we were not able to fund our participation in future years until it would align more with our content.”
- “Possibly just make the curriculum a little more accessible to those with reading disabilities.”
- “Send out more e-mails in the summer about upcoming workshops.”

Parent Survey

In 2015, Cadmus fielded a participant survey with parents (n = 70) regarding program satisfaction, installation of all kit measures, adoption of kit recommendations, and household characteristics and demographics. This section describes the process findings from the parent follow-up survey.

Energy Education Promotion

Parent survey results strongly suggested that student involvement in the program significantly increased energy-related conversations and conservation actions in households:

- 51% of respondents discussed energy topics once a week or more
- 23% discussed energy topics frequently (about once a month), even six to 12 months after the program's completion.

Of the open-ended responses, 53% (37 of 70 responses) directly referenced the program leading to increased energy education and awareness. Four parents offered the following remarks:

- "I was pleased that they were offering a way for children to learn before they became adults about this sort of stuff and I thought the information provided was good."
- "[It is] a good program…. I've had a couple kids who have done the program and it makes them more conscious and aware of the electricity that we use around the home; there's eight of us so it helps out when the doors are being open, the lights being on, and windows being open. It has helped them be aware of those things."
- "It's something that they don't teach kids too often, I also appreciate the energy savings and a cleaner Earth."
- "[It is] cool that the school educates kids on energy. And your child comes home to talk about it."

Customer Satisfaction

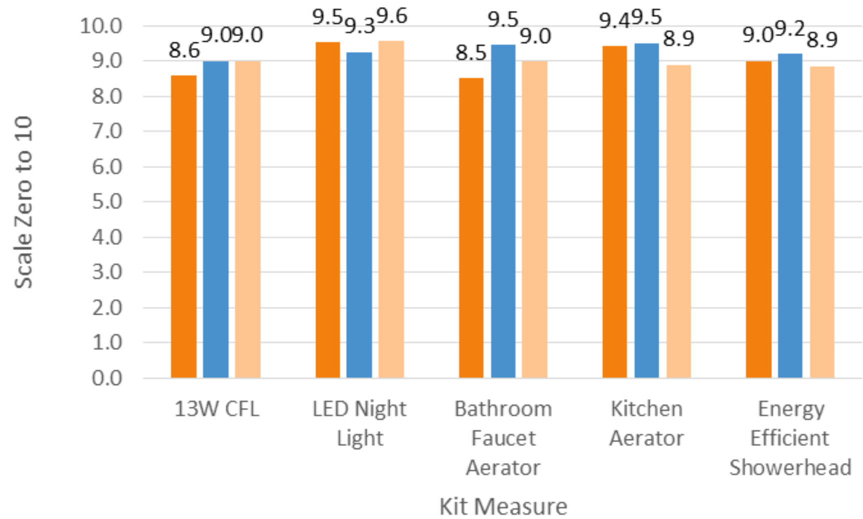
Satisfaction with Kit Measures

When asked to rate their satisfaction with each measure on a scale from 0 to 10, with 10 as extremely satisfied, high numbers of participants rated measures as an 8, 9, or 10. Ratings equal to and less than 6 meant low satisfaction levels. Average satisfaction ratings ran very high, ranging from 8.9 for the kitchen aerator and energy-efficient showerhead, to 9.6 for the LED night light.

Two participants reported less-than-satisfactory ratings for LED night lights due to malfunctioning equipment (n = 1) or not understanding energy savings right away (n = 1). In terms of water-savings measures, all participants expressed satisfaction with bathroom faucet aerators. Participants expressing dissatisfaction with showerheads (i.e., three participants) all cited water pressure (n = 3) as their reasons.

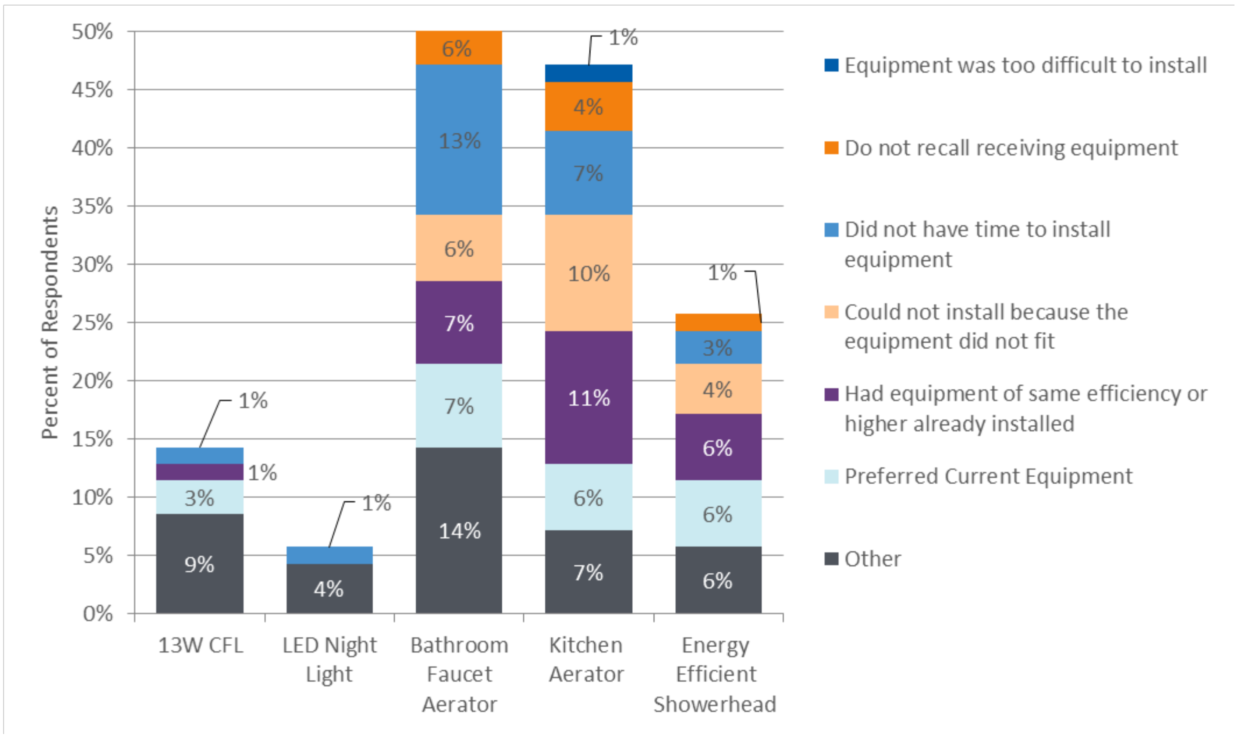
Figure 31 illustrates that measures consistently received high satisfaction ratings; the figure also shows the 2015 ratings in comparison to previous years.

Figure 31. 2013–2015 Participant Satisfaction with Kit Measures



Additionally, if customers reported the quantities of units currently installed fell below the number provided in the kit, Cadmus asked why they did not install measures. Figure 32 presents the results.

Figure 32. Reasons for Not Installing Measures

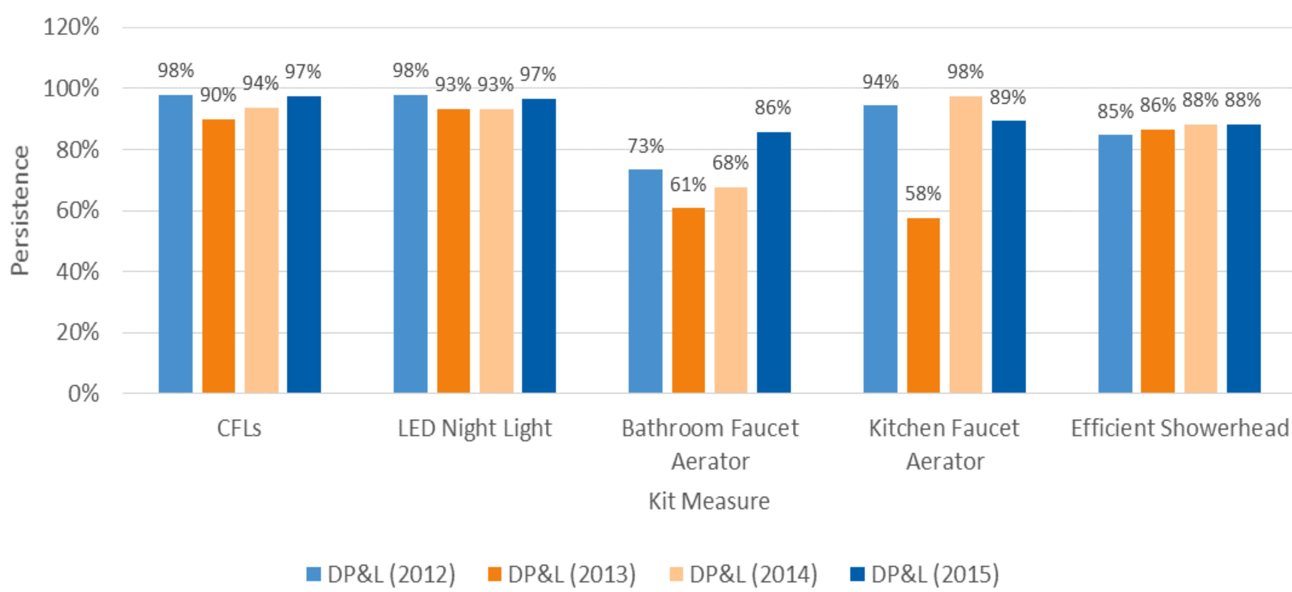


Respondents did not install the measures for the following reasons:

- Thirteen participants never installed the CFLs, most commonly because they saved the bulbs until current bulbs burned out (n = 3) or they had other equipment in place (n = 3).
- Five survey participants never installed the LED night light because they moved, did not use night lights, or did not receive the night light.
- Respondents cited not having time (13%) as their top reason for not installing the bathroom faucet aerator.
- For kitchen faucet aerators, respondents cited two main reasons for not installing the measures: having similar equipment already in place (11% of surveyed participants); and improper fit (10%). These results greatly resembled those in 2014, when 9% and 10% of respondents, respectively, reported the same reasons for not installing the kitchen faucet aerator.
- Respondents did not install the showerhead due to a preference for current equipment (6%); already owning equipment at the same efficiency levels (6%); and improper fit (4%).

To capture measure persistence, Cadmus asked participants whether they installed and later removed a measure. Figure 33 compares measure persistence across 2012–2015 DP&L Be E^3 Smart program results. Except for kitchen faucet aerators (which exhibited higher removal rates in 2013), DP&L's persistence rates have not varied greatly from year to year.

Figure 33. Reported Measure Persistence



Satisfaction with Overall Program Experience and Suggested Program Improvements

Of survey participants, 90% reported they were somewhat or very satisfied with the program. One respondent expressed dissatisfaction, claiming she did not receive all materials. In addition, 67 respondents (99%) reported being as satisfied or more satisfied with DP&L due to the program (n = 68). The remaining respondent who answered the question did not provide a follow-up response. Table 77 provides additional details.

Table 77. Overall Satisfaction with the Be E^3 Smart Program

Satisfaction Category	Follow-up Parent Survey Count (n = 70)	Percentage of Total
Very satisfied	52	74%
Somewhat satisfied	11	16%
Neither satisfied nor dissatisfied	5	7%
Somewhat dissatisfied	0	0%
Very dissatisfied	1	1%

Finally, 10 parents (14% of respondents) suggested program improvements, a few of which follow:

- Replace CFL bulb with LED bulb
- Include more installation details on the faucet aerators
- Show the difference in bulb efficiencies by sending home a bulb meter or challenging the family to compare electricity usage before and after the efficient products are installed
- More education on how energy works
- More contact throughout the program via e-mail or marketing

Parents have asked for more detailed installation instructions and more parent interaction with the program in past years' evaluations as well.

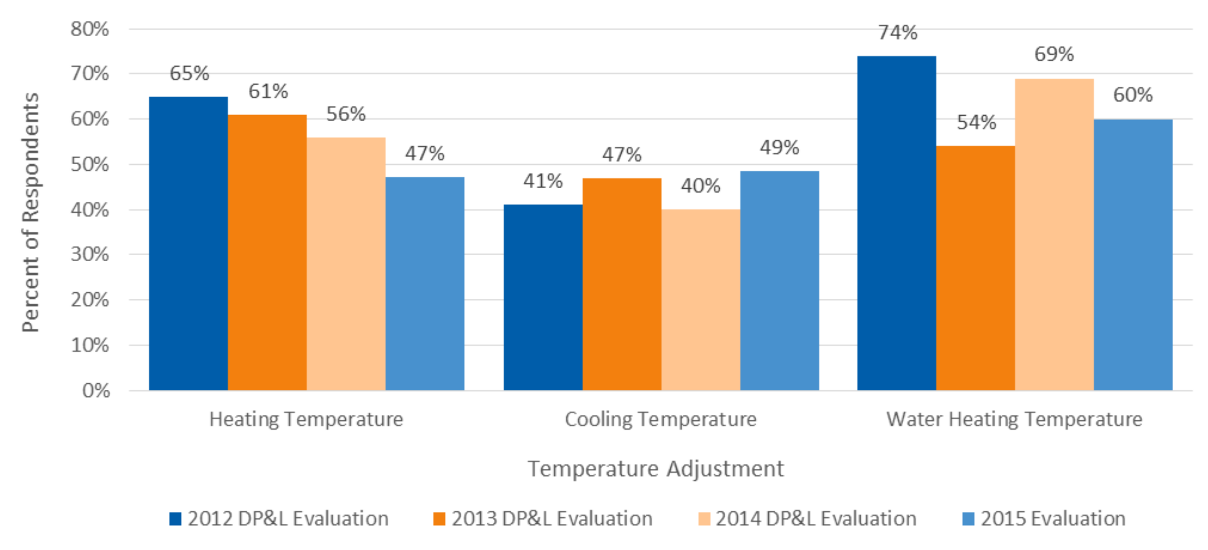
Energy Conservation

To evaluate the program's effectiveness in promoting energy conservation beyond the evaluated kit measures, Cadmus asked participants two questions addressing energy-saving behaviors they adopted and that could be attributed to program participation:

- Whether households adjusted temperature settings to DOE-recommended levels for several end uses, including heating, cooling, and water heating.
- Whether participants used the kit's weather stripping, door sweep, or furnace filter whistle.

Program kit and curriculum material recommended certain temperature levels for HVAC systems and water heaters. Figure 34 shows the percentage of surveyed participants who appropriately adjusted temperature settings to recommended levels.

Figure 34. Energy-Saving Behaviors: Temperature Adjustments



Overall, fewer participants adjusted their heating temperatures in 2015 compared to previous years. In 2015, however, more participants adjusted their cooling temperature settings compared to the previous year.

Regarding questions about whether participants installed the weather stripping, door sweep, or furnace filter whistle, 59% of respondents installed the weather stripping, a slight decrease from 2014. Door sweep and furnace filter whistle installation rates also dropped, to 53% and 14%, respectively. Cadmus asked respondents who installed the devices whether the measure proved useful (i.e., a score of 6 or higher on a scale of 0 to 10). Overall, the measures received very high ratings: 8.7 for weather stripping, 8.6 for the door sweep, and 8.3 for the furnace whistle. Table 78 presents the complete results.

Table 78. Additional Non-Evaluated Kit Measures: Installation Rate*

Kit Measures	2014	2015
Weather Stripping	70%	59%
Door Sweep	60%	53%
Furnace Filter Whistle	36%	14%

*n=70

The evaluated and non-evaluated kit measure installations were designed to lead participants to adopt energy-awareness actions (e.g., adjusting HVAC systems and water-heating temperatures) and to increase energy awareness and lower electricity bills. The follow-up survey of parents asked about benefits realized from program participation. Respondents most commonly cited increased awareness of energy usage and waste (73%); and respondents' second-most common benefit was learning about energy efficiency items (11%).

DP&L's Energy Efficiency Program Promotion

The Be E^3 kit contained a list of DP&L energy efficiency programs and, where possible, DP&L-branded materials. The company, however, did not officially monitor whether school education program participation increased participation in DP&L's overall energy efficiency portfolio.

In assessing this, Cadmus asked survey respondents whether they participated in other DP&L energy efficiency programs since participating in Be E^3 Smart. Nearly all respondents (97%) said no, they did not do so, meaning Be E^3 Smart had little effect on DP&L's total 2015 participation rate. The other 3% responded that they did not know.

Recommendations

Drawn from the preceding findings, Cadmus offers the following recommendation:

- **Phase out CFL bulbs from future kits.** DP&L's Home Energy Efficiency Kit currently contains four 13-watt CFL light bulbs. According to the new 2017 ENERGY STAR lighting specifications, ENERGY STAR will no longer certify CFL models. Furthermore, CFLs' ISRs have declining over past years, falling from 93% in 2014 to 86% in 2015—currently 1% below the 87% 2012 level. Therefore, Cadmus recommends that DP&L remove CFL bulbs from the kits in preparation for future ENERGY STAR specifications; future CFLs will not add savings to the kits. DP&L might consider replacing the CFLs with a smaller quantity of LEDs. Cadmus ran a cost-effectiveness analysis to estimate the change in cost per kit if CFLs were replaced with LEDs. The analysis used a proxy cost of $6.05 per LED, for up to three LEDs per kit, to predict changes in kit costs. While the program's cost-effectiveness will likely decrease slightly, the program would still remain highly cost effective with the removal of CFLs and addition of LEDs.
- **Investigate the possibility of expanding kit offerings to include new measures.** Surveys with participants showed that the ISRs for the kit's non-evaluated measures (weather stripping, door sweep, and furnace filter whistle) have fallen. Cadmus recommends that DP&L consider replacing one of these less popular kit measures with a new measure. One example is the ShowerStartTM TSV, a thermostatic valve shut-off valve that attaches to an existing showerhead and reduces water flow once the temperature of the water reaches 95° F. The device targets behavioral water waste that occurs when the user lets the water run prior to showering.

Nonresidential Prescriptive Rebate Program

This section describes the evaluation approach, detailed findings, and conclusions and recommendations for the Nonresidential Prescriptive Rebate Program. Total savings for the Nonresidential Prescriptive Rebate Program include savings from four groups of measures: Rapid Rebate measures, Residential Lighting Program bulbs installed in commercial allocations, measures from the Commercial Lighting Incentive Program (CLIP) and measures from the residential ARP program implemented at nonresidential sites. Savings for all four groups are included in this section, but details related to the latter three may be found in their respective report sections.

Evaluation Overview

Cadmus' evaluation of the 2015 Nonresidential Prescriptive Rebate Program followed researchable questions and evaluation activities outlined in DP&L's 2015 *Evaluation, Measurement, and Verification Plans* document. Table 79 identifies key researchable evaluation questions.

Table 79. Key Researchable Questions

Researchable Questions	Activity to Support Question
How do Ohio TRM-deemed savings compare with validated program savings?	• Site visits • Engineering analysis • Database review • Participant distributor surveys • Program and implementation staff interviews • Customer surveys for midstream participants
What gross electric savings and demand reductions does the program achieve?	• Engineering analysis • Database review • Meter installations
What experiences do program administrators have with program processes?	• Program staff interviews
Is the program cost-effective?	• Cost-effectiveness analysis

Detailed Evaluation Findings

DP&L exceeded its savings goals of 54,446,250 kWh and 9,636 kW, achieving the following:

- 78,555,936 kWh and 13,040 kW in *ex ante* savings
- 80,583,691 kWh and 11,882 kW in adjusted gross savings

These adjusted gross savings represent realization rates of 103% and 91%, respectively, against *ex ante* claimed energy and demand savings.

In addition to the typical Rapid Rebates measures (e.g., efficient commercial lighting, motors), DP&L offered prescriptive incentives in 2015 through a midstream channel called the Commercial Lighting Incentive Program (CLIP).

- Table 80 presents claimed and achieved program savings. Key impact evaluation findings follow.

Table 80. 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*
HVAC	7,112,699	1,724	7,112,699	1,724	10,718,189	2,022	± 13.3%
Lighting	44,422,467	6,136	44,422,467	6,136	43,387,500	5,061	± 4.5%
Motors	6,524,832	1,015	6,524,832	1,015	8,904,609	1,445	± 72.0%
Compressed Air	2,442,639	190	2,442,639	190	2,442,279	190	± 91.6%
Midstream Lighting Incentives (CLIP)	8,653,068	1,763	8,397,489	1,734	7,504,402	1,375	±10.7%
Residential Lighting Bulbs**	9,288,454	2,194	7,616,532	1,799	7,548,640	1,776	± 12.7%
Appliance Recycling at Nonresidential Sites	111,776	18	111,776	18	78,072	13	± 8.5%
Total* **	**78,555,936**	**13,040**	**76,628,434**	**12,617**	**80,583,691**	**11,882**	**± 9.1%**

* Precision at 90% confidence.

**Bulbs sold through the residential lighting program and allocated to the commercial program. For *ex ante* savings, 5% of upstream residential lighting bulbs were allocated to commercial applications. Verified and adjusted savings used 4.1%.

***Values in table may not sum to 100% due to rounding.

- Cadmus expected project-level realization rates to fall above and below 100%, given the use of deemed assumptions for *ex ante* calculations and site-specific parameters used for adjusted gross calculations. *Ex ante* values and assumptions are derived from the Ohio TRM, and represented average, expected savings. Using site-specific parameters to calculate adjusted gross savings lead to some projects achieving greater savings and some projects achieving lower savings than that predicted by the Ohio TRM.
- The prescriptive program included adjusted gross energy savings of 7,548,640 kWh and demand reductions of 1,776 kW for CFLs and LEDs purchased at retailers that participated in the Residential Lighting program and installed in commercial applications.
- The bulbs received savings based on the Ohio TRM's commercial lighting systems measure. This resulted in higher unit savings, in comparison with residential program. Bulbs likely were installed in office buildings and experienced higher usage, coincidence, and interactive effects.
- HVAC and Motors Measures exhibited realization rates over 100%, largely due to variable frequency drive (VFD) installations. Throughout the metered time period, sampled sites with VFDs operated at greater hours than reported and at lower average speeds than anticipated.

- In lieu of conducting formal staff interviews with the DP&L program staff, Cadmus maintained regular phone and email communications, staying informed of program issues as they arose.
- Overall, Cadmus found minimal discrepancies during on-site verification work, with notable discrepancies isolated to a few projects.

Impact Evaluation Data Collection Methods

Cadmus designed the impact evaluation to verify reported measure installations and to estimate gross energy and demand reductions. This effort included collecting impact evaluation data from the following sources:

- The DP&L program tracking database
- Online application forms
- DP&L pre-and post-audit inspection reports
- On-site visits conducted by Cadmus
- Metering lighting operation hours for selected projects
- Metering power data from fan, pump, and compressor motors for selected projects.
- Data-meter trend data for temperatures on selected non-lighting projects.

As part of the evaluation, Cadmus reviewed and referenced the Ohio TRM and utility Joint Objections and Comments regarding the Ohio TRM.

Baseline Assumptions

Baseline assumptions typically addressed data obtained on site and included replaced fixture types and quantities as well as parameters such as original operation hours and temperature setpoints. Where data could not be obtained on site (e.g., HVAC equivalent full load hours [EFLH], baseline motor efficiency), Cadmus used assumptions provided in the Ohio TRM.

Impact Evaluation Methodology

Cadmus collected baseline data through interviews with facility staff at each site and used program implementation and tracking data. On-site visits verified measure installations and identified changes in operating parameters occurring since those installations. On-site data served to inform the savings impact calculations.

Project and Site Review

Cadmus used on-site visits to evaluate a statistically valid sample of projects, based on a 90% confidence interval with a 10% precision level. For the projects selected, Cadmus engineers thoroughly reviewed all application materials.

Site visits took place in two rounds: one in July 2015; and one in December 2015. Both rounds involved verifying prescriptive and custom measures:

- For the prescriptive measure verification, the first round included site visits to 62 unique locations (by account number)
- The second round included site visits to 32 unique locations

By project category, Table 81 shows total projects evaluated through site visits for each round.

Table 81. Prescriptive 2015 Site Visit Breakdown by Measure Category—By Project ID*

Measure Category	Number of Site Visits Conducted			Total Number of Reported Projects
	July	December	Total	
Lighting	69	9	78	78
HVAC	6	7	13	13
Motors	5	0	5	5
Compressed Air	2	0	2	2
Total	**82**	**16**	**98**	**98**

*The table represents total projects; individual customer accounts may have multiple projects.

To account for the wide range in project sizes, Cadmus divided lighting projects into large, medium, and small subcategories, based on *ex ante* claimed savings in the DP&L database, and then prioritized analysis of large, high-impact projects by their disproportionate effect on overall program savings. Consequently, Cadmus successfully verified three of the nine prescriptive large lighting projects in the program population. Table 82 provides details regarding the number of measure types (iterations)[27] for each strata evaluated. The three sampled projects represented four measures.

Table 82. Prescriptive 2015 Project, Measure Type, and Site Visit Breakdown by Subcategory

Measure Category (By Project ID)*	Program Project Count*	Program Measure Type Count	Sample Project Count	Sample Measure Type Count
Large Lighting >500,000 kWh	9	15	3	4
Medium Lighting <500,000 kWh, >100,000 kWh	69	59	8	30
Small Lighting <100,000 kWh	951	82	67	43
HVAC	144	18	13	9
Motors	30	5	5	3
Compressed Air	54	3	2	1
Total	**1,257**	**182**	**98**	**90**

*The table represents total projects; individual customer accounts may have multiple projects.

[27] Measure-type iterations represented the number of line items in the tracking database where a project could have multiple types of lighting technologies installed.

Site Verification Visits and Document Review

After selecting projects to verify through on-site verification activities, Cadmus downloaded project documentation from DP&L's administrative website. In preparation for each site visit, Cadmus reviewed documentation and other relevant program information. The review focused on calculation procedures and energy-savings estimate documentation.

Cadmus also reviewed DP&L's tracking spreadsheet and online application data, comparing entries to original application materials for consistency and accuracy.

On-site visits enabled Cadmus to conduct the following primary tasks:

- Verify implementation, installation, and characteristics of incented equipment
- Collect additional, detailed data (such as ballast factors) needed to calculate energy savings
- Install light meters on selected projects to determine hours of operation

Appendix I provides detailed site visit findings.

Engineering Analysis and Savings Verification

For each project in the site visit sample, Cadmus performed an engineering analysis—using data verified on site and supplemented by project documentation—to validate energy savings and demand reductions.

Procedures used to validate savings depended on the measure type analyzed. Major measure groups including the following:

- Lighting measures
- HVAC measures
- Motors and VFDs
- Air compressors

Generally, the review methodology relied upon industry-standard algorithms, the Ohio TRM, secondary research, and engineering experience. The following sections describe procedures used to validate savings from the first four measure categories.

Lighting Measures

Lighting measures included retrofits of existing fixtures, lamps, and/or ballasts with energy-efficient models as well as lighting control technologies. Cadmus generally assumed fixtures operated in the same way (i.e., the same duration of time) pre- and post-retrofit.

Analyzing lighting fixture measure savings required specific fixture data, including the following:

- Wattage before and after the retrofit
- Hours of operation after the retrofit

- Number of fixtures affected by the measure

Cadmus used two sources to calculate hours of operation for lighting fixtures:

- Cadmus engineers verifying lighting hours of operation during site visits
- Where hours could not be verified, employing the Ohio TRM

For a sample of projects, Cadmus installed light meters to accurately determine hours of operation. During the first round of site visits, this included sampling sites for light metering, based on DP&L peak demand reduction evaluation requirements.[28] During the second round of site visits, Cadmus asked site contacts about hours of operation for retrofitted lighting. If these hours of operation varied by more than ±10% of the reported values (from the DP&L database), schedulers selected the site for light metering.

Cadmus identified 61 sites meeting the light-metering criterion, as shown in Table 83, which includes the number of light meters installed.

Table 83. Light Meter Installation Summary

Round	Number of Sites Selected for Light Metering	Number of Light Meters Installed
Round 1	49	204
Round 2	12	37
Total	**61**	**241**

Metered sites represented a variety of building types (e.g., schools, universities, foundries, restaurants, warehouses, retail spaces). As reported hours of operation in DP&L's database only reflected fixture types and not space types, Cadmus installed meters on lighting fixtures in different space types (e.g., restrooms, break rooms, storage, office space).

Cadmus analyzed hours of operation for each fixture by day type (e.g., weekday, Saturday, Sunday, holiday). When the metering period did not include a public holiday, Cadmus assumed six federal holidays for businesses. For buildings following a special schedule (e.g., schools, universities), Cadmus discussed annual holidays with site contacts. To ensure redundancy, Cadmus field staff installed at least two meters for large spaces. When installing multiple meters in the same space, Cadmus averaged hours recorded by the meters. Appendix H, provides a summary of the memo Cadmus issued to inform DP&L about the light meter installations and retrieval protocols for the first round.

[28] In DP&L's 2013–2015 portfolio plan, a stipulation requires that DP&L bids 75% of eligible MW derived from its energy efficiency programs into the PJM (Pennsylvania, Jersey, Maryland) peak demand auctions. To fulfill this requirement Cadmus conducted metering, with the results used to estimate energy efficiency savings.

In addition to lighting fixture retrofit measures, Cadmus analyzed savings for wall, ceiling, and fixture-mounted occupancy sensors using the following data:

- Total connected lighting load
- Space type
- Facility operating hours (light metering where applicable)Any operational characteristics identified through the on-site survey

Calculations used wattage values reported on applications, unless those deviated significantly from published databases or manufacturers' claims.

During on-site visits, Cadmus verified the parameters discussed above, and conducted interviews with facility personnel to verify operating hours and to determine locations where measures had been applied. If a significant discrepancy in reported and verified hours emerged, Cadmus installed light meters. When on site, field engineers collected lamp information (e.g., actual fixture and ballast details) and performed a fixture count.

As the Ohio TRM provided a specific baseline for fixtures, based on high-efficiency replacements for lighting measures, Cadmus used (where applicable) the baseline wattage values in the TRM for the savings calculations.

For additional upstream lighting savings achieved when customers purchased CFLs and LEDs from retailers and installed the lamps in commercial applications, Cadmus conducted analysis as part of the Residential Lighting program and attributed savings to the Nonresidential Prescriptive Rebate program lighting measure category. Analysis used the Ohio TRM to account for differences between sectors. Cadmus adjusted hours of operation, WHFs, and demand CFs for small commercial applications, using the commercial lighting inputs shown in Table 24.

HVAC Measures

HVAC measures represented a variety of technologies, including the following:

- Unitary and split system air conditioners
- Packaged terminal air conditioners and heat pumps
- Chillers
- Ground-source heat pumps
- Variable Refrigerant Flow (VRF) systems
- Programmable thermostats
- Energy recovery ventilators
- HVAC VFDs
- HVAC occupancy sensors

Using the Ohio TRM as a guide, Cadmus analyzed each measure and verified HVAC savings through site verification results and reviews of application materials.

To quantify loads controlled by the devices, the evaluation used values based on the Ohio TRM and on engineering experience. This analysis accepted Ohio TRM values for EFLH, as these had been reviewed by the various evaluation contractors supporting development of the Ohio TRM.

Motors and HVAC VFDs

Motor measures included the following:

- Premium-efficiency motors
- Air compressors less than 100 HP (load control and variable speed)
- VFDs[29] less than 250 HP

Cadmus analyzed each measure using the methodology defined in the Ohio TRM and verified motor and VFD gross savings through site-verification results and reviews of application materials.

For high-efficiency motor replacements, parameters included the following:

- Efficiency of the old and new motors
- Load factors[30]
- Usage factors

When conducting a site visit of a motor project, Cadmus engineers collected information such as nameplates and motor applications (e.g., pump, fan, process). Where applicable, the evaluation also verified motor operating hours by interviewing facility contacts. When data could not be obtained, Cadmus estimated these parameters, based on an Internet search of equipment specification data, professional experience, and deemed values from the Ohio TRM.

Compressed Air Systems

Compressed air measures included air compressors less than 100 HP (load control and variable speed) and no-loss drains. Similarly to motors, load factors serve as a critical parameter for air compressor systems. Cadmus calculated savings using load factor estimates, based on Ohio TRM values and engineering experience.

[29] In some cases, this category included HVAC VFDs.

[30] The load factor—serving as a critical parameter for air compressor and VFD installations—often is determined through pre- and post-installation metering. Due to the time and cost involved, however, metering may not be feasible for prescriptive programs. Therefore, Cadmus calculated savings using load factor estimates, based on Ohio TRM values and engineering experience.

Calculating Realization Rates

Cadmus derived program-level, end-use savings, and demand reductions through realization rates, calculated for each major measure type (e.g., HVAC, lighting, motors, compressed air, other technologies). Similar to the sample selection process, the study broke lighting measure types into three categories: large, medium, and small lighting projects. This method included the following:

- Calculating adjusted gross savings for the sample of site visit projects.
- Calculating a realization rate, based on *ex ante* claimed and adjusted gross savings, for the total sample within each measure group.
- Applying sample realization rates to the program population for each measure group to calculate total program verified and adjusted gross savings. Cadmus divided lighting into the following kWh strata:
  - Small (0–100,000)
  - Medium (100,000–500,000)
  - Large (500,000 plus)
- Realization rates, developed for each stratum, could then be applied across that population subgroup.
- Including 7,548,640 kWh in adjusted savings from the Residential Lighting program to the Nonresidential Prescriptive Rebate program.

Cadmus acknowledged several limitations resulting from this approach. For example, applying realization rates to a heterogeneous population of measures using small samples can present issues. Lighting measures, however, dominated claimed *ex ante* program savings (73%).[31] Cadmus determined the size, variability, confidence, and precision associated with the lighting sample provided the most significant influence on overall realization rates, reducing the impacts of small sample sizes in other measure groups.

Detailed Impact Findings

Gross Savings Results

Table 84 and Table 85 summarize sample-verified and adjusted results by major prescriptive measure groups (In-depth CLIP details are discussed in the CLIP Midstream Lighting Program section).

[31] This percentage did not include the transfer of upstream Residential Lighting program savings to the Nonresidential Lighting program.

Table 84. Sample Gross *Ex Ante* Claimed and Adjusted Gross *Ex Post* Energy Savings

Measure	Number of Projects	*Ex Ante* Gross Energy Savings (kWh)	Verified Energy Savings (kWh)	Adjusted Energy Savings (kWh)	Realization Rate*
Large Lighting	3	13,104,892	13,104,892	14,150,529	108%
Medium Lighting	8	13,110,309	13,110,309	13,043,515	99%
Small Lighting	67	18,207,266	18,207,266	16,193,455	89%
Compressed Air	2	2,442,639	2,442,639	2,442,279	100%
Motors	5	6,524,832	6,524,832	8,904,609	136%
HVAC	13	7,112,699	7,112,699	10,718,189	151%
Total	**98**	**60,502,637**	**60,502,637**	**65,452,576**	**108%**

*Program-level realization rates weighted by total measure sizes and rounded to the nearest whole number.

Table 85. Sample Gross *Ex Ante* Claimed and Adjusted Gross *Ex Post* Demand Savings

Measure	Number of Projects	*Ex Ante* Gross Demand Savings (kW)	Verified Demand Savings (kW)	Adjusted Demand Savings (kW)	Realization Rate*
Large Lighting	3	1,419.43	1,419.43	1,323.45	93%
Medium Lighting	8	1,728.89	1,728.89	1,639.06	95%
Small Lighting	67	2,987.96	2,987.96	2,098.82	70%
Compressed Air	2	189.92	189.92	190.00	100%
Motors	5	1,015.36	1,015.36	1,444.82	142%
HVAC	13	1,723.84	1,723.84	2,021.66	117%
Total	**98**	**9,065**	**9,065**	**8,718**	**96%**

*Program-level realization rates weighted by total measure sizes and rounded to the nearest whole number.

A summary follows of the major differences (by measure category) between *ex ante* claimed savings and adjusted savings.

Upstream bulbs account for 12% of ex ante energy savings while achieving an 81% realization rate for both energy and demand savings. The Residential Lighting Program section describes the methodology for the non-residential allocation of bulbs. The study determined that 4.1% of bulbs sold through this program were used in commercial settings. The ex ante assumed a commercial allocation of 5%. This difference in the allocation of bulbs is the largest driving factor in the upstream bulbs' realization rate.

Prescriptive Lighting Savings

For many sampled lighting projects, Cadmus calculated lower or higher energy savings than those reported. The primary differences between reported and adjusted values resulted from differences in operating hours, building types, fixture quantities, fixture types, and calculation of coincident factors.

Large lighting projects (> 500,000 kWh savings) received a 108% energy consumption realization rate and a 93% demand reduction realization rate. All three sampled projects had been metered, with an HOU higher than indicated on the rebate application. The greatest influence on the reduction in demand savings resulted from a project with a rebate calculation using an average CF of 0.732. However, because the lamps were installed in a hotel/motel, the appropriate CF factor for this project is 0.37 which the OH TRM specifies for hotel/motel. Updating the CF factor to the correct value reduced demand savings by approximately half. The CF of 0.732 is a deemed savings value based on the measure name (Energy Star LED luminaires or screw-in base lamps) and does not change the savings calculation based on building type.

The majority of sampled lighting projects in the medium lighting category received kWh savings realization rates between 90% and 110%. The main discrepancies between the projects included deviations in CF for LED applications and measured HOU.

Small lighting projects exhibited the greatest range of realization rates for savings, with project realization rates varying between 69% and 173% for kWh and 13% to 198% for kW. The majority of these projects were LED replacements.

The following bullets identify application discrepancies for DP&L's Rapid Rebate lighting program:

- **Reduced HOU**. From past evaluations, Cadmus found reported HOU for lighting projects can significantly differ from actual HOU. Cadmus installed light meters to verify HOU for lighting fixtures, selecting sites for light metering using the selection criterion discussed above. By installing light meters in different areas of a site, Cadmus could monitor differences in usage by space type. This allowed analysis of light metering data, with the results extrapolated to annual usage.
- **Deemed savings variations**. Calculations and inputs related to baseline and proposed conditions were based on deemed savings calculations. As expected (and normal), the evaluation found these deemed savings did not accurately represent actual installation conditions.
- **Missing fixtures**. Through on-site inspections, Cadmus could not verify the total number of retrofitted fixtures reported in the program tracking database and applications.

Compressed Air

The compressed air sample included two projects. Cadmus installed power meters on both air compressors and analyzed two months of trend data. Power data from one compressor were unreadable. The power meters for this specific site appeared to be in good condition, but the actual data indicated the unit was off during the trend period. Staff on site confirmed the unit was on before and after the meters were installed. The data from the other compressor indicated the air compressor ran at 35%–50% of capacity during the majority of its operations. Additionally, the facility implemented another production shift after submitting the application; so the total HOU increased by approximately 50%.

Because the evaluated performance from two sampled sites were highly variable and inconsistent with previous evaluation results, we determined the adjusted gross kW and kWh realization rates based on combining the results of the 2 sampled projects and the 2014 compressed air savings evaluation results.

Motors and HVAC VFD Savings

Cadmus evaluated five applications within the prescriptive motors category. Motor savings achieved the second highest realization rate for kWh and the highest realization rate for kW. Four of the five applications were specific to VFDs, installed on motors up to 250 HP. One application installed premium efficiency motors, and two HVAC category applications installed VFDs for motors. The following points identify typical application discrepancies for the Motors category and HVAC VFD applications:

- Similarly to the HVAC split-system and heat pump applications, DP&L uses deemed savings calculations for the VFD applications. These calculations require the applicant to provide the quantity, HOU, and HP for each VFD installed; the other calculation inputs are held as constant values. When accounting for Ohio TRM inputs, including motor efficiency and ESF, evaluated energy savings may differ from the DP&L deemed savings calculations.
- The project with the lowest demand savings (52% kW realization rate) installed a VFD to control a 12-HP motor. Cadmus installed power meters on the VFD, and trend data indicated the VFD operated from 90%–100% at all times. Additionally, HOU were higher than anticipated. Because the VFD did not modulate the motor to lower speeds as expected, the unit achieved lower-than-expected demand and total energy consumption savings.
- The project achieving the greatest savings involved a VFD installed to control a 100-HP motor. Power meters were installed, and trend data indicated an average speed of 25% during the trend period as well as much higher HOU. Due to these variations, energy savings increased to 282% for kWh and 211% for kW.

HVAC Savings

Similarly to findings from the 2014 program evaluation, verification of HVAC projects incented in 2015 resulted in the highest realization rate for kWh and the second highest for kW in the group of sampled projects. For most prescriptive HVAC projects, Cadmus applied the EFLH proposed in the Ohio TRM, as these represented reasonable usage estimates for the region.

Cadmus evaluated eight split-system projects. DP&L uses deemed savings calculations for these projects, with baseline and proposed efficiencies held constant. As the customer rebate application did not provide these efficiencies, actual energy savings may be more or less than the deemed savings calculation inputs. Cadmus installed power meters on a selection of HVAC systems to determine HOU and compare to the deemed savings estimations.

For many of the HVAC measures, the deemed savings calculations consist of multiplying the equipment quantity by the total capacity by a fixed value. The fixed value is assumed to be an average number that takes into account all possible outside air conditions, equipment efficiency, and load factors.

The Ohio TRM uses Energy Efficiency Ratio (EER), Seasonal Average Energy Efficiency Ratio (SEER), Heating Seasonal Performance Factor (HSPF), and Effective Full Load Hours (EFLH) to calculate energy savings for HVAC measures. The EER and SEER are calculated using laboratory environments with specific control parameters. These values cannot be directly measures using specific metering equipment and instead are determined using a variety of conditions and measurements. Because the SEER and EER cannot be measured directly, Cadmus cannot use the TRM calculations for evaluating metered projects. Instead, Cadmus installed data meters to measure power and temperature over a period of time. Cadmus analyzed the trend data of power consumption and outside air temperature to determine the equipment's power consumption load profile as compared to outside air temperature. The power consumption load profile was then applied to typical meteorological year (TMY) data to determine post-implementation annual energy consumption. The baseline energy consumption was determined by applying the baseline equipment's efficiency and load profile curves to TMY data. The difference between the post-implementation energy consumption and the baseline energy consumption is the project's energy savings.

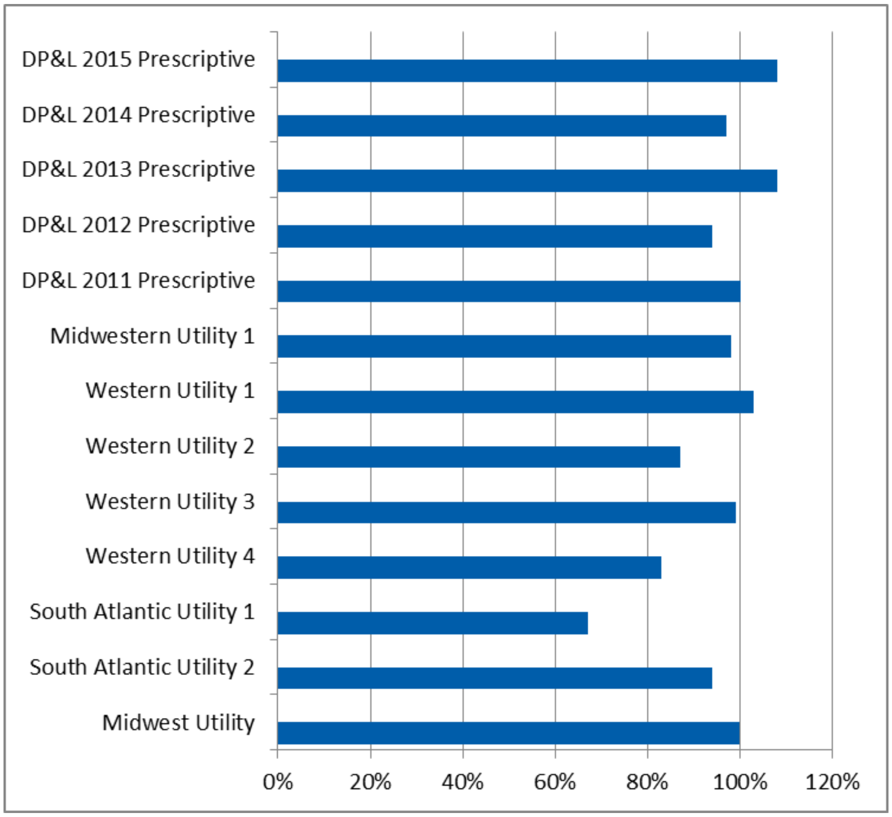
For the most part, all split-system projects resulted in kWh and kW realization rates greater than 100%. Often, the measured power consumption is higher or lower than the manufacturer's power consumption data for a given temperature. The difference may be due to equipment refrigerant charge, installation variations, or cooling mode/stage.

For all metered split-system projects, the equipment was observed running for longer periods of time at full cooling capacity than the Ohio TRM assumes. In some instances, the hours of operation are nearly twice as high as the Ohio TRM.

Realization Rate Comparison

Figure 35 compares evaluated energy realization rates for the Nonresidential Prescriptive Rebate program to rates for similar, utility-funded, commercial programs across the country. DP&L's 108% overall realization rate remains at the higher end of utility variations. Examined realization rates by measure category indicated motors, compressed air, and HVAC achieved rates higher than 100%, while the lighting measure category resulted in realization rates lower than 100%. HVAC and motor projects served as the main drivers increasing the overall realization rate.

Figure 35. Commercial Prescriptive Program Realization Rate Comparison to Other Utilities



Recommendations

Based on the preceding findings, Cadmus offers the following recommendations for prescriptive program improvements:

Request a control methodology for VFD projects. Many customers sampled for VFDs controlled them using a nontraditional manner. Typically, VFDs modulate over a range of frequencies to meet load conditions. The Ohio TRM accounts for these variations when determining the prescriptive energy-savings estimates. When placing a VFD in a manual control mode, energy savings become difficult to predict without additional information. In the future, consider requesting a control methodology as "auto" or "fixed speed" and associated expected speeds. Accurate energy-savings calculations can be automated if fixed speeds are known.

Target small businesses for lighting upgrades. The nonparticipant survey results indicated smaller businesses continued to have a high percentage of fluorescent T12 lighting in operation. This proves typical for most similar utility programs, where larger businesses tend to participate more than smaller ones. These small businesses represent a substantial opportunity to save more energy through lighting upgrades. To ensure small businesses achieve the greatest energy savings, DP&L programs should continue to promote high-efficiency lighting systems, such as LEDs and high-performance T8s. Increasing participation in the SBDI program will help promote lighting upgrades in this harder-to-reach small business segment.

CLIP Midstream Lighting Program

This section describes the evaluation approach, detailed findings, and conclusions and recommendations for the Commercial Lighting Incentive Program (CLIP). The savings for this program are included as part of the Nonresidential Prescriptive Rebate Program, while details of the program's evaluation are provided in this section.

Evaluation Overview

Cadmus' evaluation of the 2015 CLIP Program followed researchable questions and evaluation activities outlined in DP&L's 2015 *Evaluation, Measurement, and Verification Plans* document. Table 86 identifies key researchable evaluation questions.

Table 86. Key Researchable Questions

Researchable Question	Activity Used to Address Question
How do Ohio TRM-deemed savings compare with validated program savings?	• The program uses Ohio TRM-deemed values for future reported savings, which may differ from actual savings achieved. The impact evaluation should characterize any differences and provide those to DP&L for consideration.
What gross electric savings and demand reductions does the program achieve?	• Determining the amount of gross electric savings and demand reductions will help in creating a business case for continuation of the program and will be useful for planning future program designs.
Is the program cost-effective?	• Standard cost test and practices, as set forth by the Ohio Public Utility Commission, will be used.

For specific technologies (e.g., CFLs, LEDs, T8s), CLIP provided markdowns at the time of sale through commercial distributors and pro desks at the retail locations. CLEAResult developed and implemented this effort, which used two separate channels: retail and distributor.

Through the retail component, implementation staff worked with retailers located within DP&L's service territory to promote efficient, nonresidential, commercial lighting measures, using midstream incentives. Incented measures included screw-in and plug-in CFLs, screw-in LED lamps, and LED trim kits. One unique retailer with seven locations offered efficient lighting discounts through the retail channel.

Through the distributor channel, lighting distributors serving nonresidential DP&L customers could access POS incentives for purchases of energy-efficient lighting products. The distributor channel offered the following selection of bulb types:

- Screw-in and plug-in CFLs
- Screw-in LED lamps and LED trim kits
- LED exit signs
- LED wall packs
- Reduced-wattage T5 and T8 linear fluorescent lamps

- LED linear fluorescents lamps

In 2015, nine unique distributors (representing 16 locations) actively participated in the program.

A second measure category was added to the program in the 2015 year – variable frequency drives (VFDs). VFDs are controls that allow for better control over motor speed by varying the input frequency and voltage. The VFD measure accounted for only a small percentage of program savings, representing roughly 5% of the program's claimed savings. In 2015, two unique distributors (representing two locations) actively participated in the VFD portion of the program.

Detailed Evaluation Findings

Table 80 presents claimed and achieved program savings, which are included in the roll-up for the Nonresidential Prescriptive Rebate Program. Key impact evaluation findings follow.

The adjusted gross savings achieved realization rates of 86% and 77% against *ex ante* energy and demand reduction respectively. The VFD measure category accounted for less than 5% of CLIP savings in PY15. Cadmus reviewed the ex-ante savings, algorithms, and inputs for the new VFD measures. As this is a new measure for the program, and because it accounted for such a small percentage of the program's overall savings, Cadmus passed all ex-ante savings through in PY15. Based on discussions with the program managers, Cadmus expects that the VFD measures will account for a larger portion of program savings going forward. Cadmus will pursue more rigorous evaluation activities for VFDs in PY16.

Table 87. Nonresidential Prescriptive Rebate Program Claimed and Achieved Energy Savings

Measure	*Ex Ante* Claimed Savings		Verified Gross Savings		Adjusted Gross Savings		
	Gross kWh	Gross kW	Gross kWh	Gross kW	Gross kWh	Gross kW	Precision*
Midstream Lighting Measures	8,252,946	1,665	7,997,366	1,637	7,104,279	1,277	10.7%
VFD Measures	400,123	98	400,123	98	400,123	98	10.0%
Total	**8,653,069**	**1,763**	**8,397,489**	**1,734**	**7,504,402**	**1,375**	

* Precision at 90% confidence.

** Values in table may not sum to 100% exactly due to rounding.

- Two main variables drove the realization rates: the assumed baseline wattage and the CF. A program documentation review revealed the following:
    - A pre-EISA baseline wattage was used to calculate savings for many lamps sold through the program; and
    - A number of lamps were allocated savings based on assumed wattages and wattage multipliers, rather than the actual lamp characteristics.

- Cadmus used a lower CF value in kW calculations, based on a review of the prescriptive program's project database and the 2010 Lighting Market Characterization.[32] This factor only impacts the demand savings and is reflected in the lower demand realization rate.
- Distributor customer surveys provided insights into installation rates and locations of lamps purchased through CLIP. The survey findings support application of a netted, multiyear ISR to account for lamps installed after the year of purchase.

Impact Evaluation Methodology and Findings

Cadmus used the following approaches and algorithms to evaluate the midstream lighting measures:

$$\Delta kWh = \frac{\Delta W}{1{,}000} * ISR * AOH * WHF_e$$

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

Where:

ΔW	= delta watts = baseline watts–efficient watts
ISR	= in-service rate
AOH	= annual hours of operation [hours/year]
WHF_e	= WHF for energy
WHF_d	= WHF for demand
CF	= summer peak CF

Table 88 shows the input values used to calculate energy and demand reduction for *ex ante*, verified, and adjusted gross savings. Additional details follow.

[32] Available online at: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010-lmc-final-jan-2012.pdf

Table 88. 2015 Lighting Evaluation Inputs

Savings Algorithm Input	*Ex Ante* Inputs*	Verified Inputs	Adjusted Inputs**
HOU	3,988	3,988	4,017
WHF_e	1.09	1.09	1.09
WHF_d	1.20	1.20	1.19
ISR	1.00	0.98	0.98
ΔW ***	24.6	24.6	20.7
CF	0.73	0.73	0.69

*Cadmus calculated overall averages using inputs supplied by the implementation team and data derived from program tracking data. These values represented a weighted average for all rebated bulbs.

**Cadmus calculated overall weighted averages, which represented the weighted average of all rebated bulbs.

***This value reflected a weighted average of delta watts for all rebated bulbs. Cadmus' baselines were calculated using the lumens equivalency method.

Installation Rate

One challenge in evaluating midstream delivery arises from not knowing the final installed location of the purchased bulbs. In the 2014 program evaluation, Cadmus conducted a literature review and used the findings to develop an average installation rate. The review indicated that installation rates for similar programs ranged from 70% to 85%, and Cadmus used the average of the two studies, resulting in a 76% ISR applied during the evaluation.[33]

For the 2015 program year, Cadmus and CLEAResult worked with distributors to field an online survey, intending to identify a more DP&L-specific ISR for CLIP. The evaluation team fielded the survey from late October 2015 through the end of February 2016 at six distributor locations.[34] Each time a customer made a program-qualifying purchase, whether in-store or through a distributor's outside sales staff, they were prompted to complete an online survey in exchange for a $10 gift card. Through the survey

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33 Cadmus benchmarked against the following two studies:
Navigant Consulting, Inc. *Energy Efficiency / Demand Response Plan: Plan Year 4 (6/1/2011–5/31/2012) Evaluation Report: Midstream Incentives Lighting Program. FINAL.* January 30, 2013. Available online: http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd%20EPY4%20Evaluation%20Reports/ComEd_Midstream_Incentives_Lighting_EPY4_Eval_Report_Final.pdf
DNV-GL (KEMA). *Impact Evaluation of National Grid Rhode Island Commercial and Industrial Upstream Lighting Program. Final Report.* August 1, 2014. Available online: http://www.rieermc.ri.gov/documents/2014%20Evaluation%20Studies/Impact%20Evaluation%20of%20National%20Grid%20Rhode%20Island%20Commercial%20and%20Industrial%20Upstream%20Lighting%20Program.pdf.

34 Selected by CLEAResult for their high participation rates in the CLIP program, these locations cumulatively represented nearly one-half of all bulbs sold through the program.

process, Cadmus developed a program-wide, multiyear installation rate, based on the UMP, which accounted for lamps installed after the year of purchase. A 98.2% ISR resulted for the 2015 evaluation.[35]

HOU

Similar to the installation rate, HOU depends on a bulb's installed location. Cadmus used a combination of previous DP&L program data and a literature review to identify building types that lamps likely went into after purchase. The DP&L prescriptive program database allowed identification of the percentage of lighting projects performed for each building type, weighted by the number of rebates filed. Database records without a specified building type were omitted.

Cadmus supplemented this information with data from the 2010 Lighting Market Characterization, which provided estimates of the number of bulbs installed outside of buildings. Table 89 shows the building type distribution.

Table 89. Commercial Lighting Building Type Distribution

Building Type	Project Percentage by Rebate Quantity*	Estimated Building Type Weight (Inc. Exterior)**	HOU	CF
College	2%	1%	3,900	0.68
Food Sales	3%	3%	5,544	0.92
Food Service	3%	2%	4,482	0.83
Garage	3%	2%	8,760	1.00
Health Care	4%	4%	3,677	0.78
Hotel/Motel	3%	2%	3,356	0.37
Industrial	11%	11%	4,739	0.76
Office	8%	8%	3,526	0.76
Other	34%	33%	3,672	0.65
Public Assembly	4%	4%	2,729	0.65
Public Services (non-food)	3%	3%	3,425	0.64
Retail	13%	13%	4,226	0.84
School	5%	5%	2,302	0.50
Warehouse	4%	4%	3,464	0.79
Exterior		3%	3,833	0.00
Total / Average	**100%**	**100%**	**3,933**	**0.69**

* Rebate percentage calculated from the number of rebates recorded in the DP&L prescriptive program database.
** Estimated building type weight is based on the number of rebates recorded in the DP&L prescriptive program database, with the added assumption that 3% of lamps are installed outdoors, based on the 2010 Lighting Market Characterization.

[35] Cadmus could not use a multiyear ISR in the 2014 evaluation because primary data were unavailable (as were insufficient secondary data to support the claim).

Cadmus used the Ohio TRM's annual hours of operation for each building type to develop overall commercial building annual operating hours (i.e., HOU), using a program-average 3,933 hours for all non-exit lamps and 8,760 hours for exit lamps. This resulted in an overall, program-average HOU value of 4,017.

Cadmus compared the HOU value to the sources used to evaluate the program installation rate. These other programs experienced HOU values ranging from 3,684 to 4,125 hours. The evaluated HOU of 3,933 hours fell within the bounds established by the literature review; when considering exit lamps, an overall weighted HOU of 4,017 very nearly matched the implementation team's HOU of 3,988.

Waste Heat Factor

Cadmus used the building-type weightings developed for the HOU input to determine WHF values for energy and demand. Combining prior program data and a literature review indicated roughly 3% of all commercial bulbs were installed on building exteriors, with an evaluated WHF_e of 1.09 and a WHF_d of 1.19. LED Exit lamps were evaluated using a WHF of 1.08 for energy and 1.17 for demand; LED wall packs were evaluated with a WHF_e and a WHF_d of 1.0.

Coincidence Factor

Cadmus evaluated the CF using the same approach adopted in estimating annual operating hours. The building-type distribution resulted in an overall commercial CF of 0.65. LED Exit lamps were evaluated using a CF of 1.00; LED wall packs were evaluated with a CF of 0.

Baseline Wattage

Similarly to a residential upstream program, Cadmus could not determine the wattage of a lamp replaced by a lamp sold through the Midstream Lighting Incentives channel. Cadmus used the lumen equivalence method to determine a baseline lamp wattage, based on the lumen output of a purchased lamp. This methodology assumed a customer would purchase lamps producing similar lighting characteristics to those already installed.

Though this method applied to evaluated bulbs sold through the retail and distributor channels, it did not apply for LED exit signs and LED wall packs. For LED exit signs, Cadmus followed guidelines in the Ohio TRM, which dictated these equipment reduce the connected load by 9 watts. For LED wall packs, Cadmus used baselines provided with the program tracking data; derived from the Minnesota TRM, Cadmus deemed these baselines reasonable.

For screw- and pin-based CFLs and LEDs, Cadmus used the lumen equivalence approach in conjunction with ENERGY STAR lumens bins to assign baseline wattages. Cadmus first matched the program tracking data to the ENERGY STAR database, confirming the lamps' rated wattages and lumen outputs. Using the classifications outlined in the UMP, Cadmus then assigned baseline wattages, adopting the ENERGY STAR lumens bins. Lamps sold through the retail channel received the same baselines as those used by the Residential Lighting Program, which accounted for the presence of incandescent lamps still available on store shelves. Lamps sold through the distributor channel received baselines outlined by the UMP and ENERGY STAR, not baselines used by the Residential upstream program. Across the program, Cadmus evaluated an average baseline of 41.1 watts.

Process Evaluation Methodology and Findings

Throughout the fourth quarter of 2015 and the first quarter of 2016, Cadmus—with the assistance of the implementation team and distributor personnel—conducted online surveys with DP&L customers that made a qualifying purchase under the midstream CLIP. This resulted in a total of 70 surveys completed during the survey period.

The commercial midstream program provides discounts for qualifying lamps and fixtures without requiring the customer to submit a rebate. This program methodology allows passing immediate savings on to the customer, but it results in a tradeoff: uncertainties arise regarding the equipment's final installation location. The evaluators designed the customer surveys to collect information about two key savings inputs: ISR and HOU—both of which can greatly impact overall program savings.

Cadmus implemented two channels by which customers could participate in the survey; both gathered data from the customer (purchaser) via an online survey.

Customers purchasing in-store were asked to take the survey at the time of sale using an iPad (provided by Cadmus). Interested customers without time to complete a survey in-store were provided with a postcard that presented survey directions allowing them to access the survey online, at their convenience. Customers making a purchase through an outside sales channel had the option of taking the survey online at their convenience, or having the outside sales representative complete the survey on their behalf.

Potential for Bias

The survey's design sought to minimize impacts on distributor staff responsible for procuring customers' participation in the study. As such, the survey did not screen for customers who may have already participated. Customers became eligible to take the survey each time they made a CLIP-qualified purchase, though they could only submit one survey per transaction.

The survey process recorded a total of 70 transactions, but only 35 unique participants completed surveys. This can be attributed to facility maintenance staff, responsible for multiple locations (e.g., staff working for a school district) or making multiple purchases over the course of the survey. Given the relatively small number of unique customers, coupled with the large number of lamps purchased by a small subset of these customers, Cadmus cautions that some bias could occur in the survey results.

In-Service Rate

For each qualifying transaction, the survey asked customers to report when they would install their purchases, breaking this down to how many lamps or equipment would be installed within the following timeframes:

- Within four months

- Within one year
- In one to two years
- In two to three years
- In more than three years
- Unknown

As shown in Table 90, data were collected by technology for each purchase (e.g., CFL, LED, linear, exit sign).

Table 90. Number of Lamps by Technology Type and Estimated Installation Date

When will the lamps be installed?	Quantity of Lamps				
	CFL	LED	Linear	Exit Sign	Overall
Within 4 Months	179	1,401	2,706	93	4,379
Within 1 Year	30	258	818	19	1,125
In 1-2 Years	50	541	222	2	815
In 2-3 Years	0	350	0	0	350
In 3+ Years	0	2	0	0	2
Unknown	40	3,397	740	30	4,207
Total	**299**	**5,949**	**4,486**	**144**	**10,878**

Based on this information, Cadmus computed an overall ISR for the program, assuming all lamps installed "in 3+ years" would be installed in the fourth year from purchase. The analysis excluded lamps with an "unknown" installation date. By year three, nearly 100% of all lamps with a known installation date were accounted for. As shown in Table 91, the online survey results indicate 100% of the incentivized equipment would be installed by the fourth year after purchase.

Table 91. Overall Program ISR by Year

Year	Overall ISR
Year 1	83%
Year 2	12%
Year 3	5%
Year 4	0%

Hours of Operation

Similarly to the ISR, Cadmus sought to identify HOU for the purchased equipment. Thus, the survey asked participants: for lamps to be installed within the next four months, what type of facility would they be installed in? Nearly one-half (49%) of the lamps sold would be installed in schools, and another one-quarter (25%) would be installed in office buildings. The remaining 26% of lamps were distributed across 12 other building types outlined in the Ohio TRM, as shown in Table 92.

Table 92. Number of Lamps by Expected Installation Location

Building Type	Quantity of Lamps by Expected Installation Location (in the Next 4 Months)				
	CFL	LED	Linear	Exit Sign	Overall Percent
College	0	0	0	0	0%
Exterior	11	97	0	0	2%
Food Sales	0	8	0	0	0%
Food Service	6	45	20	0	2%
Garage	8	0	0	0	0%
Health Care	12	130	0	0	3%
Hotel/Motel	0	0	0	0	0%
Industrial	0	203	0	6	5%
Office	38	233	806	37	25%
Public Assembly	0	2	0	0	0%
Retail	0	18	0	0	0%
School	104	489	1,500	43	49%
Warehouse	0	77	180	7	6%
Other	0	99	200	0	7%
Total	**179**	**1,401**	**2,706**	**93**	**100%**

Based on the building type distribution in Table 92, and assuming 8,760 hours for all exit signs, a lamp sold through the CLIP midstream channel would have an average HOU of 3,158.

Cadmus also investigated the possible HOU if all lamps reported in the survey had been included in the above calculation. By assuming all lamps in a given transaction—regardless of projected installation date—would be installed in the same building types as lamps installed within four months, Cadmus developed an average HOU of 3,427. In this secondary analysis, the following primary building types drove HOU: office (34%), school (33%), and industrial (15%).

Customer Demographics

The survey asked respondents a few demographic questions to help Cadmus understand the characteristics of customers participating in the CLIP midstream lighting channel. As shown in Table 93, of 35 unique participants, nearly two-thirds (66%) reporting being facility maintenance staff, accounting for 75% of the transactions reported through the survey. Two customers reported being something other than facility maintenance staff, lighting or electrical contractors, or business owners: one self-reported as a homeowner and the other as a consumer.

Table 93. Number of Customers and Transactions by Customer Type

Customer Classification	Number of Unique Customers	Number of Transactions
Facility maintenance staff	23	50
Lighting or electrical contractor	6	11
Business owner	4	4
Other	2	2

Detailed Impact Findings

Cadmus evaluated savings for 75,233 lamps, spanning four primary measure categories: CFLs, LEDs, linear fluorescents, and linear LEDs. A summary follows of the major differences between *ex ante* claimed savings and adjusted savings.

The following primary factors drove the program's realization rate:

- **Installation rate.** Discussions with the program implementer indicated *ex ante* savings were calculated using a 100% ISR. Cadmus' participant survey found a 98.2% multiyear ISR. The differences in ISRs resulted in a roughly 2% decrease in adjusted savings.
- **Connected load reduction**. Cadmus evaluated a 20.7-watt per lamp reduction in connected load, compared to a 24.6-watt *ex ante* reduction. The various baseline wattages assigned to program lamps by the DP&L implementation team and by Cadmus drove this 17% difference. A review of program tracking data indicated the implementation team used deemed wattages and wattage multipliers rather than incented lamp wattages and assigned baseline wattages for roughly 20% of the lamps sold through the program (e.g., CFL pin- and screw-base lamps). The deemed wattage multiplier used in the *ex ante* calculation did not represent the lamps sold through the program and likely overestimated reductions in connected load by roughly 13%. Another 53% of lamps sold (e.g., LED screw-in lamps) used efficient and baseline wattages tracked in the database, but these line items overestimated the reduction in connected load by nearly 30%, given the outdated baselines in the database. Some Federal efficiency standards dictate maximum baseline wattages based on light output.
- **CF**. The implementation team used a 0.73 CF to evaluate kW savings for the Midstream Lighting Incentives program. Based on building-type distributions identified by Cadmus, adjusted savings were calculated using a 0.69 CF. The discrepancy in CF values reduced adjusted savings by roughly 5%.

Table 94 shows the difference in inputs used by the evaluation and implementation teams when evaluating savings for the Midstream Lighting Incentives program.

Table 94. Factors Driving the Midstream Lighting Incentives Program Realization Rate

Weighted Input Value	HOU	ISR	IEFe	IEFd	CF	Delta Watts
Ex Ante Inputs	3,988	100%	1.09	1.20	0.73	24.60
Adjusted Inputs	4,017	98%	1.09	1.19	0.69	20.44
Overall Impact	**1%**	**-2%**	**0%**	**0%**	**-5%**	**-17%**

Recommendations

Drawn from the preceding findings, Cadmus offers the following recommendations:

Implement a four-year, staged ISR. The survey found that, by year four, 100% of the lamps sold through the midstream channel had been installed. Cadmus recommends claiming savings for all lamps sold through the program, but savings for lamps installed during the second, third, and fourth year after purchase should be netted back to the present value using the utility discount rate. This would allow future savings to be claimed at their present value.

Adopt a lumen-equivalence approach to assigning baseline wattages for screw- and pin-based CFLs and LEDs incented through the CLIP program, consistent with EISA and the UMP. The implementation team currently tracks efficient and expected baseline wattages for each lamp sold through the program. For screw- and pin-base lamps, tracked wattages were inconsistent with Federal efficiency standards or the guidelines outlined in the UMP. To improve the program tracking database's accuracy, Cadmus recommends the implementation team adopt the following actions:

- Track lumen outputs for each lamp sold through the program.
- Use a lumens equivalence approach to assign baseline wattages consistent with Federal efficiency standards and the UMP.

Calculate the connected load reduction for lamps sold through the CLIP program using the efficient and baseline wattages captured in the program tracking data. Currently, *ex ante* savings are based on connected load reductions calculated one of two ways:

- Through deemed wattage and wattage multiplier values.

  By taking the difference of the tracked baseline and efficient wattage in the tracking database.

Cadmus recommends the implementation team adopt the second methodology, in conjunction with an approach more accurately assigning baseline wattages (as discussed above) for all measures incented through the program.

Conduct additional research regarding HOU for lamps sold through the CLIP midstream channel. The survey results indicate a much lower HOU value than implementation and evaluation teams currently claim. To better understand the building types and HOU for midstream lamps, further research is required.

Conduct a more thorough review of VFD sales and the associated savings. Cadmus performed a desk review of ex-ante savings for the VFD measure category this year. This measure category was new to the CLIP program offerings this year, and the savings constituted a small percentage of the program sales and savings. VFDs will be a much larger portion of the program going forward, and Cadmus recommends a more thorough review of the measure to ensure that these measures receive appropriate savings.

Nonresidential Custom Rebate Program

This section describes the evaluation approach, detailed findings, conclusions, and recommendations for the Nonresidential Custom Rebate Program.

Evaluation Overview

Cadmus' evaluation of the 2015 Nonresidential Custom Rebate program followed researchable questions and evaluation activities outlined in DP&L's *2015 Evaluation, Measurement, and Verification Plans* document. Table 95 identifies key researchable evaluation questions.

Table 95. Key Researchable Questions

Researchable Questions	Activity to Support Question
What are the program's gross electric savings and demand reductions?	• Engineering analysis. • Database review. • Site visit observations • Power and Temperature metering
What are DP&L's experiences with the program processes?	• Program staff interviews.
Is this program cost-effective?	• Standard cost test and practices set forth by the Ohio Public Utility Commission will be used...

Detailed Evaluation Findings

DP&L fell short of its energy-savings goal of 28,144,000 kWh, achieving 16,483,813 kWh. The program also achieved less than its kW goal of 5,200, with 2,126 in *ex ante* demand reduction. Cadmus calculated 16,561,765 kWh and 2,029 kW in adjusted gross savings. These adjusted gross savings represent realization rates of 100% and 95% for *ex ante* energy and demand savings, respectively.

DP&L divides the Custom Rebate offering into two separate categories: Custom and New Construction. New Construction projects account for 31 of the 114 rebated projects. The following key findings apply for each of these categories.

Table 96. Nonresidential Custom-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*
Custom	10,940,861	774	10,940,861	774	10,984,651	791	± 24.62%
New Construction	5,542,952	1,352	5,542,952	1,352	5,577,114	1,238	± 12.76%
Total	**16,483,813**	**2,126**	**16,483,813**	**2,126**	**16,561,765**	**2,029**	**± 8.3%**

*Precision at 90% confidence.

- Similar to the previous evaluation, the Custom and New Construction projects found only minor variations in adjusted savings compared to *ex ante* savings. Cadmus found few differences between customer application data and on-site verification work. The majority of projects achieved realization rates between 80% and 100%, with only a handful of sites falling outside of this range.

- The evaluation identified only minor issues during the desk reviews. The most significant issue involved demand reduction being claimed for exterior lights: the adjusted savings excluded this demand reduction. The desk reviews assigned realization rates off 100% to almost all reviewed sites.
- In lieu of conducting formal staff interviews with the DP&L program staff, Cadmus maintained regular phone and email communications, staying informed of program issues as they arose.

Evaluation Data Collection Methods

Using the Nonresidential Custom Rebate program database, Cadmus selected a sample for on-site verification activities. This required subdividing Custom projects into two populations, according to project type: Custom Rebate and New Construction Rebate building performance projects.

Cadmus evaluated a statistically valid sample of projects through on-site visits, determining the sample size based on a 90% confidence interval with a 10% precision level, and with a correction factor for a finite population. For projects selected in the sample, Cadmus engineers thoroughly reviewed rebate application materials. For selected New Construction building performance projects, Cadmus evaluated project savings by calibrating simulation models (provided as part of the project documentation) to utility usage data. In addition to performing on-site visits, Cadmus performed desk reviews for a sample of Custom sites.

Project and Site Review

The 13 visited projects and 10 desk reviewed projects represented 11% of the program's overall reported savings. Of the 114 custom projects included in the 2015 program, 27 represented relatively large savings levels (greater than 100,000 kWh per year). Cadmus verified three of these projects.

Cadmus performed two rounds of site visits, in July 2015 and December 2015. The first round consisted of site visits to 11 unique locations (by account number); the second consisted of site visits to two unique locations. By project category, Table 97 shows total projects evaluated through site visits per each round.

Table 97. Custom Site Visit and Desk Review Summary

Measure Category	Number of Site Visits Conducted			Number of Desk Reviews Conducted	Total Number of Reported Projects
	July	December	Total	Total	
Custom	9	0	9	5	83
New Construction	2	2	4	5	31
Total	**11**	**2**	**13**	**10**	**114**

Baseline Assumptions

Typically, baseline assumptions involve data obtained on site and include replaced fixture types and quantities as well as parameters such as original operation hours, pressure settings, and baseline equipment power draws.

In some cases, DP&L's third-party engineering firms conducted monitoring to obtain baseline consumption. In these cases, Cadmus verified that operating conditions remained valid on site and used logged data to inform the baseline conditions. When data could not be obtained on site or through project documentation (e.g., baseline motor efficiencies, fixture wattages), Cadmus used assumptions provided in the Ohio TRM. Baseline conditions for New Construction projects were based on the 2009 International Building Code, which included references to the International Energy Conservation Code and ASHRAE 90.1-2007.

Impact Evaluation Methodology and Findings

Site Verification Visits and Documentation Review

After selecting projects to verify through on-site activities, Cadmus downloaded project documentation from DP&L's administrative website. In preparation for each site visit, Cadmus reviewed this documentation and other relevant program data. The review focused on calculation procedures and energy-savings estimate documentation.

On-site visits enabled Cadmus to accomplish four primary tasks:

- Verify the implementation, installation, and characteristics of incented equipment.
- Collect additional detailed equipment data (e.g., ballast factors) needed to calculate energy savings.
- If applicable, collect available energy management systems data to inform the savings analysis.
- For New Construction projects, verify and collect additional building characteristic data to inform the building simulations.

Appendix I provides detailed site-visit findings.

Cadmus also performed desk reviews for 10 Custom projects. When performing desk reviews, Cadmus reviewed all documentation available within the program database for each project. Documents available for review include equipment invoices, specification sheets, audit forms, calculation spreadsheets, and application documents. Cadmus analyzed the available documents to identify potential discrepancies between the application data and the installation documentation. Where Cadmus identified discrepancies, the energy savings calculations were revised to accurately reflect the installed condition.

Engineering Analysis and Savings Verification

By major measure groups, Table 98 and Table 99 summarize the sample's verified and adjusted results. Cadmus applied very few adjustments to the *ex ante* savings and demand reduction, driving realization rates that are close to 100%.

Table 98. Gross *Ex Ante* Claimed and Adjusted Gross *Ex Post* Savings for Sampled Projects*

Measure	Number of Projects	*Ex Ante* Gross Energy Savings (kWh)	Verified Energy Savings (kWh)	Adjusted Energy Savings (kWh)	Realization Rate
Custom	14	872,013	872,013	837,101	104%
New Construction	9	1,007,449	1,007,449	1,013,659	101%
Total	**23**	**1,844,550**	**1,844,550**	**1,885,671**	**102%**

*Program-level realization rates weighted by total measure savings.

Table 99. Gross *Ex Ante* Claimed and Adjusted Gross *Ex Post* Demand Savings for Sampled Projects*

Measure	Number of Projects	*Ex Ante* Gross Demand Savings (kW)	Verified Demand Savings (kW)	Adjusted Demand Savings (kW)	Realization Rate
Custom	14	25.4	25.4	26.5	104%
New Construction	9	243.55	243.55	222.96	92%
Total	**23**	**268.9**	**268.9**	**249.4**	**93%**

*Program-level realization rates weighted by total measure savings.

A summary follows of the major differences, by measure category, between *ex ante* claimed savings and adjusted savings.

Custom Savings

Custom projects primarily fall into four types of projects:

- Lighting
- HVAC
- New construction
- Other technologies.

Overall, the evaluation validated realization rates of 100% for energy savings and 102% for demand reductions. Cadmus found few discrepancies for the majority of projects. The primary differences between reported and adjusted values resulted from differences in operating hours and fixture quantities. One project in particular saw a 186% kWh realization rate due to an increase in hours of use based on meter data.

The evaluation addressed seven lighting custom projects. Cadmus installed light meters at all projects. Though meter data revealed discrepancies between claimed hours of operation and measured hours of operation, deviations from claimed operations were minimal and realization rates varied between 88% and 110% for the majority of projects.

Cadmus evaluated one of the five HVAC custom projects, which involved the installation of programmable thermostats. The equipment installed matched the rebate application data, and no discrepancies emerged.

Cadmus evaluated one of the 26 Other technology category projects involving implementation of custom controls for an air compressor. No major discrepancies appeared on site, resulting in a 100% realization rate.

New Construction Project Savings

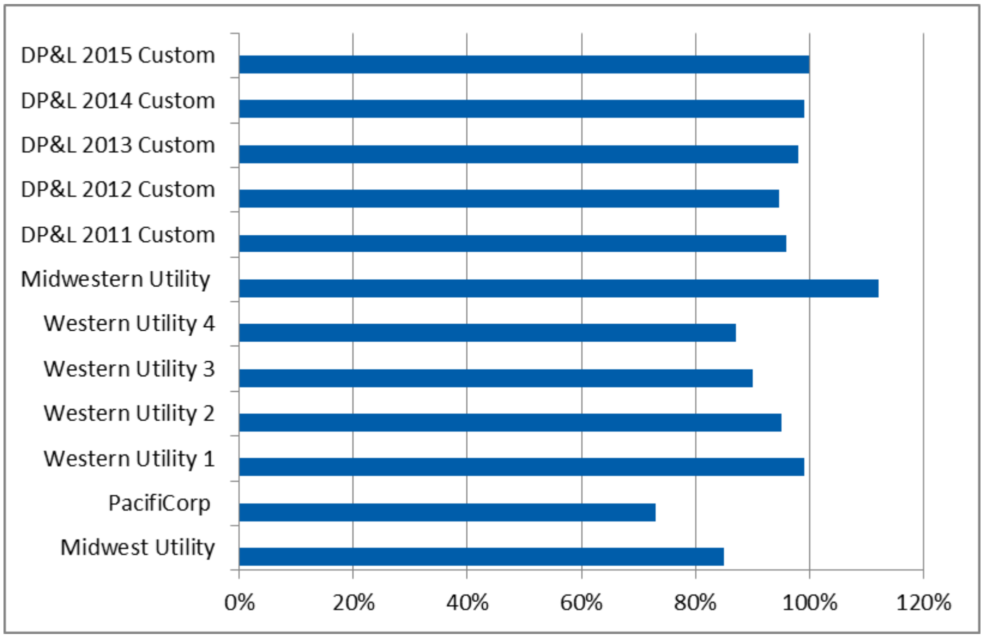
The 2015 New Construction program includes two types of projects: whole building performance incentives; and lighting power density (LPD) reductions. In the 2015 program year, 31 New Construction projects received incentives.

The LPD reduction projects required a thorough, room-by-room audit of lighting systems. The watts-reduced value, derived from LPD in watts per square foot, was calculated as savings for new lighting, as obtained from baseline LPD values listed in the ASHRAE 90.1-2007 space-by-space method for various building types. Cadmus collected lamp wattage and room square footage for each room type. If not all rooms at a facility could be accessed, Cadmus compared a sample of rooms to the project documentation. Additionally, Cadmus installed light meters at all four LPD-reduction projects. Trend data indicated HOU lower at one location and higher at another.

Realization Rate Comparison

As shown in Figure 36, Cadmus found evaluated energy realization rates for the Nonresidential Custom Rebate program comparable to evaluation findings from other, utility-sponsored, custom programs across the country.

Figure 36. Nonresidential Custom Program Realization Rate Comparison to Other Utilities



This year, DP&L's custom program exhibited a 100% realization rate. Evaluations of other utility-sponsored custom programs across the country indicated realization rates ranging from 87% to 112% (i.e., a 98% average). The accuracy of a utility's program engineering assumptions tend to drive realization rates.

Recommendations

Cadmus' evaluation did not prompt substantial recommendations for the Nonresidential Custom Rebate Program. While Cadmus found some variation in reported savings, program energy realization rates achieved 100%, consistent to previous year's findings. Cadmus found project and supporting documentation generally sufficient and in good order. Cadmus recommends DP&L continues to operate the Nonresidential Custom Rebate Program, using the same approach and execution used for the past several years.

Small Business Direct Install Program

Overview

Through the SBDI pilot program, DP&L targeted a diverse selection of small businesses and organizations with demand of 100 kW or less, offering incentives for measures such as LED bulbs, linear fluorescent bulbs, vending misers, and occupancy sensors. Rebate incentives varied from 75% to 100%, depending on the type of lighting retrofit. Lighting Optimizers, USA, served as the pilot implementer, conducting all energy audits and retrofit work.

DP&L designed the pilot, spanning the 2014 and 2015 calendar years, to obtain 200 or more participants and to generate energy savings and demand reduction near 1,300,000 kWh and 417 kW, respectively, by May 2015. The pilot targeted customers that typically have not participated in DP&L's business programs or did not have the financial backing or capital to undergo a lighting retrofit. These savings targets reflect unofficial goals and were not filed as part of the evaluation portfolio.

Methodology

Evaluation

To evaluate program impacts, Cadmus adjusted reported *ex ante* savings using information gathered through document reviews, database tracking, and follow-up telephone surveys with implementation staff. DP&L provided an invoice listing all participating customers, project energy savings and demand reduction, and rebate amounts. The implementer provided individual participant calculators they used to determine verified gross savings for all sites.

Specific details regarding this analysis can be found in 2014's evaluation report.

Benchmarking

Cadmus benchmarked elements of DP&L's SBDI pilot with other small business, direct-install rebate programs across the country. Based on input from DP&L, the benchmarking research focused on the following elements:

- Measure types
- Incentive levels
- Implementation structure
- Marketing
- Program performance

Cadmus reviewed programs with designs similar to the SBDI pilot's, accessing details through an in-house benchmarking database, internal reports, and publicly available reports (including public utility commission filings and individual utility websites). Cadmus then selected comparison programs that provided a set of offerings similar to those of SBDI.

Table 100 lists programs reviewed, along with utilities and states where implemented.

Table 100. Programs Included in Benchmarking Study

Utility	Program Name	State
Entergy Arkansas, Inc. (EAI)	Small Business Program	Arkansas
Salt River Project (SRP)	Small Business Solutions Program	Arizona
Southwestern Electric Power Company (SWEPCO)	Small Business Direct Install Program	Arkansas
Wisconsin FOE*	Small Business Program	Wisconsin
Xcel Energy	Small Business Lighting Program	Colorado

*Wisconsin FOE serves as the utilities' statewide energy efficiency and renewable resource program.

Detailed Evaluation Findings

The program had overall (unfiled) savings goals of 1,300,000 kWh and 400 kW. In 2014, DP&L claimed savings achieved during that program and evaluation year. This report uses savings achieved in 2015 for portfolio-level saving estimates and cost-effectiveness. Table 101 presents savings achieved in 2014, 2015, and combined (along with pilot *ex ante* claimed, verified, and adjusted gross energy savings and demand reduction).

Table 101. SBDI Pilot Savings by Measure Type

Measure	*Ex Ante* Claimed		Verified Gross		Adjusted Gross	
	kWh	kW	kWh	kW	kWh	kW
2014 Measures	513,268	194	513,268	194	506,429	180
2015 Measures	854,829	299	854,829	299	776,118	313
All Measures Combined	**1,368,097**	**493**	**1,278,548**	**493**	**1,282,547**	**493**

Through the 2014–2015 program periods, DP&L's SBDI pilot achieved 1,368,097 kWh and 493.1 kW in *ex ante* energy savings and demand reduction, respectively. These *ex ante* savings represented 115% and 118% of the pilot's savings goals. Cadmus calculated 1,282,547 kWh and 493.2 kW in adjusted gross savings, which represent 94% and 100% realization rates compared to *ex ante* claimed energy savings and demand reduction, respectively. The decreased energy savings indicated by the 94% realization rate resulted from variances between hours of operation identified in the initial rebate application and those recorded on post-installation audit forms.

In 2014 and 2015, 102 businesses received the 100% rebated audit and direct-installs, and 90 businesses moved on to conduct the larger, lighting retrofit upgrades. The following points address key impact and process evaluation findings, covering the two-year time period:

- The pilot measures consisted of LED bulbs, linear fluorescent bulbs, or occupancy sensor-type upgrades. LED retrofits were the most common measure installed, followed by linear fluorescents.

- The majority of retrofit calculators reviewed from the implementer proved accurate in values and methodology used. They provided reasonable HOU estimates for participants, accurate for approximately 70% of the initial rebate applications. The deviations from expected HOUs on the remaining applications did not result from systematic errors.
- Participating businesses reported high satisfaction levels with the program in terms of ease in scheduling audits, the clarity of clear audits and recommendations, and satisfaction with lighting upgrades during and following the audit. Most customers characterized themselves as very satisfied with all program elements and offered few recommendations.
- Most customers with plans to conduct additional lighting upgrades followed through with these. Those not following through most commonly cited insufficient funds. Other reasons included satisfaction with current lighting, choosing to use a different lighting contractor, and scheduling difficulties.

Detailed Benchmarking Findings

Program Summaries

Each benchmarked program applies many of the DP&L SBDI pilot elements: an initial walkthrough assessment, prescriptive rebates, and a trade partner or partners that implement all upgrades. Brief descriptions of each program follow, highlighting key features and differences.

Entergy Arkansas, Inc.: Small Business Program

Through the Small Business Program, EAI offers facility assessments and rebate opportunities for customers with a peak electrical demand below 100 kW. EAI relies on trade allies to help customers participate in this program by performing an initial assessment, identifying energy efficiency improvement opportunities, and installing the associated energy-improvement equipment. Customers receive the initial energy assessment and direct-install measures for free, with additional measures available for customers at a discount. Direct-install measures include pre-rinse spray valves, low-flow faucet aerators, low-flow showerheads, CFLs, and vending misers. Rebated measures include high-efficiency lighting, lighting controls, ECM motors and controls, anti-sweat heater controls, novelty cooler shut-off controls, gaskets, and strip curtains.

Salt River Project: Small Business Solutions Program

Through the Small Business Solutions Program, SRP offers a facility assessment and high-efficiency lighting rebates for customers with cumulative, 12-month, energy consumption below 145,000 kWh per year and with one of six utility price plans. SRP's trade allies (i.e., Alliance Participants) help customers participate in this program by performing an initial assessment, identifying eligible lighting equipment opportunities, and installing measures. SRP provides the customer with a free initial energy assessment and offers eligible lighting equipment rebates that cover approximately 75% to 85% of typical installation costs. Lighting equipment includes T5 and T8 fluorescent lighting, LED lighting fixtures, and occupancy sensors.

Southwestern Electric Power Company: Small Business Direct Install Program

Through the Small Business Direct Install Program, SWEPCO offers a facility assessment and rebate opportunities for customers with peak electrical demand less than 50 kW. SWEPCO relies on trade allies to perform a free initial assessment, identify energy efficiency improvement opportunities, and install the associated improvement equipment. SWEPCO pays incentives directly to the trade allies for all work performed, determined based on energy savings ($0.16/kWh reduced up to 90% of project cost). The fully funded direct-install measures include aerators, pre-rinse spray valves, and vending economizers. Rebated measures include high-efficiency lighting (e.g., CFLs, LEDs, T8s), ECM motors, door heater controls, daylighting controls, and occupancy controls.

Wisconsin Focus on Energy: Small Business Program

Through the Small Business Program, FOE provides a facility assessment and energy-efficient equipment through defined packages for customers with average monthly demand below 100 kW and with four or fewer locations statewide. Trade allies perform a free initial assessment, identify energy efficiency improvement opportunities, and install the associated improvement equipment. The customer and trade ally select between three, distinct, energy-efficient equipment packages, based on identified improvement opportunities. For selected packages costing $75, $175, or $295, the customer provides FOE with a co-pay, and FOE pays the trade ally an incentive for each measure installed. Customers can receive additional measures at a discount. Energy efficiency equipment includes aerators, showerheads, pipe wrap, LED open signs, vending misers, CFLs, LEDs, exit signs, occupancy sensors, and T8 fluorescent lighting.

Xcel Energy: Small Business Lighting Program

Through the Small Business Lighting Program, Xcel Energy offers a free facility assessment and high-efficiency lighting rebate opportunities for customers with peak electrical demand less than 400 kW. Xcel Energy performs a free facility assessment and assists each customer with the process of identifying lighting opportunities, selecting an implementation contractor, and completing all rebate applications and associated documents. Xcel Energy does not approve the implementing contractors or require them to be associated with the program. Rebates are paid per fixture for LED lighting, occupancy sensors, photocells, T5 and T8 fluorescent lighting, and ceramic metal halide lighting.

Measure Types

All benchmarked programs include free facility assessments and rebates for lighting equipment. Three of the five programs include rebates for measures in addition to lighting offerings. Similar to DP&L's 100% rebate within the SBDI pilot, two of the five benchmarked utilities provide free, direct-install measures. Table 102 outlines the benchmarked programs' measure offerings.

Table 102. Benchmarked Program Measure Offer Types

Program	Measures Offered
DP&L: SBDI Pilot	T5 and T8 fluorescent lighting, LED lighting, vending misers, occupancy sensors.
EAI: Small Business Program	High-efficiency lighting, lighting controls, ECM motors and controls, anti-sweat heater controls, novelty cooler shut-off controls, gaskets, pre-rinse spray valves, low-flow faucet aerators, low-flow showerheads, CFLs, vending misers, and strip curtains.
SRP: Small Business Solutions Program	T5 and T8 fluorescent lighting, LED lighting fixtures, and occupancy sensors.
SWEPCO: Small Business Direct-Install Program	Aerators, pre-rinse spray valves, vending economizers, high-efficiency lighting, ECM motors, door heater controls, daylighting controls, and occupancy controls.
Wisconsin FOE: Small Business Program	Aerators, showerheads, pipe wrap, LED open signs, vending misers, CFLs, LEDs, exit signs, occupancy sensors, and T8s fluorescent lighting.
Xcel Energy: Small Business Lighting Program	LED lighting, occupancy sensors, photocells, T5 and T8 fluorescent lighting, and ceramic metal halide lighting.

Incentive Levels

Each benchmarked program provides incentives directly to the contractor or the customer. For the SBDI pilot, DP&L provides incentives for 100% rebated projects and 75% rebated projects. The customer rebate does not directly tie to a prescribed energy savings amount; rather, the customer chooses the quantity and type of fixtures for replacement, and DP&L organizes the rebated projects by the qualifying fixtures. Cadmus compared incentives to total savings for all 100% rebated projects, which averaged $0.26 per kWh reduced. The 75% rebated projects averaged $0.46 per kWh reduced. Table 103 outlines the incentive structures for each benchmarked program.

Table 103. Benchmarked Program Incentive Structures

Program	Incentive Structure
DP&L: SBDI Pilot	DP&L incentivized projects pursuing the 100% rebate for the full cost of all measures installed. Measures were limited to a prescriptive list of T8 fluorescent lighting, LED lighting, and vending misers. DP&L incentivized projects pursuing the 75% rebate for 75% of the installation and equipment cost of measures installed.
EAI: Small Business Program	EAI pays incentives to the participating contractor, based on annual electric energy consumption reduction ($0.16/kWh reduced, up to 90% of project cost), determined through post inspections, deemed savings calculations, and other verification activities.
SRP: Small Business Solutions Program	SRP pays incentives directly to the utility-approved contractor that are between 75% and 85% of the total costs of the lighting project. The specific amount per project is determined on a case-by-case basis.
SWEPCO: Small Business Direct - Install Program	SWEPCO provides customers with free, direct-install measures and pays incentives directly to participating contractors, based on annual electric energy consumption reductions per measure type, up to 75% of total project costs (i.e., $0.18/kWh reduced for lighting and HVAC projects; $0.30/kWh reduced for refrigeration projects; $0.35/kWh reduced for window film, duct ceiling, and ceiling insulation projects). Energy consumption reductions

Program	Incentive Structure
	are determined through post-inspections, deemed savings calculations, and other verification activities.
Wisconsin FOE: Small Business Program	FOE pays incentives of $3 to $90 per fixture directly to the contractor, and customers select one of three packages: 1. Silver packages cost $75 and include up to 25 LEDs, 1 LED sign, 10 feet of pipe wrap, and unlimited showerheads. 2. Gold packages cost $175 and include everything from Silver package plus an additional 25 LEDs, 4 LED exit signs, 2 occupancy sensors, and 20 T8 linear fixtures. 3. Platinum packages cost $295 and include everything from Gold package plus an additional 75 LEDs, 8 LED exit signs, 2 occupancy sensors, and 14 LED linear fixtures.
Xcel Energy: Small Business Lighting Program	Xcel Energy directly provides rebates to the customer; these range between $1 and $175 per fixture installed.

Implementation Structure

All benchmarked programs use a similar implementation structure: the utility contracts with a program implementer, provides a free facility assessment, and identifies energy efficiency measures. The customer works with a contractor to complete a rebate application and to implement the approved measures; and the utility provides final payment after all work has been performed.

The following points specify nuances among the programs:

- **EAI: Small Business Program**. EAI contracted with a program implementer (CLEAResult) to manage the program. CLEAResult recruits contractors to become trade allies and to be listed on the program website (which requires them to receive technical and sales training from CLEAResult). Trade allies promote the program to small business customers and perform free energy assessments for qualified customers (although they do not receive reimbursement for the free energy assessment). The trade ally works with the customer to identify eligible energy conservation measures and to provide a work order, and the customer signs a contract for the trade ally to install the eligible measures. The trade ally sends the contract and rebate application to CLEAResult, which performs energy savings calculations for all projects and processed rebate applications after receiving the customer-signed contract. CLEAResult also performs pre- and post-implementation inspections.
- **SRP: Small Business Solutions Program**. Similar to EAI, SRP contracted with a program implementer (Nexant) to manage the program. Nexant provides day-to-day program management, trains contractors, provides program updates to SRP, and takes responsibility for the program achieving its goals. Once contractors' receive training by Nexant, they become classified as Small Business Alliance Participants and receive listings on the program website. Alliance Participants promote the program to small business customers, perform free energy assessments for qualified customers, and identify and provide a proposal for installing eligible lighting improvements. Customers work directly with Nexant in reviewing the scope of work,

project cost, and discounts. Nexant approves the projects and confirms rebate amounts. Alliance Participants implement the measures and receive a discounted project payment from the customer and the rebate payment from Nexant.

- **SWEPCO: Small Business Direct Install Program**. SWEPCO contracted with CLEAResult to implement and manage the program. Though much like the program process for EAI's Small Business Program (also implemented by CLEAResult), the program differs as follows: throughout the process, the SWEPCO trade ally uses tablet-based software tool to immediately determine customer eligibility, identify multi-measure energy efficiency opportunities, and immediately provide cost and energy savings estimates.
- **Wisconsin FOE: Small Business Program**. FOE contracted with a program implementer (Staples) to manage the program. Staples provides two-hour, in-person training for electrical contractors; upon completion, this allows the classification of contractors as FOE Small Business Program Trade Allies. Trade allies promote the program to small business customers and perform free energy assessments for qualified customers, although not reimbursed for the free energy assessment. The trade ally works with the customer to identify eligible energy conservation measures and to choose the appropriate Small Business Program Package: Silver, Gold, or Platinum. Each Small Business Program Package uses specific fixture types and quantities. The customer signs a contract for the trade ally to install eligible measures for the package price. The trade ally sends the contract and rebate application to Staples, which processes the rebate and provides a payment based on the sum of all fixtures and their associated incentive amounts. After the packaged measures has been completed, the customer can request installation of additional fixtures at a rebated cost. For these additional measures, the customer pays the cost-per-fixture, and Staples provides a per-fixture rebate to the trade ally.
- **Xcel Energy: Small Business Lighting Program**. Xcel Energy contracted with CLEAResult to implement and manage this program. This program uses a process similar to EAI's Small Business Program (also implemented by CLEAResult), with the following differences: rebates are determined per fixture type and quantity; savings calculations are not required; and rebate payments could go directly to the approved contractor or the customer.

Marketing

All benchmarked programs' sponsors rely on trade allies to market and sell the programs. Minimal promotion and marketing is done by the utility, other than maintaining a dedicated website and providing marketing flyers to trade allies.

Program Performance

Table 104, Table 105, Table 106, Table 107, and Table 108 compare benchmarked programs' performance regarding participation, annual energy consumption reduction, demand reduction, budget, and (respectively) performance per participant, as found in regulatory filings and evaluation reports.

Table 104. Program Performance: Participation

Program Year	Utility	Goal	Actual	Percentage of Goal Achieved
2014	DP&L: SBDI Pilot	200	192*	96%
2014	EAI: Small Business Program	1,880	782	42%
2015	SRP: Small Business Solutions Program	802	941	117%
2014	SWEPCO: Small Business Direct Install Program	316	253	80%
2014	Wisconsin FOE: Small Business Program	N/A	2,571**	N/A
2014	Xcel Energy: Small Business Lighting Program	525	399	76%

*102 customers received 100% rebated projects; of those, 90 followed up with the 75% rebated projects.

**Many utilities throughout Wisconsin offer this FOE program, accounting for the large participation number compared to other utilities.

Table 105. Program Performance: Annual Energy Consumption Reduction

Program Year	Utility	Goal	*Ex Post* Gross Energy Consumption Savings (kWh)	Percentage of Goal Achieved
2014	DP&L: SBDI Pilot	1,300,000	1,282,548*	99%
2014	EAI: Small Business Program	9,998,000	13,235,000	132%
2015	SRP: Small Business Solutions Program	7,083,000	8,903,000	126%
2014	SWEPCO: Small Business Direct Install Program	4,583,000	4,158,000	91%
2014	Wisconsin FOE: Small Business Program	N/A	30,051,761	N/A
2014	Xcel Energy: Small Business Lighting Program	27,339,812	11,626,207	43%

*The pilot achieved 115% using *ex ante* values.

Table 106. Program Performance: Demand Reduction

Program Year	Utility	Goal	*Ex Post* Gross Energy Demand Reduction (kW)	Percentage of Goal Achieved
2014	DP&L: SBDI Pilot	417	493.2	118%
2014	EAI: Small Business Program	2,263	2,256	100%
2015	SRP: Small Business Solutions Program	N/A	N/A	N/A
2014	SWEPCO: Small Business Direct Install Program	798	791	99%
2014	Wisconsin FOE: Small Business Program	N/A	5,775	N/A
2014	Xcel Energy: Small Business Lighting Program	4,459	2,207	49%

Table 107. Program Performance: Budget

Program Year	Utility	Budget	Budget Spent	Percentage of Goal Achieved
2014	DP&L: SBDI Pilot	$500,000	$480,427	96%
2014	EAI: Small Business Program	$2,489,000	$3,171,022	127%
2015	SRP: Small Business Solutions Program	$2,154,796	$2,488,747	115%
2014	SWEPCO: Small Business Direct Install Program	$1,059,155	$1,062,837	100%
2014	Wisconsin FOE: Small Business Program	N/A	$5,039,892	N/A
2014	Xcel Energy: Small Business Lighting Program	$5,994,148	$3,015,630	50%

Table 108. Program Performance: Per Participant

Program Year	Utility	Number of Participants	Energy Saved per Rebated Project (kWh)	Incentive per Rebated Project ($)	Cost Savings ($ per first year kWh saved)
2014	DP&L: SBDI Pilot	200	6,412	$2,402	$0.37
2014	EAI: Small Business Program	782	16,924	$4,055	$0.24
2015	SRP: Small Business Solutions Program	802	11,100	$3,103	$0.28
2014	SWEPCO: Small Business Direct Install Program	316	13,158	$3,363	$0.26
2014	Wisconsin FOE: Small Business Program	2,571	11,688	$1,960	$0.17
2014	Xcel Energy: Small Business Lighting Program	525	22,145	$5,744	$0.26

Table 109. Program Performance: Cost-Effectiveness

Program Year	Utility	Test	CY 2014 Actual Amount
2014	DP&L: SBDI Pilot	Total Resource Cost (TRC) Ratio: Benefit/Cost ratio	1.47
2014	EAI: Small Business Program	TRC Ratio: Benefit/Cost ratio	1.64
2014	SRP: Small Business Solutions Program	TRC Ratio: Benefit/Cost ratio	1.86
2014	SWEPCO: Small Business Direct Install Program	TRC Ratio: Benefit/Cost ratio	3.59
2014	Wisconsin FOE: Small Business Program	TRC Ratio: Benefit/Cost ratio	4.77
2014	Xcel Energy: Small Business Lighting Program	TRC Ratio: Benefit/Cost ratio	1.60

Recommendations

This section provides recommendations for the SBDI pilot, based on Cadmus' comparing it to similar programs.

Contract with an implementation firm. DP&L self-implemented its SBDI pilot. All benchmarked utilities' contracted with an implementation firm to manage their small business programs. Cadmus recommends that DP&L contract with an implementation firm to manage the SBDI pilot, freeing up limited DP&L personnel resources and leveraging a specialized firm's expertise. An open solicitation would drive interested parties to develop a program specific for DP&L's needs and scope, based on programs that succeed elsewhere.

Expand the trade ally network. DP&L's SBDI pilot consisted of a single trade ally, performing all program activities. By restricting the trade ally network, DP&L may limit potential customers, given the single trade ally's preferences and desires. Cadmus recommends that DP&L expand the trade ally network to multiple lighting contractors, provide training, and create and provide facility assessment tools to standardize the process.

Revise the incentive structure. DP&L offers higher incentives per kWh saved than the benchmarked programs. While Cadmus recommends that DP&L retain the 100% rebate, it should revise the 75% rebate to vary based on fixture types. Such a rebate structure ensures consistent and predictable cost-effectiveness across all projects. Cadmus also recommends that the 100% rebate program limits the quantity of fixtures with the lowest cost-effectiveness.

Cost-Effectiveness

Cost-Benefit Scenarios

The TRC test serves as the primary method used to determine program and portfolio cost-effectiveness; it 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 the 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 2015:

- The Societal Cost Test (SCT)
- The Utility Cost Test (UCT) (i.e., the Program Administrator Cost Test [PAC])
- The Ratepayer Impact Measure Test (RIM)
- The 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 (T-bill) rate (2.14%) to discount future benefits.[36] Using 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 the associated risks. For society as a whole, this presents a low or almost nonexistent risk level, making the T-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 for 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 (i.e., utility measure costs); administrative costs associated with the program; and lost revenues (equal to participant energy savings benefits).

[36] For program year 2015, the SCT discount rate was updated; 2014 and 2013, respectively, used discount rates of 2.51% and 3.31%.

Table 110 shows discount rate applied to each benefit-cost test.

Table 110. Discount Rates

Benefit-Cost Test	Discount Rate
TRC	8.78%
SCT	2.14%
UTC	8.78%
RIM	8.78%
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 transmission and distribution costs
- Avoided capacity costs

For each energy efficiency measure included in a program, Cadmus adjusted the hourly (8,760) system-avoided costs by 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.[37]

Cadmus used adjusted gross energy and demand savings to perform the benefit-cost calculations. This did not factor in non-energy benefits (e.g., water savings) into the calculation, but it did apply line loss—the percentage of energy lost during transmission and distribution—to measure-level savings that reflect total savings from the point of generation. Table 111 specifies line-loss assumptions**.**[38]

Table 111. Line Loss Assumptions Used in Cost-Effectiveness Calculations

Sector	Energy Line Losses	Demand Line Losses
Residential	7.37%	8.37%
Commercial/Industrial	4.06%	5.21%

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.

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[37] 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).

[38] Line losses in Table 111**Error! Reference source not found.** represent the percentage loss in energy and demand from the point of generation to the meter.

Incremental measure costs are defined as follows: incremental expenses associated with installations of energy efficiency measures, and, where applicable, ongoing operation and maintenance costs. These costs include the incentive as well as the customer's contribution. Cadmus used data provided by DP&L as well as secondary sources to calculate the incremental cost for each measure within each program.

Utility costs include customer payments and expenses associated with the following: program development; marketing; delivery; operation; and evaluation, monitoring, and verification (EM&V). Table 112 summarizes DP&L's implementation and administrative costs (all utility costs provided by DP&L).

Table 112. Implementation and Administrative Costs

Cost Category	Level	Description
Implementation Vendor and Marketing Costs	Program Level	Incremental costs associated with performing program implementation tasks (e.g., customer service, application processing, marketing, 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 (e.g., measures installed through Appliance Recycling, Low Income Weatherization, BE^3 Smart, Small Business Direct Install).
DP&L Staff 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.
External Vendor Evaluations	Portfolio Level	Activities associated with the determination and evaluation of current and potential energy efficiency programs (e.g., benefit-cost ratio analysis, impact and process analysis, cost per kWh 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.

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 in this manner ensures measure costs are included in the TRC and included as benefits in the PCT, while not incorrectly showing participant costs.

The following programs experience direct measure costs:

- Appliance Recycling
- Low Income Weatherization
- BE^3 Smart

- Small Business Direct Install

Some projects for the Custom and Nonresidential Prescriptive programs had missing incremental cost data. Cadmus relied on the Ohio TRM and the Database for Energy Efficient Resources as well as other secondary sources to calculate incremental costs for several measures (e.g., lighting, HVAC units, motors). When secondary information was unavailable, the ratio between reported gross kWh 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 Nonresidential Custom Rebate program's new construction components as well as for the Self-Directed Mercantile program, Cadmus relied on secondary research to calculate incremental costs. Such secondary research confirms the incremental cost of constructing a LEED-Certified school as 1.65% (and 2% for non-school "green" buildings). Thus Cadmus applied these percentages to total project costs in calculating a proxy incremental cost for new construction projects.

EISA 2007 Adjusted Baseline and Avoided Maintenance Costs

For the commercial and residential lighting applications, Cadmus accounted for EISA (which applies EISA's efficiency standards prohibit production [but not sale] of certain incandescent bulbs). As described in the Residential Lighting Program section, despite the new standards, most stores selling these bulbs before the efficiency standards took place continued to sell them afterwards, due to existing inventories. The continued availability of these bulbs presents implications for the baseline of efficient bulbs sold. Therefore, the cost-effectiveness results account for these "shifting" baselines for DP&L's Residential Upstream Lighting and Nonresidential Prescriptive programs as well as the Appliance Recycling, Low Income and Be E^3 Smart programs.

Additionally, Cadmus included avoided maintenance costs for the above-discussed lighting measures. These costs are average bulb prices of baseline lighting types; as energy-efficient lighting units installed through DP&L's programs have longer measure lives than comparative baseline incandescents and halogens, customers no longer have to purchase new bulbs every few years. Therefore, the prices accordingly represent the "avoided maintenance cost" to customers, they are modeled as TRC, SCT, and PCT benefits.

Overall Portfolio Cost-Effectiveness Results

Full Portfolio Results

Table 113 summarizes ex ante energy savings, demand impacts, and costs for DP&L's entire energy efficiency portfolio, utilizing adjusted gross savings. The portfolio includes the following:

- DP&L's five residential sector programs: Lighting, Appliance Recycling, Low-Income Weatherization Through OPAE, Heating and Cooling Rebate, and Be E^3 Smart.
- Two Residential pilot programs, also included in the residential portfolio: Appliance Rebates, and a Low-Income program through PWC.

- DP&L's four nonresidential programs: Prescriptive Rebate, Custom Rebate, Small Business Direct Install, and Self-Directed Mercantile.
- Portfolio costs for education and awareness.
- EM&V costs.

Table 113. DP&L Energy Impacts and Costs: 2015 Portfolio

Benefit/Cost Component	2015 Values
Gross Savings (MWh)	171,697
Capacity Savings (kW)	25,176
Total TRC Costs	$42,010,175
Direct Participant Costs	$33,168,394
Direct Utility Costs	$19,654,675
Incentives	$10,812,894
Direct Measure Costs	$1,680,392
DP&L Staff Costs	$886,664
Implementation Vendor & Marketing	$4,970,112
External Vendor Evaluations	$767,257
Education, Awareness Building & Market Transformation	$537,356

The portfolio passes the TRC test with a 1.78 benefit-cost ratio. All other tests have benefit-cost ratios above 1.0, except for the RIM test. Table 114 shows benefits, costs, and benefit/cost ratios for each test.

Table 114. DP&L Cost Effective Test Results: 2015 Portfolio

Cost Effective Test	Present Value Benefits	Present Value Costs	Benefit-Cost Ratio
TRC	$74,720,737	$42,010,175	**1.78**
UCT	$68,949,263	$19,654,675	**3.51**
PCT	$134,100,092	$33,168,394	**4.04**
RIM	$68,949,263	$141,200,066	**0.49**
SCT	$106,716,680	$42,010,175	**2.54**

Residential Portfolio Results

Table 115 (below) summarizes energy savings, demand impacts, and costs for DP&L's residential programs.

Overall, the residential portfolio proved cost-effective, with a 1.80 TRC. The most cost-effective program in the portfolio, the Lighting program has a 5.75 benefit/cost ratio. The Heating and Cooling Rebate program did not pass the TRC test as a standalone program. Additionally, the Residential Low-Income programs did not pass the TRC test. These programs, however, provided numerous non-energy benefits, such as better health and safety for low-income customers.

As discussed, all residential portfolio programs incorporating energy efficiency lighting include avoided maintenance costs.

Nonresidential Portfolio Results

Table 116 (below) presents a summary of energy savings, demand impacts, and costs for DP&L's commercial and industrial programs. Overall, the nonresidential portfolio proves cost-effective, with a 1.87 TRC. Further, except for Self-Directed Mercantile, all programs prove cost-effective.

Table 115. Residential Portfolio

Benefit/Cost Component	Lighting	Heating and Cooling Rebate	Appliance Recycling	Appliance Rebates	Be E^3 Smart	Low Income (OPAE)	Low Income (PWC)	Total
Gross Savings (MWh)	50,865	9,603	5,232	477	4,204	1,536	158	72,075
Capacity Savings (kW)	6,088	1,656	817	65	287	195	24	9,132
Total TRC Costs	$3,310,212	$8,847,987	$782,267	$390,967	$278,819	$1,155,182	$305,236	$15,070,669
Direct Participant Costs	$1,942,690	$8,144,009	$0	$258,036	$0	$0	$0	$10,344,734
Direct Utility Costs	$3,310,527	$2,333,348	$782,267	$275,131	$278,819	$1,155,182	$305,236	$8,440,510
Incentives	$1,943,005	$1,629,370	$0	$142,200	$0	$0	$0	$3,714,575
Direct Measure Costs	$420,568	$0	$217,651	$0	$114,687	$927,486	$0	$1,680,392
DP&L Staff Costs	$43,066	$51,782	$23,151	$8,039	$19,082	$35,133	$8,039	$188,292
Implementation Vendor & Marketing	$903,888	$652,196	$541,465	$124,892	$145,050	$192,563	$297,197	$2,857,251
Benefit-Cost Ratios								
TRC								
Present Value Benefits	$19,040,054	$4,366,814	$1,754,971	$253,069	$1,036,202	$675,158	$58,087	$27,184,355
Present Value Costs	$3,310,212	$8,847,987	$782,267	$390,967	$278,819	$1,155,182	$305,236	$15,070,669
Benefit-Cost Ratio	**5.75**	**0.49**	**2.24**	**0.65**	**3.72**	**0.58**	**0.19**	**1.80**
Utility								
Present Value Benefits	$13,787,791	$4,366,814	$1,745,953	$253,069	$905,430	$633,527	$55,482	$21,748,065
Present Value Costs	$3,310,527	$2,333,348	$782,267	$275,131	$278,819	$1,155,182	$305,236	$8,440,510
Benefit-Cost Ratio	**4.16**	**1.87**	**2.23**	**0.92**	**3.25**	**0.55**	**0.18**	**2.58**
Participant								
Present Value Benefits	$41,493,107	$10,436,766	$3,978,015	$656,671	$2,541,387	$1,389,715	$126,379	$60,622,040
Present Value Costs	$1,942,690	$8,144,009	$0	$258,036	$0	$0	$0	$10,344,734
Benefit-Cost Ratio	**21.36**	**1.28**	**-**	**2.54**	**-**	**-**	**-**	**5.86**

RIM								
Present Value Benefits	$13,787,791	$4,366,814	$1,745,953	$253,069	$905,430	$633,527	$55,482	$21,748,065
Present Value Costs	$37,144,938	$11,643,242	$4,885,748	$820,751	$2,750,313	$2,575,039	$433,720	$60,253,752
Benefit-Cost Ratio	**0.37**	**0.38**	**0.36**	**0.31**	**0.33**	**0.25**	**0.13**	**0.36**
Societal								
Present Value Benefits	$24,453,415	$6,710,434	$2,172,741	$388,062	$1,212,839	$1,016,690	$74,448	$36,028,629
Present Value Costs	$3,310,212	$8,847,987	$782,267	$390,967	$278,819	$1,155,182	$305,236	$15,070,669
Benefit-Cost Ratio	**7.39**	**0.76**	**2.78**	**0.99**	**4.35**	**0.88**	**0.24**	**2.39**

Table 116. Nonresidential Portfolio

Benefit/Cost Component	Prescriptive Rebates	Custom Rebate	Self-Directed Mercantile	SBDI Rebates	Total
Gross Savings (MWh)	78,556	16,484	3,727	855	99,622
Capacity Savings (kW)	13,040	2,126	579	299	16,044
Total TRC Costs	$16,056,394	$7,035,428	$1,957,830	$405,845	25,455,498
Direct Participant Costs	$14,555,819	$6,063,078	$1,813,185	$391,577	22,823,660
Direct Utility Costs	$6,322,119	$2,632,672	$420,881	$354,485	9,730,157
Incentives	$4,821,544	$1,660,322	$276,236	$340,217	7,098,319
Direct Measure Costs	$0	$0	$0	$0	0
DP&L Staff Costs	$292,311	$165,142	$49,459	$12,065	518,977
Implementation Vendor & Marketing	$1,208,264	$807,208	$95,186	$2,203	2,112,861
Benefit-Cost Ratios					
TRC					
Present Value Benefits	$36,684,719	$8,804,410	$1,470,646	$576,608	47,536,383
Present Value Costs	$16,056,394	$7,035,428	$1,957,830	$405,845	25,455,498
Benefit-Cost Ratio	**2.28**	**1.25**	**0.75**	**1.42**	**1.87**
Utility					
Present Value Benefits	$36,349,534	$8,804,410	$1,470,646	$576,608	47,201,197
Present Value Costs	$6,322,119	$2,632,672	$420,881	$354,485	9,730,157
Benefit-Cost Ratio	**5.75**	**3.34**	**3.49**	**1.63**	**4.85**
Participant					
Present Value Benefits	$55,931,718	$14,185,671	$2,370,897	$989,765	73,478,052
Present Value Costs	$14,555,819	$6,063,078	$1,813,185	$391,577	22,823,660
Benefit-Cost Ratio	**3.84**	**2.34**	**1.31**	**2.53**	**3.22**
RIM					

Present Value Benefits	$36,349,534	$8,804,410	$1,470,646	$576,608	47,201,197
Present Value Costs	$59,881,005	$15,931,666	$2,605,482	$1,044,153	79,462,306
Benefit-Cost Ratio	**0.61**	**0.55**	**0.56**	**0.55**	**0.59**
Societal					
Present Value Benefits	$54,347,076	$13,516,008	$1,941,578	$883,389	70,688,051
Present Value Costs	$16,056,394	$7,035,428	$1,957,830	$405,845	25,455,498
Benefit-Cost Ratio	**3.38**	**1.92**	**0.99**	**2.18**	**2.78**

Appendix A. Measure Level Savings

Program	Measure	Verified Gross Savings		Adjusted Gross Savings	
		kWh	kW	kWh	kW
Residential					
Lighting	CFL	43,933,148	5,256	43,281,838	4,558
	LED	7,413,573	890	7,131,592	753
Appliance Recycling	Recycled Refrigerator	3,997,280	639	2,835,280	465
	Recycled Freezer	877,020	141	515,355	85
	Energy Kit	269,835	17	269,835	17
Low-Income (OPAE)	Air Sealing	26,384	0	1,345,730	170
	Attic Insulation	231,687	2		
	CFLs	351,582	37		
	Duct Sealing	0	0		
	Faucet Aerator	2,480	0		
	Foundation Wall Insulation	12,310	0		
	Freezer Replacement	94,508	14		
	Freezer Retire	0	0		
	Heat Pump	112,886	33		
	HVAC	0	0		
	LED NightLight	736	0		
	Pipe Insulation	110	0		
	Refrigerator Replacement	686,799	106		
	Refrigerator Retire	0	0		
	Showerhead	4,054	0		
	Smart Strip	1,410	0		
	Wall Insulation	4,044	0		
	WH Tank Setback	0	0		
	WH Wrap	7,230	1		
Low-Income (PWC)	Central AC	477	0	477	0
	CFLs	20,712	2	20,712	2
	Faucet Aerator	432	0	432	0
	Freezer Replacement	25,144	4	25,144	4
	Heat Pump	4,513	1	4,513	1
	Pipe Insulation	219	0	219	0
	Refrigerator Replacement	105,084	16	105,084	16
	Showerhead	1,137	0	1,137	0
	WH Wrap	255	0	255	0
HVAC Rebate	ER AC 14/15 SEER	1,217,433	495	1,217,433	470
	ER AC 16+ SEER	1,198,245	487	1,198,245	474
	NC AC 14/15 SEER	7,065	4	10,450	4
	NC AC 16+ SEER	19,771	8	24,474	10
	RP AC 14/15 SEER	11,177	7	11,177	5
	RP AC 16+ SEER	9,798	4	10,317	4

Program	Measure	Verified Gross Savings		Adjusted Gross Savings	
		kWh	kW	kWh	kW
	ER GSHP 16/18 EER	475,142	24	486,696	22
	ER GSHP 19+ EER	602,754	40	762,588	40
	NC GSHP 16/18 EER	193,897	10	164,223	9
	NC GSHP 19+ SEER	146,102	11	135,312	9
	RP GSHP 16/18 EER	27,934	1	19,714	1
	RP GSHP 19+ EER	40,278	3	34,908	3
	ER HP 14/15 SEER	1,685,861	219	1,685,861	206
	ER HP 16+ SEER	1,617,511	218	1,617,511	231
	NC HP 14/15 SEER	39,155	6	31,389	5
	NC HP 16+ SEER	37,091	5	50,229	6
	RP HP 14/15 SEER	33,724	5	25,216	3
	RP HP 16+ SEER	33,442	4	40,810	5
	NC MS AC 14/15 SEER	0	0	0	0
	NC MS AC 16+ SEER	1,170	1	1,381	1
	RP MS AC 14/15 SEER	0	0	0	0
	RP MS AC 16+ SEER	0	0	0	0
	RP MS HP 14/15 SEER	0	0	0	0
	RP MS HP 16+ SEER	0	0	0	0
	NC MS HP 14/15 SEER	6,769	0	9,193	1
	NC MS HP 16+ SEER	304,510	17	298,600	22
	ECM with New AC	670,873	0	670,873	0
	ECM	366,897	86	366,897	86
	ECM with New HP	39,045	0	0	0
	Programmable Thermostat with AC	215,149	0	337,512	0
	Programmable Thermostat with HP	497,491	0	228,096	0
	ProgrammableThermostat with GSHP	95,079	0	41,319	0
	Smart Thermostat with AC	2,681	0	4,168	0
	Smart Thermostat with HP or GSHP	1,492	0	858	0
	Heat Pump Water Heater - Gas Home	0	0	0	0
	Heat Pump Water Heater - Electric Home	5,188	1	5,188	1
Be E3 Smart	CFL (four 13W)	1,255,089	134	1,213,019	128
	LED Night Light	48,947	0	48,947	0
	Bathroom Faucet Aerator (2 per kit)	364,800	50	364,800	50
	Kitchen Faucet Aerator	865,583	19	865,583	19
	Efficient Showerhead	1,670,018	84	1,670,018	84
Appliance Rebate	Refrigerator	156,626	28	69,166	12
	Washing Machine	271,488	38	345,751	37
	Wi-fi Thermostat	48,434	0	113,966	0
Non-Residential					
Non-Residential Prescriptive	HVAC	7,112,699	1,724	10,718,189	2,022
	Lighting	44,422,467	6,136	43,387,500	5,061

Program	Measure	Verified Gross Savings		Adjusted Gross Savings	
		kWh	kW	kWh	kW
	Motors	6,524,832	1,015	8,904,609	1,445
	Compressed Air	2,442,639	190	2,442,279	190
	Midstream Lighting	7,997,366	1,637	7,104,279	1,277
	Midstream VFDs	400,123	98	400,123	98
	Upstream Lighting	7,616,532	1,799	7,548,640	1,776
	Appliance Recycling	111,776	18	78,072	13
Non-Residential Custom	Custom	16,483,813	2,126	16,561,765	2,029
Small Business Direct Install	75% and 100%	854,829	299	776,118	313
Total		**166,435,834**	**24,210**	**167,641,066**	**22,243**

Appendix B. Ex Ante Measure-Level Savings

Program	Measure	Verified Participation Count	Ex Ante Per Unit kWh Impact	Ex Ante Per Unit kW Impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
Residential						
Lighting	CFL	1,413,658	30.79	0.00	43,520,845	5,207
	LED	170,813	42.99	0.01	7,343,998	881
Appliance Recycling	Refrigerator Replacement	2,905	1,376.00	0.22	3,997,280	639
	Freezer Replacement	705	1,244.00	0.20	877,020	141
	Energy Kit	2,193	163.26	0.02	358,025	37
Low-Income (OPAE)*	Air Sealing	23	1,147.15	0.01	26,384	0.2
	Attic Insulation	65	3,564.42	0.03	231,687	2.2
	CFL 15 watt dimmable	42	30.13	0.00	6,237	0.7
	CFL 15 watt globe	30	30.31	0.00	5,335	0.6
	CFL 15 watt or less outdoor	2	50.45	0.00	151	0.0
	CFL 16-20 watt floodlight	0	0.00	0.00	0	0.0
	CFL 16-20 watt outdoor	27	57.52	0.00	4,084	0.0
	CFL 16-20 watt spiral	244	35.59	0.00	55,978	5.9
	CFL 21 watt or above sprial	96	46.87	0.00	19,169	2.0
	CFL 3-way dimmable torchiere	7	75.83	0.01	682	0.1
	CFL 3-way spiral	202	76.20	0.01	37,947	4.0
	CFL 7-9 watt candelabra	99	32.67	0.00	17,151	1.8
	CFL 9 watt globe	129	31.54	0.00	18,513	2.0
	CFL 9-15 watt spiral	460	33.90	0.00	186,334	19.7
	Duct Sealing	0	0.00	0.00	0	0.0
	Faucet Aerator	31	43.50	0.01	2,480	0.3
	Foundation Wall Insulation	6	2,051.68	0.04	12,310	0.3
	Freezer Replacement	109	867.05	0.13	94,508	14.3
	Freezer Retire	0	0.00	0.00	0	0.0
	Heat Pump	119	948.62	0.28	112,886	33.4
	HVAC	1	0.00	0.00	0	0.0

Program	Measure	Verified Participation Count	Ex Ante Per Unit kWh Impact	Ex Ante Per Unit kW Impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
	LED NightLight	26	13.14	0.00	736	0.0
	Pipe Insulation	1	109.73	0.01	110	0.0
	Refrigerator Replacement	435	1,251.00	0.19	686,799	105.6
	Refrigerator Retire	0	0.00	0.00	0	0.0
	Showerhead	24	155.94	0.01	4,054	0.3
	Smart Strip	25	47.01	0.01	1,410	0.2
	Wall Insulation	3	1,348.06	0.03	4,044	0.1
	WH Tank Setback	0	0.00	0.00	0	0.0
	WH Wrap	85	85.06	0.01	7,230	0.8
Low-Income (PWC)	Central AC	1	477	0.314	477	0.3
	CFLs	172	34	0.004	20,712	2.2
	Faucet Aerator	4	54	0.015	432	0.1
	Freezer Replacement	29	867	0.131	25,144	3.8
	Heat Pump	3	1,504	0.314	4,513	0.9
	Pipe Insulation	2	110	0.013	219	0.0
	Refrigerator Replacement	84	1,251	0.192	105,084	16.2
	Showerhead	4	284	0.021	1,137	0.1
	WH Wrap	3	85	0.010	255	0.0
HVAC Rebate	ER AC 14/15 SEER	1,118	1,088.94	0.44	1,217,433	495
	ER AC 16+ SEER	962	1,245.58	0.51	1,198,245	487
	NC AC 14/15 SEER	44	160.56	0.08	7,065	4
	NC AC 16+ SEER	44	449.35	0.18	19,771	8
	RP AC 14/15 SEER	57	196.09	0.13	11,177	7
	RP AC 16+ SEER	19	515.66	0.21	9,798	4
	ER GSHP 16/18 EER	67	7,091.68	0.36	475,142	24
	ER GSHP 19+ EER	89	6,772.51	0.45	602,754	40
	NC GSHP 16/18 EER	31	6,254.74	0.32	193,897	10
	NC GSHP 19+ SEER	23	6,352.28	0.48	146,102	11
	RP GSHP 16/18 EER	4	6,983.40	0.36	27,934	1

Program	Measure	Verified Participation Count	Ex Ante Per Unit kWh Impact	Ex Ante Per Unit kW Impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
	RP GSHP 19+ EER	6	6,712.98	0.51	40,278	3
	ER HP 14/15 SEER	545	3,093.32	0.40	1,685,861	219
	ER HP 16+ SEER	490	3,301.04	0.44	1,617,511	218
	NC HP 14/15 SEER	44	889.89	0.13	39,155	6
	NC HP 16+ SEER	26	1,426.58	0.18	37,091	5
	RP HP 14/15 SEER	35	963.53	0.14	33,724	5
	RP HP 16+ SEER	23	1,453.99	0.18	33,442	4
	NC MS AC 14/15 SEER	0	108.00	0.11	0	0
	NC MS AC 16+ SEER	13	89.97	0.09	1,170	1
	RP MS AC 14/15 SEER	0	108.00	0.11	0	0
	RP MS AC 16+ SEER	0	77.65	0.08	0	0
	RP MS HP 14/15 SEER	0	2,092.00	0.11	0	0
	RP MS HP 16+ SEER	0	2,517.16	0.28	0	0
	NC MS HP 14/15 SEER	3	2,256.19	0.16	6,769	0
	NC MS HP 16+ SEER	137	2,222.70	0.12	304,510	17
	ECM with New AC	1,609	416.95	0.00	670,873	0
	ECM	484	758.05	0.18	366,897	86
	ECM with New HP	137	285.00	0.00	39,045	0
	Programmable Thermostat with AC	1,520	141.55	0.00	215,149	0
	Programmable Thermostat with HP	743	669.57	0.00	497,491	0
	ProgrammableThermostat with GSHP	142	669.57	0.00	95,079	0
	Smart Thermostat with AC	17	157.68	0.00	2,681	0
	Smart Thermostat with HP or GSHP	2	745.89	0.00	1,492	0
	Heat Pump Water Heater - Gas Home	0	2,076.00	0.28	0	0
	Heat Pump Water Heater - Electric Home	4	1,297.00	0.18	5,188	1
Be E3 Smart	13W CFLs (4 Bulbs in each kit)	31,802	39.47	0.004	1,255,089	134
	Nightlights (1 in each kit)	3,589	13.64	0.000	48,947	0
	Bathroom Faucet Aerators (2 in each kit)	7,771	46.94	0.006	364,800	50
	Kitchen Faucet Aerators (1 in each kit)	4,005	216.11	0.005	865,583	19

Program	Measure	Verified Participation Count	Ex Ante Per Unit kWh Impact	Ex Ante Per Unit kW Impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
	Efficient Showerheads (1 in each kit)	5,829	286.52	0.014	1,670,018	84
Appliance Rebate	Refrigerator	1,103	142.00	0.02	156,626	28
	Washing Machine	1,344	202.00	0.03	271,488	38
	Wi-fi Thermostat	397	122.00	0.00	48,434	0
Non-Residential						
Non-Residential Prescriptive: HVAC	Air cooled chiller - any size	6	53,951	24.27	323,703	146
	Air source heat pump < 65,000 BTUH (split)	25	466	0.18	11,655	5
	Air source heat pump 65,000 - 135,000 BTUH	2	1,469	0.63	2,938	1
	Energy recovery ventilation > 450 CFM	1	138	0.11	138	0
	HVAC occupancy sensor	401	21	0.02	8,474	7
	Outside air economizer with two enthalpy sensors	5	1,309	0.00	6,545	0
	Packaged terminal air conditioning and heat pumps	180	247	0.25	44,460	45
	Unitary and split system A/C 65,000 - 135,000 BTUH (5.4-11.25 tons)	60	628	0.49	37,671	30
	Unitary and split system A/C < 65,000 BTUH (<5.4 tons)	77	247	0.19	19,027	15
	Unitary and split system A/C > 760,000 BTUH (>63.33 tons)	1	5,067	3.98	5,067	4
	Unitary and split system A/C 136,000 - 240,000 BTUH (11.33-20 tons)	33	2,168	1.70	71,529	56
	Unitary and split system A/C 241,000 - 760,000 BTUH (20-63.33 tons)	26	1,888	1.48	49,099	39
	Variable frequency drive up to 250 HP	140	40,389	7.00	5,654,434	980
	Variable Refrigerant Flow System < 65,000 BTUH	2	805	0.49	1,610	1
	Variable Refrigerant Flow System 136,000 - 240,000 BTUH	4	3,381	2.06	13,524	8
	Water cooled chiller > 300 tons	3	284,980	128.44	854,939	385
	Window film	24	329	0.13	7,884	3

Program	Measure	Verified Participation Count	Ex Ante Per Unit kWh Impact	Ex Ante Per Unit kW Impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
Non-Residential Prescriptive: Lighting	Central lighting control	1	286	0.00	286	0
	CFL screw-in bulb or pin-based fixture > 32W replacing incandescent	22	378	0.10	8,322	2
	CFL screw-in bulb or pin-based fixture 21W to 32W replacing incandescent	147	113	0.03	16,643	4
	CFL screw-in bulb or pin-based fixture up to 20W replacing incandescent	297	214	0.05	63,565	15
	Delamping HID	510,853	6	0.00	2,814,449	447
	Delamping T12 (# linear feet)	21,294	72	0.02	1,543,310	337
	Delamping T8 (# linear feet)	14,668	20	0.01	294,699	91
	Energy Star CFL screw-in bulb or pin-based fixture > 32W replacing incandescent	24	84	0.08	2,013	2
	Energy Star CFL screw-in bulb or pin-based fixture 21W to 32W replacing incandescent	412	110	0.03	45,503	13
	Energy Star CFL screw-in bulb or pin-based fixture up to 20W replacing incandescent	1,087	234	0.04	254,548	48
	Energy Star LED luminaires or screw-in base lamps (replacing incandescent)	40,632	153	0.03	6,201,660	1,403
	Energy Star LED screw-in base lamps (replacing CFL)	276	36	0.00	10,063	0
	Exterior - LED or Induction (8,760 operating hours) replacing 175 W or less	68	835	0.13	56,750	9
	Exterior - LED or Induction (8,760 operating hours) replacing 176W to 250W	18	1,439	0.26	25,895	5
	Exterior - LED or Induction (8,760 operating hours) replacing 251W or greater	1	4,237	0.98	4,237	1
	Exterior - LED or Induction (operating hours < 8,760) replacing 175W or less	1,169	541	0.00	632,041	0
	Exterior - LED or Induction (operating hours < 8,760) replacing 176W to 250W	567	971	0.00	550,427	0
	Exterior - LED or Induction (operating hours <	1,250	1,751	0.00	2,188,699	0

Program	Measure	Verified Participation Count	Ex Ante Per Unit kWh Impact	Ex Ante Per Unit kW Impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
	8,760) replacing 251W or greater					
	Exterior LED recessed downlight luminaires or screw-in base lamps (replacing incandescent, ENERGY STAR certified)	808	148	0.00	119,691	0
	Exterior LED recessed downlight luminaires or screw-in base lamps (replacing incandescent, ENERGY STAR certified)1	151	432	0.00	65,221	0
	Fixture-mounted occupancy sensor	367	372	0.01	136,492	4
	LED 4-ft 1-lamp tube	758	63	0.02	47,829	13
	LED 4-ft 2-lamp tubes	2,857	179	0.03	511,433	88
	LED 4-ft 3-lamp tubes	870	156	0.04	135,950	38
	LED 4-ft 3-lamp tubes 1	312	182	0.05	56,916	14
	LED 4-ft 4-lamp tubes	545	447	0.07	243,816	36
	LED case lighting sensor controls	15	0	0.00	0	0
	LED High Bay Replacing 150 W or less HID, T8 or T5	131	475	0.11	62,170	14
	LED High Bay Replacing 151 W to 200 W HID, T8 or T5	206	589	0.13	121,379	27
	LED High Bay Replacing 201 W to 350 W HID, T8 or T5	182	1,152	0.22	209,653	40
	LED High Bay Replacing 351 W to 500 W HID, T8 or T5	3,235	1,523	0.18	4,927,515	596
	LED High Bay Replacing 501 W or greater HID, T8 or T5	40	6,328	0.73	253,109	29
	LED lighting in reach-in freezer/cooler case	784	428	0.07	335,678	55
	LED lighting in reach-in freezer/cooler case (per tube)	415	224	0.04	92,942	15
	LED luminaires up to 18 watts (replacing incandescent)	218	191	0.06	41,592	12
	LED or Electroluminescent exit sign	304	83	0.01	25,367	3
	LED or Induction (8,760 operating hours)	95	1,056	0.14	100,305	14

Program	Measure	Verified Participation Count	Ex Ante Per Unit kWh Impact	Ex Ante Per Unit kW Impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
	replacing 175 W or less					
	LED or Induction (8,760 operating hours) replacing 251W or greater	5	3,101	0.35	15,505	2
	LED or Induction (operating hours < 8,760) replacing 175W or less	3,089	507	0.00	1,565,060	0
	LED or Induction (operating hours < 8,760) replacing 176W to 250W	1,266	732	0.00	927,141	0
	LED or Induction (operating hours < 8,760) replacing 251W or greater	1,467	1,505	0.00	2,208,114	0
	LED or Induction (operating hours < 8,760) replacing 251W to 400W	729	1,036	0.00	755,423	0
	LED pedestrian walk/don't walk sign	18	946	0.05	17,029	1
	LED Replacing 50 W or less HID or Fluorescent	370	119	0.02	44,024	6
	LED Replacing 51 W to 100 W HID or Fluorescent	4,420	197	0.03	869,039	150
	LED Replacing 101 W to 150 W HID or Fluorescent	2,021	417	0.07	843,374	142
	LED Replacing 151 W to 200 W HID or Fluorescent	1,468	630	0.10	924,412	144
	LED Replacing 201 W to 350 W HID or Fluorescent	540	558	0.13	301,507	70
	LED Replacing 351 W to 500 W HID or Fluorescent	1,002	1,113	0.22	1,115,112	218
	LED Replacing 501 W or greater HID or Fluorescent	172	4,060	0.69	698,251	119
	LED traffic signal - green	62	373	0.04	23,122	3
	LED traffic signal - red	64	496	0.06	31,760	4
	LED Traffic Signal (Arrow)	11	53	0.01	586	0
	Low-watt T8 4-foot 1 lamp fixture replacing T12	413	90	0.02	37,354	8
	Low-watt T8 4-foot 2 lamp fixture replacing T12	2,181	120	0.03	262,722	57
	Low-watt T8 4-foot 2 lamp fixture replacing T8	2,276	46	0.01	103,760	34
	Low-watt T8 4-foot 3 lamp fixture replacing T12	211	231	0.04	48,800	9

Program	Measure	Verified Participation Count	Ex Ante Per Unit kWh Impact	Ex Ante Per Unit kW Impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
	Low-watt T8 4-foot 3 lamp fixture replacing T8	1,268	75	0.02	94,663	28
	Low-watt T8 4-foot 4 lamp fixture replacing T12	2,238	205	0.05	459,502	116
	Low-watt T8 4-foot 4 lamp fixture replacing T8	263	109	0.02	28,732	6
	Occupancy sensor controlling 100 watts or more	2,176	143	0.02	311,458	40
	Occupancy sensor controlling less than 100 watts	56	63	0.00	3,507	0
	Relamping 25 watt or less	4,169	31	0.01	130,859	26
	Relamping 28 watt	28,194	13	0.00	358,361	99
	T5 high-output high-bay 10 lamp fixture replacing HID	120	4,128	0.43	495,330	52
	T5 high-output high-bay 2 lamp fixture replacing HID	25	256	0.06	6,395	2
	T5 high-output high-bay 4 lamp fixture replacing HID	1,338	1,319	0.20	1,765,232	263
	T5 high-output high-bay 6 lamp fixture replacing HID	664	425	0.09	281,918	62
	T5 high-output high-bay 8 lamp fixture replacing HID	103	3,436	0.34	353,884	35
	T8 (BF < 0.78) 4-foot 1 lamp fixture replacing T12	41	42	0.02	1,738	1
	T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T12	1,153	74	0.02	84,763	24
	T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T8	96	50	0.01	4,769	1
	T8 (BF < 0.78) 4-foot 3 lamp fixture replacing T12	29	129	0.04	3,734	1
	T8 (BF < 0.78) 4-foot 3 lamp fixture replacing T8	52	72	0.01	3,734	1
	T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T12	1,650	232	0.04	383,572	69
	T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T8	64	64	0.01	4,119	1
	T8 high-bay 4-foot 3 lamp fixture replacing HID	11	214	0.07	2,349	1
	T8 high-bay 4-foot 4 lamp fixture replacing HID	703	746	0.13	524,178	89
	T8 high-bay 4-foot 6 lamp fixture replacing HID	3,701	1,107	0.20	4,098,045	758
	T8 high-bay 4-foot 8 lamp fixture replacing HID	288	611	0.15	176,001	43
	Vending equipment controller	30	1,612	0.00	48,355	0
	Wall or Ceiling-mounted occupancy sensor	3,368	536	0.02	1,805,005	79

Program	Measure	Verified Participation Count	Ex Ante Per Unit kWh Impact	Ex Ante Per Unit kW Impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
Non-Residential Prescriptive: Compressed Air	Air compressor 1 - 100 HP Load/No Load	15	13,393	0.89	200,890	13
	Air compressor 1 - 100 HP Variable Speed	64	33,941	2.62	2,172,250	168
	No-loss drain	17	4,088	0.51	69,499	9
Non-Residential Prescriptive: Motors	Barrel wraps	12	42,480	5.90	509,760	71
	CEE premium efficiency motor 20HP	1	529	0.10	529	0
	CEE premium efficiency motor 30HP	3	766	0.12	2,297	0
	Premium Efficiency Motor 125HP	1	6,116	0.27	6,116	0
	Variable frequency drive up to 250 HP	199	30,182	4.74	6,006,130	944
Non-Residential Prescriptive: Midstream Lighting	CFL Pin	0	N/A	N/A	0	0
	CFL Screw-in 20 watts or less	10,501	147	0.030	1,538,817	310
	CFL Screw-in 21-32 watts	853	151	0.030	128,718	26
	CFL Screw-in greater than 32 watts	6	151	0.030	905	0
	LED Screw-in	19,321	225	0.051	4,352,788	977
	LED Exit	1,319	84	0.011	111,309	14
	Re-lamp 25 watt	9,402	32	0.006	297,323	58
	Re-lamp 28 watt	25,789	21	0.005	536,868	121
	LED T8	7,511	55	0.011	410,407	82
	Eatons Cooper LED Fixtures	0	N/A	N/A	0	0
	Eatons Cooper LED Fixtures with Integrated Sensors	0	N/A	N/A	0	0
	Wall Pack	531	670	0.000	355,773	0
	Midstream VFDs	35	11,432	2.788	400,123	98
	Lighting Adjustment	2	260,019	38.490	520,038	77
Non-Residential Prescriptive: Upstream Lighting	CFL Lamps	70,622	113	0.03	7,947,362.63	1,877.25
	LED Lamps	8,601	156	0.04	1,341,091.09	316.78
Non-Residential Appliance Recycling	Refrigerator Replacement	74	1,376.00	0.22	101,824.00	16.28
	Freezer Replacement	8	1,244.00	0.20	9,952.00	1.60
	Energy Kit	0	163.26	0.02	0.00	0.00

Program	Measure	Verified Participation Count	Ex Ante Per Unit kWh Impact	Ex Ante Per Unit kW Impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
Total Non-Residential Prescriptive Rebate					**78,444,160**	**13,022**
Non-Residential Custom	Custom NC	9	342,139	82.54	3,079,250	743
	Custom NC-LPD	23	107,117	26.48	2,463,702	609
	Custom-HVAC	5	767,373	42.43	3,836,867	212
	Custom-Lighting	74	46,112	3.04	3,412,308	225
	Custom-Other	26	141,988	12.95	3,691,686	337
Total Non-Residential Custom Rebate					**16,483,813**	**2,126**
Small Business Direct Install	Site Level Savings	54	15,830	5.54	854,829	299
Total					**167,969,648**	**24,596**

*Participant count for the Low Income program represents measure count. The exception to this is the insulation and air sealing measures where it represents participants

Appendix C. Program Measure-Level Incentives

Program	Measure	Incentives
Residential		
Lighting	CFLs	$1.00 - $1.75 (Average: $1.25)
	LEDs	$1.33 - $7.00 (Average: $3.74)
Appliance Recycling	Recycled Freezer	$40.00 - $50.00
	Recycled Refrigerator	$40.00 - $50.00
	Energy Kit	Provided at no cost to customer
Low-Income (OPAE)	Air Sealing	Services provided at no cost to customer. Cap of $5,000 in measure costs per home. In addition, agencies can charge 15 percent of the admin cost for total installations.
	Attic Insulation	
	CFLs	
	Duct Sealing	
	Faucet Aerator	
	Foundation Wall Insulation	
	Freezer Replacement	
	Freezer Retire	
	Heat Pump	
	HVAC	
	LED NightLight	
	Pipe Insulation	
	Refrigerator Replacement	
	Refrigerator Retire	
	Showerhead	
	Smart Strip	
	Wall Insulation	
	WH Tank Setback	
	WH Wrap	
Low-Income (PWC)	Central AC	Services provided at no cost to customer. Agencies can charge 15 percent of the admin cost for total installations.
	CFLs	
	Faucet Aerator	
	Freezer Replacement	
	Heat Pump	
	Pipe Insulation	
	Refrigerator Replacement	
	Showerhead	
	WH Wrap	
HVAC Rebate	ER AC 14/15 SEER	$200
	ER AC 16+ SEER	$300
	NC AC 14/15 SEER	$100
	NC AC 16+ SEER	$150
	RP AC 14/15 SEER	$100
	RP AC 16+ SEER	$150
	ER GSHP 16/18 EER	$1,200
	ER GSHP 19+ EER	$1,600
	NC GSHP 16/18 EER	$800
	NC GSHP 19+ SEER	$1,200

Program	Measure	Incentives
	RP GSHP 16/18 EER	$800
	RP GSHP 19+ EER	$1,200
	ER HP 14/15 SEER	$400
	ER HP 16+ SEER	$600
	NC HP 14/15 SEER	$200
	NC HP 16+ SEER	$300
	RP HP 14/15 SEER	$200
	RP HP 16+ SEER	$300
	NC MS AC 14/15 SEER	$200
	NC MS AC 16+ SEER	$300
	RP MS AC 14/15 SEER	$200
	RP MS AC 16+ SEER	$300
	RP MS HP 14/15 SEER	$200
	RP MS HP 16+ SEER	$300
	NC MS HP 14/15 SEER	$200
	NC MS HP 16+ SEER	$300
	ECM with New AC	$100
	ECM	$100
	ECM with New HP	$50
	Programmable Thermostat with AC	$20
	Programmable Thermostat with HP	$50
	ProgrammableThermostat with GSHP	$50
	Smart Thermostat with AC	$20
	Smart Thermostat with HP or GSHP	$50
	Heat Pump Water Heater - Gas Home	$800
	Heat Pump Water Heater - Electric Home	$800
Be E3 Smart	CFLs	Provided at no cost to customer
	LED Night Light	
	Bathroom Faucet Aerator	
	Kitchen Faucet Aerator	
	Efficient Showerhead	
Appliance Rebate	Refrigerator	$50
	Washing Machine	$50
	Wi-fi Thermostat	$50
Commercial		
Non-Residential Prescriptive	Air cooled chiller - any size	$40.00 - $60.00 / ton
	Air source heat pump < 65,000 BTUH (split)	$400.00 - $600.00 / unit
	Air source heat pump 65,000 - 135,000 BTUH	$40.00 / ton
	Energy recovery ventilation > 450 CFM	$1.00 / CFM
	HVAC occupancy sensor	$30.00 / sensor
	Outside air economizer with two enthalpy sensors	$250.00 /
	Packaged terminal air conditioning and heat pumps	$50.00 / unit
	Unitary and split system A/C 65,000 - 135,000 BTUH (5.4-11.25 tons)	$40.00 - $60.00 / ton

Program	Measure	Incentives
	Unitary and split system A/C < 65,000 BTUH (<5.4 tons)	$200.00 - $300.00 / unit
	Unitary and split system A/C > 760,000 BTUH (>63.33 tons)	$40.00 / ton
	Unitary and split system A/C 136,000 - 240,000 BTUH (11.33-20 tons)	$40.00 / ton
	Unitary and split system A/C 241,000 - 760,000 BTUH (20-63.33 tons)	$40.00 - $60.00 / ton
	Variable frequency drive up to 250 HP	$40.00 - $60.00 / HP
	Variable Refrigerant Flow System < 65,000 BTUH	$400.00 / unit
	Variable Refrigerant Flow System 136,000 - 240,000 BTUH	$50.00 / ton
	Water cooled chiller > 300 tons	$40.00 / ton
	Window film	$2.00 - $3.00 / sq ft
	Central lighting control	$0.04 / connected watt
	CFL screw-in bulb or pin-based fixture > 32W replacing incandescent	$6.00 / bulb
	CFL screw-in bulb or pin-based fixture 21W to 32W replacing incandescent	$1.50 - $2.25 / bulb
	CFL screw-in bulb or pin-based fixture up to 20W replacing incandescent	$1.50 - $2.25 / bulb
	Delamping HID	$0.05 - $0.075 / rated fixture watt
	Delamping T12 (# linear feet)	$2.25 - $3.38 / linear foot
	Delamping T8 (# linear feet)	$1.20 - $1.80 / linear foot
	Energy Star CFL screw-in bulb or pin-based fixture > 32W replacing incandescent	$4.00 - $6.00 / bulb
	Energy Star CFL screw-in bulb or pin-based fixture 21W to 32W replacing incandescent	$1.50 - $2.25 / bulb
	Energy Star CFL screw-in bulb or pin-based fixture up to 20W replacing incandescent	$1.50 - $2.25 / bulb
	Energy Star LED luminaires or screw-in base lamps (replacing incandescent)	$10.00 - $15.00 / lamp
	Energy Star LED screw-in base lamps (replacing CFL)	$3.00 / lamp
	Exterior - LED or Induction (8,760 operating hours) replacing 175 W or less	$100.00 / fixture
	Exterior - LED or Induction (8,760 operating hours) replacing 176W to 250W	$150.00 / fixture
	Exterior - LED or Induction (8,760 operating hours) replacing 251W or greater	$200.00 / fixture
	Exterior - LED or Induction (operating hours < 8,760) replacing 175W or less	$50.00 - $75.00 / fixture
	Exterior - LED or Induction (operating hours < 8,760) replacing 176W to 250W	$75.00 - $112.50 / fixture
	Exterior - LED or Induction (operating hours < 8,760) replacing 251W or greater	$75.00 - $180.00 / fixture

Program	Measure	Incentives
	Exterior LED recessed downlight luminaires or screw-in base lamps (replacing incandescent, ENERGY STAR certified)	$10.00 - $15.00 / fixture
	Exterior LED recessed downlight luminaires or screw-in base lamps (replacing incandescent, ENERGY STAR certified)1	$10.00 / fixture
	Fixture-mounted occupancy sensor	$15.00 - $22.50 / sensor
	LED 4-ft 1-lamp tube	$8.00 - $12.00 / fixture
	LED 4-ft 2-lamp tubes	$12.00 - $18.00 / fixture
	LED 4-ft 3-lamp tubes	$20.00 - $30.00 / fixture
	LED 4-ft 3-lamp tubes 1	$20.00 / fixture
	LED 4-ft 4-lamp tubes	$24.00 - $36.00 / fixture
	LED case lighting sensor controls	$10.00 / unit
	LED High Bay Replacing 150 W or less HID, T8 or T5	$25.00 - $50.00 / fixture
	LED High Bay Replacing 151 W to 200 W HID, T8 or T5	$50.00 - $75.00 / fixture
	LED High Bay Replacing 201 W to 350 W HID, T8 or T5	$75.00 - $112.50 / fixture
	LED High Bay Replacing 351 W to 500 W HID, T8 or T5	$95.00 - $142.50 / fixture
	LED High Bay Replacing 501 W or greater HID, T8 or T5	$120.00 - $180.00 / fixture
	LED lighting in reach-in freezer/cooler case	$50.00 - $75.00 / tube
	LED lighting in reach-in freezer/cooler case (per tube)	$25.00 / tube
	LED luminaires up to 18 watts (replacing incandescent)	$10.00 - $15.00 / lamp
	LED or Electroluminescent exit sign	$10.00 - $15.00 / sign
	LED or Induction (8,760 operating hours) replacing 175 W or less	$100.00 / fixture
	LED or Induction (8,760 operating hours) replacing 251W or greater	$200.00 / fixture
	LED or Induction (operating hours < 8,760) replacing 175W or less	$50.00 - $75.00 / fixture
	LED or Induction (operating hours < 8,760) replacing 176W to 250W	$75.00 - $112.50 / fixture
	LED or Induction (operating hours < 8,760) replacing 251W or greater	$120.00 - $180.00 / fixture
	LED or Induction (operating hours < 8,760) replacing 251W to 400W	$120.00 - $180.00 / fixture
	LED pedestrian walk/don't walk sign	$75.00 / sign
	LED Replacing 50 W or less HID or Fluorescent	$15.00 / fixture
	LED Replacing 51 W to 100 W HID or Fluorescent	$25.00 / fixture
	LED Replacing 101 W to 150 W HID or Fluorescent	$35.00 / fixture
	LED Replacing 151 W to 200 W HID or	$50.00 / fixture

Program	Measure	Incentives
	Fluorescent	
	LED Replacing 201 W to 350 W HID or Fluorescent	$75.00 / fixture
	LED Replacing 351 W to 500 W HID or Fluorescent	$95.00 / fixture
	LED Replacing 501 W or greater HID or Fluorescent	$120.00 / fixture
	LED traffic signal - green	$37.50 / signal
	LED traffic signal - red	$37.50 / signal
	LED Traffic Signal (Arrow)	$3.00 / signal
	Low-watt T8 4-foot 1 lamp fixture replacing T12	$4.50 - $6.75 / fixture
	Low-watt T8 4-foot 2 lamp fixture replacing T12	$7.00 - $10.50 / fixture
	Low-watt T8 4-foot 2 lamp fixture replacing T8	$7.00 - $10.50 / fixture
	Low-watt T8 4-foot 3 lamp fixture replacing T12	$11.50 - $17.25 / fixture
	Low-watt T8 4-foot 3 lamp fixture replacing T8	$17.25 / fixture
	Low-watt T8 4-foot 4 lamp fixture replacing T12	$14.00 - $21.00 / fixture
	Low-watt T8 4-foot 4 lamp fixture replacing T8	$14.00 - $21.00 / fixture
	Occupancy sensor controlling 100 watts or more	$30.00 / sensor
	Occupancy sensor controlling less than 100 watts	$5.00 / sensor
	Relamping 25 watt or less	$1.50 - $2.25 / 4-foot lamp
	Relamping 28 watt	$1.00 - $1.50 / 4-foot lamp
	T5 high-output high-bay 10 lamp fixture replacing HID	$80.00 - $120.00 / fixture
	T5 high-output high-bay 2 lamp fixture replacing HID	$30.00 / fixture
	T5 high-output high-bay 4 lamp fixture replacing HID	$50.00 - $75.00 / fixture
	T5 high-output high-bay 6 lamp fixture replacing HID	$60.00 - $90.00 / fixture
	T5 high-output high-bay 8 lamp fixture replacing HID	$70.00 / fixture
	T8 (BF < 0.78) 4-foot 1 lamp fixture replacing T12	$4.00 - $6.00 / fixture
	T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T12	$6.00 -$9.00 / fixture
	T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T8	$6.00 / fixture
	T8 (BF < 0.78) 4-foot 3 lamp fixture replacing T12	$10.00 / fixture
	T8 (BF < 0.78) 4-foot 3 lamp fixture replacing T8	$10.00 / fixture
	T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T12	$12.00 - $18.00 / fixture
	T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T8	$12.00 - $18.00 / fixture
	T8 high-bay 4-foot 3 lamp fixture replacing HID	$30.00 / fixture
	T8 high-bay 4-foot 4 lamp fixture replacing HID	$40.00 - $60.00 / fixture
	T8 high-bay 4-foot 6 lamp fixture replacing HID	$50.00 - $75.00 / fixture
	T8 high-bay 4-foot 8 lamp fixture replacing HID	$55.00 - $82.50 / fixture
	Vending equipment controller	$50.00 - $75.00 / unit
	Wall or Ceiling-mounted occupancy sensor	$30.00 - $45.00 / sensor
	Air compressor 1 - 100 HP Load/No Load	$45.00 - $67.50 / HP
	Air compressor 1 - 100 HP Variable Speed	$125.00 - $187.50 / HP

Program	Measure	Incentives
	No-loss drain	$100.00 / each
	Barrel wraps	$1.50 / ton
	CEE premium efficiency motor 20HP	$15.00 / HP
	CEE premium efficiency motor 30HP	$10.00 - $15.00 / HP
	Premium Efficiency Motor 125HP	$10.00 / HP
	Variable frequency drive up to 250 HP	$40.00 - $60.00 / HP
Non-Residential Prescriptive: Midstream Lighting	CFL Pin	No units this year
	CFL Screw-in 20 watts or less	$1.00 - $5.00 per unit
	CFL Screw-in 21-32 watts	$1.00 - $3.75 per unit
	CFL Screw-in greater than 32 watts	$1.25 - $1.25 per unit
	LED Screw-in	$1.00 - $35.00 per unit
	LED Exit	$10.00 - $10.00 per unit
	Re-lamp 25 watt	$1.00 - $1.00 per unit
	Re-lamp 28 watt	$1.00 - $1.00 per unit
	LED T8	$1.00 - $6.00 per unit
	Eatons Cooper LED Fixtures	No units this year
	Eatons Cooper LED Fixtures with Integrated Sensors	No units this year
	Wall Pack	$50.00 - $120.00 per unit
	Midstream VFDs	$40.00 per horsepower
	Lighting Adjustment	$0.00 - $1.00 per unit
Non-Residential 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.
Small Business Direct Install	LED, CFL, LED exit signs, Vending miser direct install measures	Provided at no cost to customer
	2- 8 lamp T8 replacements	DP&L Pays up to 75% of Install Price
	9 - 15 watt LED	DP&L Pays up to 75% of Install Price
	45 - 131 watt LED Area/Parking Head	DP&L Pays up to 75% of Install Price
	21 - 158 watt LED Flood	DP&L Pays up to 75% of Install Price
	Motion sensors	DP&L Pays up to 75% of Install Price

Appendix D. Evaluated Energy Savings Calculation Sources

Program	Measure	Source
Residential		
Residential Lighting	CFLs and LEDs	Draft 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. Savings reflect 95% of bulbs sold to account for 5% of the bulbs sold being installed in commercial applications. Baseline wattages account for store inventories of incandescent bulbs based on the results of the in-store shelfstocking study. The LED ISR of 0.96 is based on benchmarking LED ISR values from five studies. See Comment 1 below.
Appliance Recycling	Refrigerator	Regression model and participant survey.
	Freezer	Regression model and participant survey.
	Kit CFLs	Draft Ohio TRM. Joint Utility Comments were used to update the waste heat factor for demand. Delta Watts input was based on participant survey responses. Updated with ISR from participant survey for adjusted gross calculations.
	Kit Bathroom Faucet Aerators	Draft Ohio TRM. Adjusted gross calculations were made using internal engineering algorithms, 2012 water metering data, and particiant survey results. See Comment 2 below. Updated with ISR from participant survey for adjusted gross calculations.
	Kit Kitchen Faucet Aerators	Draft Ohio TRM. Adjusted gross calculations were made using internal engineering algorithms, 2012 water metering data, and particiant survey results. See Comment 2 below. Updated with ISR from participant survey for adjusted gross calculations.
	Kit Showerhead	Draft Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms, participant survey results, and 2012 water metering data. See Comment 2 below. Updated with ISR from participant survey for adjusted gross calculations.
Low-Income (OPAE)	All Measures	Billing analysis conducted using a final billing dataset of 471 customers that participated in the OPAE's Low-Income program between 2012 and 2015. The billing analysis employed a PRISM model to calculate the savings, analyzing weather-normalized pre- and post-installation annual usage for each account.
Low-Income (PWC)	Central AC	Average cooling savings of the 4 heat pump installations in the 2014 LIWx (OPAE) program. Savings for these 4 installations use algorithms and inputs from Draft Ohio TRM.
	CFLs	Draft Ohio TRM. Joint Utility Comments were used to update the waste heat factor for demand. Updated with ISR from participant surveys for verified and adjusted gross calculations. Delta Watts input was based on lumens equivalence method and used baseline data from the Residential Lighting program. See Comment 1 below.

Program	Measure	Source
	Faucet Aerator	Draft Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms and 2012 water metering data. Flowrate inputs based on measured values. See Comment 2 below.
	Freezer Replacement	The calculation for freezer replacement savings is not included in the draft Ohio TRM. The TRM provided an algorithm for freezer early retirement, from which we took the baseline assumption for usage (1,244 kWh). This baseline consumption was scaled up to align with the Joint Utility Comments for the Refrigerator Replacement measure which adjusts the baseline consumption up to account for the unit being installed in a low income application and being the primary unit. The energy consumption of the replacement unit was determined by matching consumption estimates for the efficient freezer by size and type, assuming replacement with an ENERGY STAR® unit. We calculated a weighted average usage estimate for the efficient unit based on the distribution of installations through the program.
	Heat Pump	Average savings of the 4 heat pump installations in the 2014 LIWx (OPAE) program. Savings for these 4 installations use algorithms and inputs from Draft Ohio TRM.
	Pipe Insulation	Draft Ohio TRM. Adjusted gross savings were calculated based on an internal engineering algorithm from other evaluations that is based on the number of people per home in the LIWx program and the temperature of the ground water in Dayton.
	Refrigerator Replacement	The Joint Utility Comments on the Draft Ohio TRM presented alternative unit energy consumption measures for the existing unit part-use factor and for Energy Star refrigerators. The main assumption they make is that for low-income families, these refrigerators are primary units that are being replaced so they should be modeled as running full time. The adjusted gross calculations use these alternative inputs in the TRM deemed savings formula.
	Showerhead	Draft Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms and 2012 water metering data. Flowrate inputs based on measured values. See Comment 2 below.
	WH Wrap	Draft Ohio TRM. Corrected an error in the TRM equation which originally divided by the wrong efficiency.
HVAC Rebate and Tune-Up	AC Early Retirement (all SEERs)	Participant billing analysis, kW calculated using draft Ohio TRM. See comment 3 below.
	AC Std Replacement SEER 14/15	Participant billing analysis, kW calculated using draft Ohio TRM. See comment 3 below.
	AC Std Replacement SEER 16+	kWh and kW calculated using draft Ohio TRM. See comment 3 below.
	AC New Construction (all	kWh and kW calculated using draft Ohio TRM. See comment 3 below.

Program	Measure	Source
	SEERs)	
	GSHP Early Retirement/Std/New Construction (all EERs)	kWh and kW calculated using draft Ohio TRM. See comment 3 below.
	HP Early Retirement (all SEERs)	Participant billing analysis, kW calculated using draft Ohio TRM. See comment 3 below.
	HP New Construction and Std Replacement (all SEERs)	kWh and kW calculated using draft Ohio TRM. See comment 3 below.
	Mini-split AC Std Replacment (all SEERs)	kWh and kW calculated using draft Ohio TRM. See comment 3 below.
	Mini-split AC New Construction (all SEERs)	kWh and kW calculated using draft Ohio TRM. See comment 3 below.
	Mini-split HP New Construction (all SEERs)	kWh and kW calculated using draft Ohio TRM and secondary sources. See comment 4 below.
	ECM with furnace or AC	Participant billing analysis, kW calculated using draft Ohio TRM. See comment 3 below.
	Programmable and Smart Thermostats	kWh calculated using engineering equations with savings factors derived from Cadmus studies.
Be E3 Smart	CFLs	Draft Ohio TRM and results from the lighting stocking study and phone surveys. ISR from parent follow-up phone survey.
	LED night lights	Draft Ohio TRM dated October 15, 2009. This was the utility-defined TRM. ISR from parent follow-up phone survey.
	Bathroom Faucet Aerator	Draft Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms, family installation survey results, and 2012 water metering data. See Comment 2 below. ISR from follow-up parent phone survey.
	Kitchen Faucet Aerator	Draft Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms, family installation survey results, and 2012 water metering data. See Comment 2 below. ISR from follow-up parent phone survey.
	Efficient Showerhead	Draft Ohio TRM. Adjusted gross calculations were calculated using internal engineering algorithms, family installation survey results, and 2012 water metering data. See Comment 2 below. ISR from follow-up parent phone survey.
Appliance Rebate	Refrigerator	Draft Ohio TRM. Federal baselines were calculated using EnergyStar database data
	Washing Machine	Mid Atlantic TRM version 5.0. Federal baselines were calculated using EnergyStar database data. Number of cycles and hours of use from phone survey data. HOU and CF using draft Ohio TRM.

Program	Measure	Source
	Wi-fi Thermostat	Wisconsin TRM. Effective full load cooling/heating hours are from Ohio TRM. Cooling capacity and efficiency of heat pumps from Res HVAC analysis. Phone survey data used to determine average of what previous system was installed.
Commercial		
Non-Residential Prescriptive	HVAC	See comment 5 below.
	Lighting	See comment 5 below.
	Motors	See comment 5 below.
	Other	See comment 5 below.
	Midstream Lighting	Draft Ohio TRM. Waste heat factor and hours of use were evaluated using the building type distribution of commercial lighting projects from previous evaluation years, in conjunction with a 3% adjustment to account for the perecentage of commercial lamps installed outside. In-service rate was evaluated based on an online survey of customers who particpated through the distributor channel. Baseline wattages for bulbs sold through retail channels account for store inventories of incandescent bulbs based on the results of the retail phone survey. See comment 1 below. Baseline wattages for bulbs sold through distributor channels are based on EISA and other federal legislation, based on the results of the distributor phone surveys.
	Midstream VFDs	Desk review of implementation team's savings values.
Non-Residential Custom	Lighting	See comment 6 below.
	Other	See comment 7 below.
Small Business Direct Install	Lighting	Draft Ohio TRM.
	Vending Misers	Draft Ohio TRM.

Comments:

1. We applied the results of the in-store shelf stocking study (part of the Residential Lighting program) to calculate baseline wattages that change each quarter of the year. These baseline wattages account for the availability of inefficient incandescent bulbs that are phased out by the EISA law.
2. We used an algorithm that better accounts for DP&L specific variables, such as: number of people per home, number of faucets per home, and the temperature of the ground water. Other variables were taken from a Cadmus water metering study done in Michigan in 2012 and include: baseline flow rates, length of showers and faucet usage, number of showers taken per day and shower and faucet point of use temperatures.
3. Minor adjustments were made to TRM equations and assumptions. See report section for details.
4. Mini-split HP kWh saving calculated using the draft Ohio TRM (for cooling) and engineering calculations informed by data from the following study: and http://www.env.state.ma.us/dpu/docs/electric/09-64/12409nstrd2ac.pdf.
5. We based our calculations on algorithms outlined in the draft Ohio TRM. We based our baseline conditions on the draft Ohio TRM, except when the site visit indicated a different baseline than deemed by measure type. Cadmus calculated the retrofit equipment wattage and operating parameters through site visit results and product specification sheets.
6. Cadmus calculated baseline and retrofit equipment wattage and operating parameters through site visit results and product specification sheets.

Program	Measure	Source

7. DP&L contracted with a third-party engineering firm to conduct pre and post installation metering to calculate energy savings. Cadmus reviewed the engineering reports and made revisions as necessary to evaluate savings.

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, transmission and distribution, 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, energy and capacity line losses are applied to measure-level savings to reflect total savings from the point of generation. Table 117 presents line loss assumptions for the 2015 Evaluation Measurement and Verification Report.[39]

Table 117. Line Loss Assumptions Used in Cost-Effectiveness Calculations

Sector	Energy Line Losses	Demand Line Losses
Residential	7.37%	8.37%
Commercial/Industrial	4.06%	5.21%

Retail Rates, provided by DP&L, include electric rates for all customer classes eligible for DSM programs. Table 118 provides retail rate assumptions for the 2015 Evaluation Measurement and Verification Report.

Table 118. Retail Rates Used in Cost-Effectiveness Calculations

Sector	Retail Rate	Escalator
Residential	$0.132	0%
Residential Heating	$0.119	0%
Commercial	$0.091	0%
Industrial	$0.083	0%

Load Shapes show hourly energy use over a year for each end use included in DSM Portfolio Pro. Hourly end-use load shapes were unavailable for the 2015 cost-effectiveness analysis. Therefore, Cadmus developed load shapes 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 119 shows discount rates used in 2015. The TRC, UTC, and RIM test discount rates are based on DP&L's

[39] Line losses in **Error! Reference source not found.** represent the percentage loss in energy and demand from the point of generation to the meter.

weighted cost of capital; the SCT discount rate is based on a 10-year T-bill rate; the PCT rate represents a hurdle rate. Cadmus will update discount rates in subsequent years, as new data become available.

Table 119. Discount Rates

Benefit-Cost Test	Discount Rate
TRC	8.78%
SCT	2.14%
UTC	8.78%
RIM	8.78%
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 2015 analysis, Cadmus did not include non-energy benefits. Unless otherwise requested, non-energy benefits will not be included for future cost-effectiveness tests.

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 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 costs are not measure-specific and are assessed at the program or portfolio levels. Costs categories used in the *2015 Evaluation Measurement and Verification Report*, shown in Table 120, and will be updated in subsequent cycles.

Table 120. Implementation and Administrative Costs

Cost Category	Level	Description
Implementation Vendor and Marketing Costs	Program Level	Incremental costs associated with performing program implementation tasks (e.g., customer service, application processing, marketing, 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 (e.g., measures installed through the Appliance Recycling, Low Income Weatherization, BE^3 Smart, Small Business Direct Install programs).
DP&L Staff Costs	Program Level/ Portfolio Level	Costs to administer energy-efficiency programs, including DP&L's fully-loaded incremental personnel costs. Activities

Cost Category	Level	Description
		associated with market research outside of EM&V.
External Vendor Evaluations	Portfolio Level	Activities associated with the determination and evaluation of current and potential energy efficiency programs (e.g., benefit-cost ratio analysis, impact and process analysis, cost per kWh 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 draft Ohio TRM, 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 include water heating, HVAC, and lighting.

Savings are annual kWh savings associated with installation of each energy efficiency measure. Savings used in DSM Portfolio Pro are adjusted gross savings.

Incremental Cost is the expense associated with installation of energy efficiency measures and ongoing operation and maintenance costs, where applicable. These costs include the entire cost of installing the measure and 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 measure.

Freeridership is the percent 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 2015 analysis.

Spillover is the percent of participants who installed additional energy-saving measures without incentives due to their participation in the program. Spillover was not calculated for the 2015 analysis.

Participation is the number of customers who participated in the program or the quantity of measures verified by Cadmus.

Appendix F. Nonresidential Allocation

Introduction

The upstream lighting component of DP&L's Residential Lighting Program is intended for residential customers; however, because it pays incentives directly to manufacturers, actual participants are not known. DP&L assumes small-business owners make up a proportion of customers buying discounted bulbs from participating retailers. As bulbs installed in commercial settings are subject to different assumptions that affect annual savings, Cadmus conducted a survey and analysis to estimate the proportion of the program bulbs purchased by commercial customers (i.e., the nonresidential allocation). This methodology, developed internally by Cadmus in collaboration with other evaluation firms, provides a viable alternative to expensive intercept studies, and it has been employed for evaluations in Pennsylvania and Wisconsin.

Methodology

Cadmus used data from general-population customer surveys, as well as from DP&L's customer records, to estimate the nonresidential allocation. Cadmus surveyed DP&L's general residential customer population and a subset of its small commercial customer base to estimate the percentage of customers (from each population) who purchased CFLs and/or LEDs from a participating retailer during the previous year. The phone survey included questions about purchases in the last 12 months, such as the following:

> "Where do you purchase your efficient, screw-based bulbs?"
>
> "How many efficient screw-based bulbs have you purchased in the last year?"
>
> "In what types of spaces did you install these light bulbs in your business?"

In addition to quantifying how many residential lighting program bulbs are installed in commercial applications, the survey provided insights into the ways businesses use the bulbs and, by extension, how much energy these installed bulbs saved.

In fall 2014, Cadmus conducted a residential allocation survey with DP&L customers; and data from this survey informed the calculations on residential CFL and LED purchases. The survey achieved 933 completes, with 679 customers responding that they purchased CFLs or LEDs.

In fall 2015, to inform the DP&L potential study regarding commercial and industrial lighting purchases, Cadmus conducted surveys with 200 commercial and industrial DP&L customers. This effort resulted in 49 valid respondents to the nonresidential allocation lighting questions (i.e., a small business that purchased at least one CFL or LED bulb for their business from a retailer participating in the residential lighting program).

To achieve a greater number of completes, Cadmus continued an abridged version of the survey, asking only applicable nonresidential allocation lighting questions. This continued survey achieved 90 completes with 28 respondents reporting purchases of CFLs or LEDs from retailers participating in the residential lighting program. Combined, the two surveys resulted in 77 small commercial customers reporting purchases of CFLs or LEDs from retailers participating in the residential lighting program.

Data Cleaning/Sampling Process

In reviewing and cleaning the resulting survey data, Cadmus considered responses to questions regarding business types, installation locations, and specific bulbs purchased. The count of commercial respondents excluded those purchasing LEDs if respondents installed these bulbs in rental properties or any location other than their business. Cadmus also excluded customers with annual kWh usage below 10,000 kWh. The potential study targeted the following sectors: education, grocery, health care, office, and retail. The continued survey targeted customers in sectors not called for the potential study: assembly, government, lodging, restaurants, warehouse, unclassified, miscellaneous, and other. Removals included customers who opted out, blank or incomplete contact names, and duplicates. The final sample frame consisted of 2,000 commercial and industrial customers.

Calculations

Cadmus calculated the percentage of residential and commercial customers purchasing bulbs and the average number of bulbs they purchased, then multiplied these two metrics by each surveyed population's total customer base. This resulted in a theoretical estimate of the number of bulbs purchased during the 12 month period. A relative proportion of bulbs purchased could be derived from these estimates. The resulting nonresidential allocation of bulbs purchased from participating retailers represents 4.1% of small commercial and industrial customers. Table 121 shows the computed metrics and resulting proportions.

Population	% of Customers Who Purchased CFLs or LEDs		Average Number of CFLs/LEDs Purchased per Respondent			% of Bulbs Purchased at Participating Retailers	Customers in Territory	Bulbs Purchased from Participating Retailers (% x Avg. # x % Participating x Customer Base)	% of Total
	Estimate	n	Estimate	n	Std. Dev.				
Residential	73%	933	11.3	679	7.6	97%	477,237	3,765,379	95.9%
Small Commercial and Industrial	33%	290	13.6	77	14.1	96%	37,124	162,194	4.1%
Total	**-**	**-**	**-**	**-**	**-**	**-**	**514,361**	**3,927,573**	**100%**

Table 121. Metrics and Calculated Proportions

Statistical Confidence and Proportional Adjustment

The nonresidential allocation provides an estimate based on two variables derived from the customer survey—the percentage of respondents and the average number of bulbs purchased per respondent in each population. The percentage of purchasers in each population, based on a yes/no question, produced large sample sizes (e.g., 933 for residential and 290 for nonresidential). The estimate of the average number of bulbs was calculated from a subset of responses for each population: the respondents who actually purchased bulbs (i.e., n=679 residential, n=77 commercial).

To compute a statistical confidence interval, Cadmus ran simulations of the above computations, treating the distribution of bulbs per respondent as a normally distributed random variable and the percentage of purchasers as a uniform random variable. At 90% confidence, the resulting cross-sector proportion of 4.1% falls between 3.10% and 5.18%.

Appendix G. Energy and Demand Savings Confidence and Precision

Cadmus used a multifaceted approach to construct error bounds for final kWh savings estimates due to methods varying across programs, and, in some cases, within individual programs. To determine the uncertainty level, two types of error were considered: measurement (or modeling) error; and sampling error. Measurement error refers to the uncertainty level around engineering parameters derived from simulation or professional judgment. Sampling error refers to uncertainty introduced by the use of sampled data to infer characteristics of the overall population.

For engineering calculations using simulated or assumed parameters, measurement error was assumed to have a relative precision of ±10%. This accuracy level is regarded a minimum for results in the evaluation industry, and results taken from outside evaluations or based on engineering analysis would likely be reliable within these bounds.

An example of this would be the effective full-load hours (EFLH), 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 EFLH presumable deviates from these values). Absent documentation on this uncertainty level, Cadmus assumed they were accurate within the industry standard threshold of ±10% relative precision with 90% confidence.

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 to be utilized in per-unit savings calculations (such as installation rates) or in 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), the root of the sum of the squared standard errors was calculated to estimate the confidence interval:[40]

$$Confidence\ Interval_{\bar{X}+\bar{Y}} = (\bar{X}+\bar{Y}) \pm 1.645 \cdot \sqrt{\left(\frac{s_{\bar{X}}^2}{n_{\bar{X}}}\right)+\left(\frac{s_{\bar{Y}}^2}{n_{\bar{Y}}}\right)}$$

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

[40] This approach to aggregation errors follows methods outlined in Appendix D from Schiller, Steven et. al. “National Action Plan for Energy Efficiency”. Model Energy Efficiency Program Impact Evaluation Guide. 2007. www.epa.gov/eeactionplan.

surveys. For these results, Cadmus calculated combined standard errors for the final estimates. In cases where the relationship was multiplicative, Cadmus used the following formula:[41]

$$Confidence\ Interval_{\bar{X}\cdot\bar{Y}} = \bar{X}\cdot\bar{Y} \pm 1.645 \cdot \sqrt{\bar{Y}^2\left(\frac{s_{\bar{X}}^2}{n_{\bar{X}}}\right) + \bar{X}^2\left(\frac{s_{\bar{Y}}^2}{n_{\bar{Y}}}\right) + \left(\frac{s_{\bar{X}}^2}{n_{\bar{X}}}\right)\left(\frac{s_{\bar{Y}}^2}{n_{\bar{Y}}}\right)}$$

Table 122 reports precision estimates with associated sources of uncertainty for each of the residential programs.

Table 122. Residential Energy Savings Precision

Program	Precision at 90%	Sources of Uncertainty
Lighting	± 12.7%	TRM algorithms and assumptions
Appliance Recycling	± 8.5%	Model analysis, 2012 part-use survey inputs, TRM algorithms and assumptions
Low-Income (OPAE)	± 19.2%	TRM algorithms and assumptions, CFL ISR, showerhead and aerator measure inputs from Cadmus 2012 Michigan water study
Low-Income (PWC)	± 7%	Used overlapping precision values from 2014 LI (OPAE)
HVAC Rebate and Tune-Up	± 2.3%	Secondary meter data, participant survey, and TRM algorithms and assumptions.
Be E3 Smart	± 16.1%	Follow-up parent survey, family installation survey, and TRM algorithms and assumptions
Appliance Rebate	± 9.5%	TRM, Survey, and Collected data

Nonresidential

For commercial and industrial 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 could then be applied to projects outside of the samples to obtain realized savings estimates. Cadmus divided projects selected for site visits and desk review samples into Prescriptive and Custom Rebate programs, and performed the analyses separately.

[41] Goodman, Leo. "The Variance of the Product of K Random Variables." Journal of the American Statistical Association. 1962.

For the Prescriptive Rebate program, Cadmus first estimated savings, standard errors, and precision levels by measure type, and 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 11 kWh to over 3.5 million kWh), Cadmus divided prescriptive lighting savings by strata, according to the aggregate reported *ex ante* claimed savings for each project, then allocated each project to each strata 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 two additional strata to capture the variance for these measures, and finally one "Other" strata for the remaining prescriptive projects. Table 123 reports the cut points and the distribution of sites for each of the prescriptive strata.

Table 123. Prescriptive Lighting Stratification

Statistic	Small	Medium	Large
kWh Range	**<100,000**	**100,000-500,000**	**>500,000**
Number of Projects	951	69	9
Total ex ante kWh	18,207,266	13,110,309	13,104,892

Cadmus also separated custom projects into four strata: large custom, medium custom, small custom, and new construction. Table 124 reports the cut points and distribution of sites for each of the custom strata.

Table 124. Custom Stratification

Statistic	Small	Medium	Large	NC
kWh Range	**<100,000**	**100,000-500,000**	**>500,000**	**N/A**
Number of Projects	31	24	3	31
Total ex ante kWh	1,008,193	5,512,242	4,420,426	5,542,952

The remaining project types were: prescriptive HVAC, prescriptive motors, and prescriptive other; Cadmus treated each as a single stratum.

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 125.

Table 125. 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
65,452,576	7.8%	16,561,765	8.4%

Energy-savings estimates for individual measure categories follow in Table 126. Precision at the 90% confidence is provided for each estimate. Categories with large kWh savings totals have tighter precision than those with small savings totals. This is because we allocated evaluation resources with the goal of producing efficient program-level estimates.

Table 126. Nonresidential Summary of Energy Savings Precision Estimates

Measure Type	Reported Savings (kWh)	Estimated Savings (KWh)	Realization Rate	Precision at 90% Confidence
Large Lighting	13,104,892	14,150,529	108%	4.0%
Medium Lighting	13,110,309	13,043,515	99%	1.6%
Small Lighting	18,207,266	16,193,455	89%	11.4%
P-Compressed Air	2,442,639	2,442,279	100%	91.6%
P-Motors	6,524,832	8,904,609	136%	72.0%
P-HVAC	7,112,699	4,631,695	125%	13.3%
Large Custom	4,420,426	4,420,426	100%	NA
Medium Custom	5,512,242	5,323,649	97%	30.8%
Small Custom	1,008,193	1,240,576	123%	24.6%
NC	5,542,952	5,577,114	101%	12.8%
Midstream Lighting	8,252,946	7,104,279	86%	10.7%
Midstream VFDs	400,123	400,123	100%	10.0%

For small business direct installs DP&L provided Cadmus with the population of all sites where installs were performed. Cadmus summarized the variability in the population total verified savings within the census data.

Appendix H. Nonresidential Metering Summary

Cadmus performed two rounds of nonresidential site visits as part of the 2015 program evaluation. The first round was in July 2015, the second in December 2015. Table 132 summarizes the 241 light meters and 30 power meters Cadmus installed at 61 of the nonresidential sites during the site visits.

Table 127. 2015 Nonresidential Metering Summary

Site Visits	Time Period	Light Meters Qty	Power Meters Qty
Round 1	July 2015	204	24
Round 2	December 2015	37	6
Total		**241**	**30**

Table 128 provides the quantities of light meters installed at each site during the July 2015 site visits.

Table 128. July 2015 Sites Selected for Light Metering

#	Site Name	Project #	Number of Light Meters Installed
1	Bellefontaine Marathon	JTF7KA41	3
2	Oasis Drive Thru	O3XKZFCN	2
3	Church of the Brethren	9WKG2111	2
4	Coach Tool and Die	MGNCIZR3	5
5	Southside Inn	9AX6IMFC	4
6	Troy Laminating and Coating	4002GKPK	4
7	Dimensions Enterprises	ODQPAQAK	4
8	Darke County Fairgrounds	2MG4XINR	3
9	Flory Cabinets	CS3S0QT5; 6UTTPKOD; XDG143GI	5
10	Francis Furniture	RJ2A1MFH	5
11	FedEx	4X8V8C4C; TP8WJZ6T	6
12	Bradford High School	QH7OPZ27; 9GMABPTC	6
13	Select Arc	U9I9EYS3; 0E5DVV5V	6
14	New Madison Library	3TZFPULG	2
15	Schlarman’s Health	JQIV1NX8; CTLL74JL	5
16	Coldwater Marathon	9UGVV21M	3
17	Maria Stein American Legion	KG0J4F5K	4
18	Church of the Incarnation	0NGUDA2I	1
19	Dot's Bellbrook Market	2M51JHEY	3

#	Site Name	Project #	Number of Light Meters Installed
20	Fairmont Presbyterian Church	MLOFHAS9	4
21	Jeff Schmitt Auto Group (Mazda)	5IJG13GG	1
22	Kettering City Schools - Van Buren Middle School - Lighting Retrofit	51ITXTTK	6
23	Kettering Medical Center	NIGUTEVO & 6CPKYA5D	2
24	KOHLER FOOD SERVICE	V09AFRI9	4
25	Lexus of Dayton	4MH8BL6M	1
26	McGohan Brabender	76GREUKI & D1UBN7RE	2
27	PLAS-TIX USA INC.	54MB1WYT & 43CJWHFU	6
28	Prairie Farms Dairy Inc	J19X7M94 & V1T0RM83	6
29	Salvation Army	EJF06NHK	3
30	XENIA WATER TREATMENT PLANT	ZWTE836I	4
31	Roth and Company	CCNJA9S7	7
32	Greeneview School	O5MFZQDA	7
33	Osuwitt LLC	OPOSDWKP	2
34	Today's Home Interiors	PURLPH8D	4
35	Production Tube Cutting	ZPU4BA4	11
36	Salem Bend Condos	J219DBA0	1
37	Ready Technologies	R4QL9HCN	6
38	Garber Electrical	IQP0GCK5	1
39	Autozone	HW9GYTXC	1
40	Huber Heights	SCZFPIR8	11
41	Trotwood Madison Schools	QO0XIY19	5
42	Walgreens # 12832	EIABJMPY	1
43	Advanced Door and Hardware	LZNWLYU7	5
44	Montgomery County ESC	GEP077Z1	6
45	Dayton Fire	8LOLTQEY	6
46	Cedar Hill Furniture	7Q9WKZAS	3
47	Miami Outfitters	P3Q8JHIM	3
48	Marathon Food Center	B88SQJ5L	4
49	City of Riverside	08HKRS1L	8
Total			**204**

Table 133 provides the quantities of power meters installed at each site during the July 2015 site visits.

Table 129. July 2015 Sites Selected for Power Metering

#	Site Name	Project #	Number of Power Meters Installed
1	City of Riverside	BUAJ4KHG	2
2	Custom Foam Products, Inc.	18BL62K1	1
3	Exel Inc	39NYD8W9	2
4	Keynes Bros., Inc.	KH1I1JLE	1
5	Logan County Water Pollution Control District	35E44Z8V	1
6	McDonalds Inc 2054	XROX5HD3	1
7	McDonald's Corporation (DBA: McDonalds 5359)	FB7DTIAX	1
8	Montgomery County Environmental Services	JOAGDN9T	2
9	Oakland Church of the Brethren	WW9M39RN	5
10	Riverside Schools	0H5QS8JY	2
11	Sonoco	KLSVTJ10	4
12	Swihart Industries, Inc.	8L9B1ZCP	1
13	Titan Loan Investment Fund LP c/o CBRE Inc	6R38ZP99	1
Total			**24**

Table 130 provides the quantities of light meters installed at each site during the December 2015 site visits.

Table 130. December 2015 Sites Selected for Light Metering

#	Site Name	Project #	Number of Light Meters Installed
1	Trotwood- Madison County Schools	EN90KRO7	6
2	Miracle Corp	W9C51M7P	6
3	Te-Co Manufacturing LLC	1TC7KLUF	6
4	Country Inn and Suites	DSROT891	4
5	Fuyao Glass America, INC	8MSBK0RZ	6
6	Ferno Washington	YR0XPNRZ	3
7	Millennium Reign Energy LLC	E93HO03X	6
Total			**37**

Table 131 provides the quantities of power meters installed at each site during the December 2015 site visits.

Table 131. December 2015 Sites Selected for Power Metering

#	Site Name	Project #	Number of Power Meters Installed
8	United Theological Seminary	HO7QEP1P	1
9	Montgomery County ESC	FFSGRV0W	2
10	Dayton Theatre Guild	HEF8X8LR	1
11	Parkway Local School	U6FATYYR	1
12	Miamisburg Moose Lodge	UHUF2RU8	1
Total			**6**

Database

DP&L provided Cadmus access to the rebate program database in order to select a sample for the site visits and review project documentation. The database provides information such as customer contact, confirmation number (project ID), claimed energy and demand savings, estimated lighting hours of use (HOU), project date of completion, rebate status, and vendor name. The database also contains supporting documentation such as invoices, rebate application forms, and new lighting specification.

Many projects are under the prescriptive program; therefore project specifics such as location of new fixtures, space types, lighting controls, and where new fixtures were installed were not available.

Light Meters

Light Meter Installation Protocol

During the site visit, Cadmus engineers determined the quantity and location of meter installations based on space types (locker room, office, restroom, etc.). For example, one of the selected sites selected was a school. While on site, we verified that the lighting HOU reported for the project was not applicable to all the space types: classrooms, hallways, and auditorium. Since these spaces each had different lighting schedule, we installed light meters in sample of locations.

At each site, we installed HOBO light meters (model # UX-90). Meters were installed inside the lighting fixture, with direct exposure to the lamp and hidden from natural light.

Light Meter Retrieval Protocol

Once the data collection period is over, the meters will be retrieved and returned to Cadmus by DP&L. Personnel retrieving the meters should follow the following steps:

1. Before scheduling the visit, identify meters that need ladder/scissors lift/harness for access as indicated on the meter data collection form for that site. Any special equipment needed should be prearranged.

2. Once on site, survey and locate all rooms/spaces where meters are installed before starting retrieval procedure.

3. Once meter locations have been identified, retrieve meters and note the data and time in the data collection sheets.

4. If meter(s) are missing/damaged/relocated, please notify the Cadmus contact before leaving the site.

5. When meters from all the sites are retrieved, mail them to Cadmus's Boulder office (1426 Pearl Street, Suite 400, Boulder, CO 80302)

Light Meter Analysis

Data from the meters will be filtered and analyzed, and the HOU for each space type will be determined. The recorded HOU will be extrapolated to annual HOU for each space type considering whether the space is occupied on weekends and annual holidays. Cadmus will determine the total project energy (kWh) savings by calculated HOU and the number of fixtures and lamp wattages verified during the site visit.

Power Meters

Power Meter Installation Protocol

Power meters were installed at 13 customer sites. During the site visit, Cadmus engineers determined the quantity and location of meter installations based on equipment types and quantities. At each site, if appropriate, we installed Wattnode power meters with HOBO pulse meters (model # UX-90). Meters were installed inside electrical enclosure to eliminate incidental contact with energized parts by non-qualified personnel.

Power Meter Retrieval Protocol

Once the data collection period is over, the meters and meters will be retrieved and returned to Cadmus. Personnel retrieving the meters should follow the following steps:

1. Before scheduling the visit, identify meters that need ladder/scissors lift/harness for access as indicated on the meter data collection form for that site. Any special equipment needed should be prearranged.

2. Once on site, survey and locate all rooms/spaces where meters are installed before starting retrieval procedure.

3. Once meter locations have been identified, retrieve meters and note the data and time. In a few cases, we are requesting that meter serial numbers be collected before removal. These few cases are detailed in the meter collection notes for each site.

4. If meter(s) are missing/damaged/relocated, please notify the Cadmus contact before leaving the site.

When meters from all the sites are retrieved, mail them to Cadmus's Cadmus's Boulder office (1426 Pearl Street, Suite 400, Boulder, CO 80302)

Power Meter Analysis

Data from the meters will be filtered and analyzed. Cadmus will determine the total project energy (kWh) savings using the collected data and information verified during the site visit.

We will calculate demand (kW) savings by following the Ohio TRM for reference of the peak demand timeframe (for the evaluation) and we will use the PJM definition of the peak demand timeframe to calculate kW reduction for the PJM auction. There is a one hour difference between the two definitions.

Appendix I. Nonresidential Site Visit Summary

Cadmus performed two rounds of nonresidential site visits as part of the 2015 program evaluation. The first round was in July 2015, the second in December 2015. Table 132 provides an overview of all the sites visits and the sections below provide details specific to each round.

Table 132. 2015 Nonresidential Site Visit Summary

Site Visits	Time Period	Sites Qty	Light Meters Qty	Power Meters Qty
Round 1	July 2015	85	227	24
Round 2	December 2015	18	37	6
Total		**103**	**264**	**30**

July 2015 Site Specific Summary

Cadmus conducted the first round of site visits in July 2015. A sample of 85 projects was selected from a list of 2015 program participants. In addition to the rebate program evaluation, Cadmus is also responsible for calculating peak demand savings as part of the PJM analysis. Hence the sample was designed for a two strata system: PJM and Non-PJM. Each stratum was further classified as lighting (large, medium & small), HVAC, motors, air compressor and custom. Table 133 shows the list of projects Cadmus engineers verified during this July round of site visits for the 2015 program evaluation.

Table 133. July 2015 Nonresidential Site Visit Summary

#	Site Name	Verified Sampled Project #	Strata
1	American Trim	3LEQ7ATF	P-Lighting
2	Bellefontaine Marathon	JTF7KA41	P-Lighting
3	Budget Host Inn	6TLJE1VT	P-Lighting
4	Cedar Hill Furniture (Huber)	1PFOM1AL	P-Lighting
5	Cedarville University	MAZKA3M6	P-Lighting
6	City of Fairborn	F6H0UJDA	P-Lighting
7	City of Urbana	12QV5CX5	P-Lighting
8	Shell Station	EZ9YLN6R	P-Lighting
9	Marysville Exempted Village Schools	1EGL0BWV	P-Lighting
10	Norcold Inc.	U0T2NTDJ	P-Lighting
11	Oasis Drive Thru	O3XKZFCN	P-Lighting
12	Snap Fitness	TES635K5	P-Lighting
13	Church of the Brethren	9WKG2111	P-Lighting
14	Coach Tool and Die	MGNCIZR3	P-Lighting
15	Southside Inn	9AX6IMFC	P-Lighting
16	Sacred Heart Church	3X5KT67W	P-Lighting
17	Sidney Middle School	G1T3GLKT	P-Lighting
18	Troy Laminating and Coating	4002GKPK	P-Lighting
19	Dimensions Enterprises	ODQPAQAK	P-Lighting

#	Site Name	Verified Sampled Project #	Strata
20	Darke County Fairgrounds	2MG4XINR	NC
21	Flory Cabinets	CS3S0QT5, 6UTTPKOD & XDG143GI	P-Lighting
22	Francis Furniture	RJ2A1MFH	P-Lighting
23	FedEx - DAYA	4X8V8C4C & ZXXBXUOO	P-Lighting
24	Bradford EVSD	QH7OPZ27 & 9GMABPTC	P-Lighting
25	Select Arc	U9I9EYS3 & 0E5DVV5V	Medium Custom
26	New Madison Library	3TZFPULG	P-Lighting
27	Schlarman’s Health	JQIV1NX8 & CTLL74JL	P-Lighting
28	Coldwater Marathon	9UGVV21M	P-Lighting
29	Maria Stein American Legion	KG0J4F5K	P-Lighting
30	Village of Fort Loramie	6E4LL9KX	P-Lighting
31	Precious Blood Church	UOI57ZWT	P-Lighting
32	Arvindanand Inc.	EKHIBA0F	P-Lighting
33	Brethren Retirement Community	1YS2FW3E	P-Lighting
34	Ginghamsburg UM Church	DDBYNKZQ	Small Custom
35	Miami Valley Hospital South	L4SSYY8D	Large Custom
36	Custom Foam Products, Inc.	18BL62K1	P-CAS
37	Swihart Industries, Inc.	8L9B1ZCP	P-CAS
38	McDonalds Inc 2054	XROX5HD3	P-HVAC
39	Greater Dayton Regional Transit Authority	W4H279DW	P-HVAC
40	McDonald's Corporation (DBA: McDonalds 5359)	FB7DTIAX	P-HVAC
41	Titan Loan Investment Fund LP c/o CBRE Inc	6R38ZP99	P-HVAC
42	City of Riverside	BUAJ4KHG	P-HVAC
43	Exel Inc	39NYD8W9	P-Motors
44	Logan County Water Pollution Control District	35E44Z8V	P-Motors
45	Montgomery County Environmental Services	JOAGDN9T	P-Motors
46	Keynes Bros., Inc.	KH1I1JLE	P-Motors
47	Riverside Schools	0H5QS8JY	P-Motors
48	Sonoco	KLSVTJ10	Small Custom
49	Oakland Church of the Brethren	WW9M39RN	Small Custom
50	Digestive Specialists	VJN9S2P9	P-HVAC
51	Church of the Incarnation	0NGUDA2I	P-Lighting
52	Dot's Bellbrook Market	2M51JHEY	P-Lighting
53	Fairmont Presbyterian Church	MLOFHAS9	P-Lighting
54	Jeff Schmitt Auto Group (Mazda)	5IJG13GG	Medium Custom
55	Kettering City Schools - J.E. Prass Elementary - Custom CFL to LED Exterior	WB7H20PA	Small Custom
56	Kettering City Schools - Van Buren Middle School -	51ITXTTK	P-Lighting

#	Site Name	Verified Sampled Project #	Strata
	Lighting Retrofit		
57	Kettering Medical Center	NIGUTEVO & 6CPKYA5D	P-Lighting
58	KOHLER FOOD SERVICE	V09AFRI9	P-Lighting
59	Lexus of Dayton	4MH8BL6M	P-Lighting
60	McGohan Brabender	76GREUKI & D1UBN7RE	P-Lighting
61	PLAS-TIX USA INC.	54MB1WYT	P-Lighting
62	Prairie Farms Dairy Inc	J19X7M94 & V1T0RM83	P-Lighting
63	Salvation Army	EJF06NHK	P-Lighting
64	XENIA WATER TREATMENT PLANT	ZWTE836I	P-Lighting
65	Citgo Gas Station	HRWS4VIL	P-Lighting
66	Roth and Company	CCNJA9S7	P-Lighting
67	Greenview School- lighting retrofit	O5MFZQDA	P-Lighting
68	Continental Carbonic Products, Inc.	IGV8Q9RZ	P-Lighting Lighting Lighting
69	Osuwitt LLC	OPOSDWKP	P-Lighting
70	Todays Home Interiors	PURLPH8D	P-Lighting
71	Production Tube Cutting	ZPU4BA4	P-Lighting
72	Salem Bend Condos	J219DBA0	P-Lighting
73	Ready Technologies	R4QL9HCN	P-Lighting
74	Garber Electrical	IQP0GCK5	P-Lighting
75	Autozone	HW9GYTXC	P-Lighting
76	Huber Heights	SCZFPIR8	P-Lighting
77	Trotwood Madison Schools	QO0XIY19	P-Lighting
78	Walgreens # 12832	EIABJMPY	P-Lighting
79	Montgomery County ESC	GEP077Z1	P-Lighting
80	Advanced Door and Hardware	LZNWLYU7	P-Lighting
81	Dayton Fire	8LOLTQEY	P-Lighting
82	Marathon Food Center	B88SQJ5L	P-Lighting
83	City of Riverside	08HKRS1L	P-Lighting
84	Miami Outfitters	P3Q8JHIM	P-Lighting
85	Cedar Hill Furniture	7Q9WKZAS	P-Lighting

Table 134 shows lighting and power meters installed at 62 sites.

Table 134. July 2015 Sites Selected for Metering

#	Site Name	Project #	Number of Meters Installed
1	Bellefontaine Marathon	JTF7KA41	3
2	Oasis Drive Thru	O3XKZFCN	2

3	Church of the Brethren	9WKG2111	2
4	Coach Tool and Die	MGNCIZR3	5
5	Southside Inn	9AX6IMFC	4
6	Troy Laminating and Coating	4002GKPK	4
7	Dimensions Enterprises	ODQPAQAK	4
8	Darke County Fairgrounds	2MG4XINR	3
9	Flory Cabinets	CS3S0QT5; 6UTTPKOD; XDG143GI	5
10	Francis Furniture	RJ2A1MFH	5
11	FedEx	4X8V8C4C; TP8WJZ6T	6
12	Bradford High School	QH7OPZ27; 9GMABPTC	6
13	Select Arc	U9I9EYS3; 0E5DVV5V	6
14	New Madison Library	3TZFPULG	2
15	Schlarman's Health	JQIV1NX8; CTLL74JL	5
16	Coldwater Marathon	9UGVV21M	3
17	Maria Stein American Legion	KG0J4F5K	4
18	Custom Foam Products, Inc.	18BL62K1	1
19	Swihart Industries, Inc.	8L9B1ZCP	1
20	McDonalds Inc 2054	XROX5HD3	1
21	McDonald's Corporation (DBA: McDonalds 5359)	FB7DTIAX	1
22	Titan Loan Investment Fund LP c/o CBRE Inc	6R38ZP99	1
23	City of Riverside	BUAJ4KHG	2
24	Exel Inc	39NYD8W9	2
25	Logan County Water Pollution Control District	35E44Z8V	1
26	Montgomery County Environmental Services	JOAGDN9T	2
27	Keynes Bros., Inc.	KH1I1JLE	1
28	Riverside Schools	0H5QS8JY	2
29	Sonoco	KLSVTJ10	4
30	Oakland Church of the Brethren	WW9M39RN	5
31	Church of the Incarnation	0NGUDA2I	1

32	Dot's Bellbrook Market	2M51JHEY	3
33	Fairmont Presbyterian Church	MLOFHAS9	4
34	Jeff Schmitt Auto Group (Mazda)	5IJG13GG	1
35	Kettering City Schools - Van Buren Middle School - Lighting Retrofit	51ITXTTK	6
36	Kettering Medical Center	NIGUTEVO & 6CPKYA5D	2
37	KOHLER FOOD SERVICE	V09AFRI9	4
38	Lexus of Dayton	4MH8BL6M	1
39	McGohan Brabender	76GREUKI & D1UBN7RE	2
40	PLAS-TIX USA INC.	54MB1WYT & 43CJWHFU	6
41	Prairie Farms Dairy Inc	J19X7M94 & V1T0RM83	6
42	Salvation Army	EJF06NHK	3
43	XENIA WATER TREATMENT PLANT	ZWTE836I	4
44	Roth and Company	CCNJA9S7	7
45	Greeneview School	O5MFZQDA	7
46	Osuwitt LLC	OPOSDWKP	2
47	Today's Home Interiors	PURLPH8D	4
48	Production Tube Cutting	ZPU4BA4	11
49	Salem Bend Condos	J219DBA0	1
50	Ready Technologies	R4QL9HCN	6
51	Garber Electrical	IQP0GCK5	1
52	Autozone	HW9GYTXC	1
53	Huber Heights	SCZFPIR8	11
54	Trotwood Madison Schools	QO0XIY19	5
55	Walgreens # 12832	EIABJMPY	1
56	Montgomery County ESC	GEP077Z1	6
57	Advanced Door and Hardware	LZNWLYU7	5
58	Dayton Fire	8LOLTQEY	6
59	Marathon Food Center	B88SQJ5L	4
60	City of Riverside	08HKRS1L	8
61	Miami Outfitters	P3Q8JHIM	3
62	Cedar Hill Furniture	7Q9WKZAS	2

Total	**227**

July 2015 Site Specific Findings

Table 135: American Trim (Project Number: 3LEQ7ATF)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED or Induction (8,760 operating hours) replacing 176W to 250W	3	3	0

Notes: Cadmus verified the installation of 3 LED flood lights, as reported in the project documentation. The on-site contact reported that the lights operate 8,760 hours per year.

Table 136: Bellefontaine Marathon (Project Number: JTF7KA41)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED 4-ft 4-lamp tubes	26	22	-4

Notes: Cadmus verified the installation of 4ft LED tube fixtures, as reported in the project documentation. The business owner reported that the LED fixtures that had been installed in the office and storage spaces needed to be removed and replaced with the previously-existing linear fluorescent fixtures because the LED fixtures were causing interference with the operation of the gas pumps. The owner reported that the majority of the light fixtures in the retail sales space are on only during the store's business hours, but one switch group of fixtures is left on 24 hours/day for security reasons. Cadmus installed three time-of-use light meters to verify the hours of use for the two switch groups in the retail space, as well as in the walk-in cooler.

Table 137: Budget Host Inn (Project Number: 6TLJE1VT)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	Exterior Incandescent to LED	38	34	-4

Notes: Cadmus verified the installation of 6W LED screw-in lamps, as reported in the project documentation. According to the verification report, the savings calculations were based on the installation of 38 LED lamps. Cadmus was only able to find 27 lamps installed on the building exterior. An additional 7 lamps were located in a sign in front of the building. The maintenance staff on site confirmed that the exterior lighting is controlled by a photosensor.

Table 138: Cedar Hill Furniture Huber (Project Number: 1PFOM1AL)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	5	5	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	102	102	0

Notes: Cadmus verified the installation of LED screw-in lamps, as reported in the project documentation. The on-site contact reported that the lighting is controlled by manual switches. Cadmus verified the lighting HOU by comparison to the store's hours.

Table 139: Cedarville University (Project Number: MAZKA3M6)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	100	100	0

Notes: Cadmus verified the installation of A25 LED screw-in lamps, as reported in the project documentation. The on-site contact reported that LED lighting upgrades have been performed throughout the university campus, and he was unsure of the specific locations of all 100 lamps that are included in this particular rebate. Cadmus was able to verify the installation of 49 A25 LED lamps in exterior fixtures (poles, bollards, and wall sconces) and sampled an interior classroom to find 16 A25 LED lamps.

Table 140: City of Fairborn (Project Number: F6H0UJDA)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W or greater	5	5	0

Notes: Cadmus verified the installation of LED wall packs, as reported in the project documentation. Cadmus also verified that the lights are controlled by photocell.

Table 141: City of Urbana (Project Number: 12QV5CX5)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	30	30	0

Notes: Cadmus verified the installation of LED pole-mounted fixtures, as reported in the project documentation. The on-site contact reported that the lights are controlled by photocell and time clock.

Table 142: Shell Station (Project Number: EZ9YLN6R)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W or greater	16	16	0

Notes: Cadmus verified the installation of LED canopy lights and one LED pole-mounted fixture, as reported in the project documentation. The on-site contact reported that the lights are manually shut off when the store closes at night and turned on automatically in the morning.

Table 143: Marysville Exempted Village Schools (Project Number: 1EGL0BWV)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	8	8	0
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W or greater	9	9	0
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	16	16	0

Notes: Cadmus verified the installation of LED pole fixtures in two sizes and LED wall packs, as reported in the project documentation. The on-site contact reported that the lighting is controlled by photocell, but the pole fixtures are also scheduled to shut off between midnight and 5am.

Table 144: Norcold Inc. (Project Number: U0T2NTDJ)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	T5 high-output high-bay 6 lamp fixture replacing HID	10	10	0

Notes: Cadmus verified the installation of high-bay 6-lamp fixtures. Due to their height, the fixtures were inaccessible and Cadmus was unable to verify the T5 lamps, but the on-site contact verbally confirmed that the lamps are T5s. Cadmus confirmed the HOU with the on-site contact.

Table 145: Oasis Drive Thru (Project Number: O3XKZFCN)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED lighting in reach-in freezer/cooler case	25	25	0

Notes: Cadmus verified the installation of LED strip lighting in reach-in cooler cases, as reported in the project documentation. The rebate is based on the number of doors on the cooler cases, and Cadmus verified a total of 25 doors on the cases with upgraded lighting. Cadmus installed two time-of-use light meters to verify the hours of use of the cooler case lighting.

Table 146: Snap Fitness (Project Number: TES635K5)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T12	28	28	0
Rapid – Lighting Fixtures and Controls	Delamping T12 (# linear feet)	328	328	0
Rapid – Lighting Fixtures and Controls	Occupancy sensor controlling less than 100 watts	2	0	-2

Notes: Cadmus verified the installation of 48" four-lamp linear fluorescent fixtures. Due to their mounting height, the fixtures were inaccessible so Cadmus was unable to verify the lamps, but the business owner reported that they were T8s. The owner stated that he removed all of the existing T12 fixtures before he renovated the space and installed the new T8 fixtures. The owner also reported that the lights operate 24 hours per day, seven days per week. Cadmus did not find any occupancy sensors, and the owner reported that there were none installed.

Table 147: Church of the Brethren (Project Number: 9WKG2111)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED Replacing 51 W to 100 W HID or Fluorescent	6	6	0

Notes: Cadmus verified the installation of 48" LED tube lighting throughout the facility. The site contact reported that nearly all of the lighting in the facility has been upgraded to LED, and he was not aware of which specific fixtures correspond to this rebate. Cadmus installed two time-of-use light meters in the main office and main lobby gathering space to verify the hours of use on the first floor of the facility.

Table 148: Coach Tool and Die (Project Number: MGNCIZR3)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	Low-watt T8 4-foot 4 lamp fixture replacing T12	32	32	0
Rapid – Lighting Fixtures and Controls	Low-watt T8 4-foot 2 lamp fixture replacing T12	3	3	0
Rapid – Lighting Fixtures and Controls	Low-watt T8 4-foot 4 lamp fixture replacing T12	8	8	0

Notes: Cadmus verified the installation of 48” 28W T8 linear fluorescent lighting throughout the facility. It was not clear which specific fixtures correspond to this rebate. Cadmus installed five time-of-use light meters to verify the hours of use in the various space types.

Table 149: Southside Inn (Project Number: 9AX6IMFC)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent) [A lamp]	53	36	-17
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent) [BR lamp]	34	34	0

Notes: Cadmus verified the installation of two types of LED screw-in bulbs throughout the facility, in interior and exterior locations. Cadmus installed four time-of-use light meters to verify the hours of use in the various space types.

Table 150: Sacred Heart Church (Project Number: 3X5KT67W)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	166	137	-29

Notes: Cadmus verified the installation of screw-in LED bulbs, as reported in the project documentation. Cadmus observed LED bulbs throughout the facility; in the main worship space, entry vestibule, and side chapel. Cadmus also verified the HOU with the on-site contact, who reported the typical operating schedule of the facility.

Table 151: Sidney Middle School (Project Number: G1T3GLKT)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	T8 high-bay 4-foot 6 lamp fixture replacing HID	54	54	0

Notes: Cadmus verified the installation of 48” six-lamp linear fluorescent fixtures, as reported in the project documentation. Due to their height, the fixtures were inaccessible and Cadmus was unable to verify the T8 lamps, but the on-site contact verbally confirmed that the lamps are T8s. Cadmus also verified the HOU with the on-site contact, who reported the typical operating schedule of the facility.

Table 152: Troy Laminating and Coating (Project Number: 4002GKPK)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	Delamping HID	6,412	6,412	0
Rapid-Lighting Fixtures and Controls	LED High Bay Replacing 351W to 500W HID, T8 or T5	41	41	0

Notes: During the onsite interview with the facility manager, we learned that the company has upgraded the lighting in the manufacturing space in several phases over the past several years. One of the phases encompassed a coater process area where (41) LED high bay fixtures replaced 400-watt metal halide fixtures. We installed (4) light meters in this space to verify the annual hours of use for the upgrade.

Cadmus discussed the de-lamping measure with the site contact and we believe it partially covers the facility's most recent phase of replacing (400) 8'2L fixtures for T8 fixtures. Delamping measures are typically quantified in linear feet of fluorescent tubes (400 * 8ft * 2 ≈ 6412).

Table 153: Dimensions Enterprises (Project Number: ODQPAQAK)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	12	0	-12
Rapid-Lighting Fixtures and Controls	Low-watt T8 4-foot 4 lamp fixture replacing T12	23	23	0

Notes: Cadmus performed a complete lighting audit of this facility, which consists of two manufacturing bays and a small office. Cadmus verified the (23) 4' 4L T8 fixtures in the manufacturing bays, and installed 4 light meters to verify their annual hours of use. We did not discover any LED screw-in or luminaires on site and the contact was not aware of any location that would contain them.

Table 154: Darke County Fairgrounds (Project Number: 2MG4XINR)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Custom-NC-LPD	Installing (88)8Lmp and (10)4Lmp T8 fixtures in a new approx. 41,000 sqft facility	98	98	0

Notes: Cadmus performed a complete lighting audit of this building, which is used as a cattle holding and feeding area. The building consisted of (88) 4' 8L T8 fixtures and (10) 4' 4L T8 fixtures, and measured approximately 41,000 sqft (our measurement was within 2% of the claimed area). We installed 3 light meters in the building in order to verify the annual hours of use of the lights. During the interview with the site contact, we learned that the lights in this building are only used during the month of August when the fair is open, so evaluated savings may be smaller than claimed.

Table 155: Flory Cabinets (Project Number: CS3S0QT5, 6UTTPKOD & XDG143GI)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	CS3S0QT5: LED or Induction (operating hours < 8,760) replacing 175W or less	2	2	0
Rapid-Lighting Fixtures and Controls	6UTTPKOD: T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T12	40	40	0
Rapid-Lighting Fixtures and Controls	XDG143GI: LED 4-ft 3-lamp tubes	4	4	0
Rapid-Lighting Fixtures and Controls	XDG143GI: Delamping T12 (# linear feet)	16	16	0

Notes: Cadmus performed a complete lighting audit of this building, which is a woodworking studio. Three project numbers are associated with this site:

- CS3S0QT5: This was the sampled measure for this site; it represents 2 outdoor LED spot lights replacing high-intensity discharge fixtures. Cadmus verified both fixtures but since they were outdoors, we did not install light meters (the meters are indoor-rated only).
- 6UTTPKOD: Cadmus verified 100% of the claimed fixtures and installed 5 light meters in the workshop to verify the hours of use.
- XDG143GI: Cadmus interviewed the site contact and determined that (1) 4’ 4L T8 fixture was removed and not retrofitted; this accounts for the 16 linear feet of delamping claimed. Cadmus also verified 100% of the claimed fixtures.

Table 156: Francis Furniture (Project Number: RJ2A1MFH)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	550	190	-360

Notes: Cadmus toured the show room with the site contact; it consisted of 550 screw-in track lighting fixtures with a mix of CFL and LED bulbs. Cadmus learned on-site that the store staff install the LED bulbs when the CFLs burn out. Cadmus counted 360 LED bulbs still in storage. Invoices show that the store received 550 bulbs, so we verified that only 190 LEDs have been installed thus far. Cadmus installed 5 light meters among the LED bulbs to verify the hours of use. S

Table 157: FedEx – DAYA (Project Number: 4X8V8C4C & ZXXBXUOO)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	4X8V8C4C: LED or Electroluminescent exit sign	3	3	0
Rapid-Lighting Fixtures and Controls	4X8V8C4C: T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T12	111	111	0
Rapid-Lighting Fixtures and Controls	4X8V8C4C: T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T12	29	29	0
Custom-Lighting Fixtures and Controls	ZXXBXUOO: Removal of 60W 2 Lamp T12 fixture w/ magnetic ballasts and replaced with 32W 2 Lamp HPT8 fixture (16 fixtures)	16	16	0

Notes: Cadmus toured the office and warehouse areas of the facility with the site contact. The audited quantity of each measure matched the claimed quantity as seen in the table above. However, we found one discrepancy during the site audit: the office area contained (29) 4’ 2L T8 fixtures instead of the claimed 4’ 4L T8 fixtures. This will affect the realization rate during the impact analysis. Additionally, Cadmus installed 6 light meters on site to verify the annual hours of use of the facility lighting.

Table 158: Bradford EVSD (Project Number: QH7OPZ27 & 9GMABPTC)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	9GMABPTC: LED or Induction (operating hours < 8,760) replacing 251W or greater	28	28	0
Rapid-Lighting Fixtures and Controls	QH7OPZ27: Relamping 28 watt	3,760	3,618	-142

Notes: The sampled measure for this site was 9GMABPTC, which Cadmus verified during the onsite audit with a 100% install rate; this measure consisted of outdoor parking lot pole fixtures with photocell controls. While onsite, Cadmus also performed an audit for measure # QH7OPZ27; this measure consisted of replacing all 32-watt T8 bulbs in the school with 28-watt bulbs. The site contact shared the site plans for the retrofit, which showed only 3,618 bulbs replaced (compared to 3,760 claimed). The site contact claimed to have over-ordered the number of bulbs he needed for the retrofit and showed that he had 142 in storage still in case of burn-outs. Using the site plans and a sample generating tool, Cadmus mapped out and installed 6 light meters in different space types around the school to determine the typical hours of use during the summer peak period.

Table 159: Select Arc (Project Number: U9I9EYS3 & 0E5DVV5V)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Custom-Lighting Fixtures and Controls	U9I9EYS3: Removing (11) 4' 4L T12, (44) 8'2L 110w HO, (55) 400w MH, (45) 4' 4L T8, and (9) 2x2 4L T8. Installing 117 LED High Bays	117	117	0
Rapid-Lighting Fixtures and Controls	0E5DVV5V: LED Replacing 201 W to 350 W HID or Fluorescent	106	106	0

Notes: The sampled measure for this site was U9I9EYS3; Cadmus audited the manufacturing area of the facility and verified its (117) 6L LED high bay fixtures. Integrated into the same space were the (106) 4L LED high bay fixtures claimed by measure 0E5DVV5V. We decided to include both measure IDs in our audit and analysis since both will share the same hours of use. In order to verify the hours, Cadmus installed 6 light meters throughout the manufacturing area.

Table 160: New Madison Library (Project Number: 3TZFPULG)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	24	4	-20

Notes: This library has 20 LED bulbs in storage and 4 installed in the recessed screw-in fixtures near the entrances. The library staff installs the LEDs as the existing CFLs burn out. Cadmus installed 2 light meters to verify the hours of use of lights in the facility.

Table 161: Schlarman's Health (Project Number: JQIV1NX8 & CTLL74JL)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	JQIV1NX8: LED or Induction (operating hours < 8,760) replacing 175W or less	1	1	0
Rapid-Lighting Fixtures and Controls	JQIV1NX8: LED or Induction (operating hours < 8,760) replacing 251W or greater	1	1	0
Rapid-Lighting Fixtures and Controls	JQIV1NX8: LED or Induction (operating hours < 8,760) replacing 176W to 250W	1	1	0
Rapid-Lighting Fixtures and Controls	CTLL74JL: ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	46	46	0
Rapid-Lighting Fixtures and Controls	CTLL74JL: LED lighting in reach-in freezer/cooler case	8	10	2
Rapid-Lighting Fixtures and Controls	CTLL74JL: T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T12	24	24	0

Notes: Cadmus performed a complete lighting audit of the building; spaces included a sales floor, massage parlor, community room, and restrooms. The sampled measure for this site was JQIV1NX8, which comprised of outdoor LED spot light fixtures with photocell controls. Since these fixtures are nighttime-only, they do not qualify for PJM savings. Because of this, Cadmus also included measure # CTLL74JL in the site audit. Verified quantities agreed well with claimed quantities for all measures; the only small discrepancy is that we found 2 additional freezer LED lights than claimed. To verify the hours of use for the lighting, we installed 5 light meters in the building.

Table 162: Coldwater Marathon (Project Number: 9UGVV21M)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	LED lighting in reach-in freezer/cooler case	12	22	10

Notes: Cadmus verified that 22 vertical strip LED freezer lights at the in the display coolers on-site. We installed 3 light meters to verify the hours of use. The freezer lights have wall switch controls but the store manager claims that they are typically on 24 hours-a-day.

Table 163: Maria Stein American Legion (Project Number: KG0J4F5K)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	67	67	0
Rapid-Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	1	1	0
Rapid-Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W or greater	3	3	0
Rapid-Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	35	35	0
Rapid-Lighting Fixtures and Controls	Exterior LED recessed downlight luminaires or screw-in base lamps (replacing incandescent, ENERGY STAR certified)	6	6	0

Notes: The site contact granted access to all spaces in the building including function rooms, bar/lounge, restrooms, and storage areas. Cadmus verified all reported quantities with a 100% install rate. We installed 4 light meters in the building in order to verify the hours of use of the lighting fixtures.

Table 164: Village of Fort Loramie (Project Number: 6E4LL9KX)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 176W to 250W	2	2	0

Notes: Cadmus met with town's administrators to verify the project's lighting installation. We learned that the sampled measure was part of a larger retrofit that the village performed on all street lamps in the central business district. Cadmus toured the district and verified that the street lamps were all LEDs.

Table 165: Precious Blood Church (Project Number: UOI57ZWT)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	12	12	0

Notes: Cadmus verified 12 LED luminaires installed in the suspended fixtures of the chapel. The site contact did not have a ladder on site to access the fixtures and since the room experienced large amounts of ambient light, we could not correctly install any light meters to verify the hours of use. The site contact claimed the lighting schedule was widely variable but consisted roughly of 3 hours on Sundays with an additional 1-5 hours throughout a typical week.

Table 166: Arvindanand, Inc. (Project Number: EKHIBA0F)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W or greater	1	1	0
Rapid-Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	1	1	0

Notes: Cadmus verified both measures associated with this project; they were LED spot lights located in a parking lot with a timer control. The schedule set on the timer at the time of our inspection was 9:30PM – 6:00AM daily. The property owner adjusts the timing roughly 4 times a year as the seasonal daylight hours vary.

Table 167: Brethren Retirement Community (Project Number: 1YS2FW3E)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 176W to 250W	7	7	0

Notes: Cadmus verified the 7 fixtures for this measure during the on-site inspection. All fixtures are parking lot pole lights on a central photo sensor control.

Table 168: Ginghamsburg United Methodist Church (Project Number: 10HQ5G5C)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference

Custom-Lighting Fixtures and Controls	Removal of (100) HPS fixtures and install (64) LED fixtures.	64	64	0

Notes: Cadmus verified the 64 fixtures for this measure during the on-site inspection. All fixtures are parking lot pole lights on a central photo sensor control.

Table 169: Miami Valley Hospital South (Project Number: L4SSYY8D)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Custom-Heating, Ventilation and Air Conditioning	Chiller Plant Optimization	1	1	0

Notes: The facility manager allowed Cadmus access to the building management system (BMS) to verify the installation of the optimization project. Cadmus also toured the chiller plant equipment and observed the newly installed differential pressure measurement stations. The facility manager supplied Cadmus with a copy of Demand Flow Chilled Water Plant 2015 Performance Review, M&V document published by Siemens. Cadmus reviewed the BMS graphic screens and trend data points. The facility manager agreed to supply Cadmus with two 30-day periods of data points selected by Cadmus. The month of June 2015 has been provided and July will be provided at the end of the month. Since kW & kWh data is being trended for all major equipment, no meters were deployed.

Table 170: Custom Foam Products, Inc. (Project Number: 18BL62K1)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid- Compressed Air Systems	10 HP Variable Speed Compressor	1	1	0

Note: Cadmus photo-documented the equipment and verified that the variable speed compressor was installed. Cadmus also deployed a power meter to acquire kW and kWh data.

Table 171: Swihart Industries, Inc. (Project Number: 8L9B1ZCP)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid- Compressed Air Systems	60 HP variable Speed Compressor	1	1	0

Note: Cadmus photo-documented the equipment and verified that the variable speed compressor was installed. Cadmus also deployed a power meter to acquire kW and kWh data.

Table 172: McDonald’s 2054 (Project Number XROX5HD3)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Heating, Ventilation, and Air Conditioning	10 Ton Air Source Heat Pump	1	1*	0

Notes: Cadmus was granted access to the roof where the measure is located. Cadmus identified the equipment rebated, but determined through visual inspection the equipment type varied from the rebate application. The measure is listed as an Air Source Heat Pump (ASHP) in the database, however, the installed equipment model number nomenclature indicates the unit is AC electric cooling with gas heat rather than a heat pump. Cadmus confirmed the existence of gas piping to the unit. Cadmus deployed a power meter to acquire kW and kWh data and a temperature meter to capture return, outside, and mixed air temperatures.

Table 173: Greater Dayton Regional Transit Authority (Project Number: W4H279DW)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Heating, Ventilation, and Air Conditioning	Window Film	1	1	0

Notes: Cadmus visited the site and photo-documented the measure and verified the quantity of window film installed. Cadmus verified that the glazing to which the film is applied and found it to be double-glazed.

Table 174: McDonald's Corporation (DBA: McDonalds 5359) (Project Number: FB7DTIAX)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Heating, Ventilation, and Air Conditioning	Split AC Systems (1) 10 ton, (1) 7.5 ton, (1) 5 ton	3	3	0

Notes: Cadmus was granted access to the roof where the measures are located. Cadmus photo-documented the equipment and verified the installed quantities and sizes. The units were listed as split AC systems, however, they are actually packaged AC units. Cadmus deployed a power meter to acquire kW and kWh data and a temperature meters to capture return, outside, and mixed air temperatures on the 10 ton unit. Inclement weather (thunderstorms) prevent installation of meters on the other units.

Table 175: Titan Loan Investment Fund LP c/o CBRE Inc (Project Number: 6R38ZP99)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Heating, Ventilation, and Air Conditioning	60 HP VFD	1	1	0

Notes: Cadmus was granted access to the chiller plant mechanical room where the VFD modulates either Pump 6 or Pump 7 based on the position of a manual transfer switch. Cadmus photo-documented the equipment and verified the installed quantities and size. Cadmus installed a power meter to acquire kW and kWh data.

Table 176: City of Riverside (Project Number: BUAJ4KHG)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference

Rapid-Heating, Ventilation, and Air Conditioning	Split AC Systems (1) 5 ton, (2) 4 ton	3	3	0

Notes: Cadmus was granted access to the roof where the measures are located. Cadmus photo-documented the equipment and verified the installed quantities and sizes. The units were listed as split AC systems, however, two of the three are actually packaged AC units. Cadmus deployed power meters to acquire kW and kWh data and temperatures meter to capture return, outside, and mixed air temperatures on the Fire Station and the Administration Units

Table 177: Exel, Inc (Project Number: 39NYD8W9)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Motors	(2) 30 HP VFD	2	2	0

Notes: Cadmus was granted access to the facility and equipment. Cadmus photo-documented the equipment and verified the installed quantities and sizes. Cadmus did not gain access to the VFD locations but did observe operation of the cooling tower fan VFD's via the BMS. Cadmus deployed power meters on each of the two fan circuits to acquire kW and kWh data.

Table 178: Logan County Water Pollution Control District (Project Number: 35E44Z8V)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Motors	12 HP VFD	1	1	0

Notes: Cadmus was granted access to the facility and equipment. Cadmus photo-documented the equipment and verified the installed quantities and sizes. Cadmus observed operation of the RAS #4 pump via the PLC HMI and at the pump location. Cadmus deployed a power meter on the pump to acquire kW and kWh data.

Table 179: Montgomery County Environmental Services (Project Number: JOAGDN9T)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Motors	125 HP VFD	2	2	0

Notes: Cadmus was granted access to the facility and equipment. Cadmus photo-documented the equipment and verified the installed quantities and sizes. Cadmus deployed power meters on each pump to acquire kW and kWh data. The customer is in the process of installing a PLC system which will give them remote access to the site. This is expected to be complete in approximately one month.

Table 180: Keynes Bros., Inc. (Project Number: KH1I1JLE)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference

Rapid-Motors	100 HP VFD	1	1	0

Notes: Cadmus was granted access to the facility and equipment. Cadmus photo-documented the equipment and verified the installed quantities and sizes. Cadmus deployed power meters on the conveyance system to acquire kW and kWh data.

Table 181: Riverside Schools (Project Number: 0H5QS8JY)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Motors	(1) 20 HP Motor, (1) 30 HP Motor	2	2	0

Notes: Cadmus was granted access to the facility and equipment. Cadmus photo-documented the equipment and verified the installed quantities and sizes. The tracking spreadsheet indicates VFDs were installed, however, the facility manager indicated that this was a motor replacement only project and that the VFDs were existing. The site inspection observations are consistent with this. Cadmus deployed power meters on both fan motors to acquire kW and kWh data.

Table 182: Sonoco (Project Number: KLSVTJ10)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Custom – Other Technologies	Sigma Air Manager for Air Compressors	1	1	0

Notes: Cadmus was granted access to the facility and equipment. Cadmus photo-documented the equipment and verified the installed quantities. The installed control system operates four air compressors in sequence to maintain the proper pressure and flow needed in the plant. The control system is not connected to a computer network. Cadmus installed power meters on all four air compressors to acquire kW and kWh data.

Table 183: Oakland Church of the Brethren (Project Number: WW9M39RN)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Custom-Heating, Ventilation, and Air Conditioning	Thermostats and New HVAC Units	6	6	0

Notes: Cadmus was granted access to the facility and equipment. Cadmus photo-documented the equipment and verified the installed quantities. Cadmus deployed power meters to acquire kW and kWh data and temperatures meter to capture return, outside, and mixed air temperatures on the Office and two of the four Sanctuary Units.

Table 184: Digestive Specialists (Project Number: VJN9S2P9)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference

Rapid-Heating, Ventilation, and Air Conditioning	Window Film	1	1	0

Notes: Cadmus visited the site and photo-documented the measure and verified the quantity installed. Cadmus verified that the glazing to which the film is applied and found it to be double-glazed.

Table 185: Church of the Incarnation (Project Number: 0NGUDA2I)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	T8 high-bay 4-foot 6 lamp fixture replacing HID	40	40	0

Notes: The new lighting was installed at the gym/multipurpose room. During the summer the gym is lightly used. Expected usage from 9:00AM to noon on Sunday for Mass. During the school year usage is much heavier from 6AM to 8PM Monday through Friday with occasional usage on weekends for sporting and Mass.

Table 186: Dot's Bellbrook Market (Project Number: 2M51JHEY)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	LED lighting in reach-in freezer/cooler case (per tube)	43	43	0
Rapid-Lighting Fixtures and Controls	LED Replacing 501 W or greater HID or Fluorescent	5	5	0
Rapid-Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	2	0	0

Notes: Cadmus verified refrigerated cases were retrofitted with 19watt LED tubes replacing 32 watt T8 lamps. The case lighting were logged using three lighting meters installed in various cases around the store. We also verified parking lot lighting were retrofitted with 150 watt pole lights replacing 400W HID fixtures, additionally two 11.5W LED lamps were installed on the loading dock replacing 60W incandescent lighting. Exterior lighting is on a time-clock with hours 7PM to 9AM 7days a week.

Table 187: Fairmont Presbyterian Church (Project Number: MLOFHAS9)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T12	39	39	0
Rapid-Lighting Fixtures and Controls	Low-watt T8 4-foot 4 lamp fixture replacing T12	2	2	0

Notes: This project was a lighting retrofit in the choir room for the church. Cadmus verified T8 lamps with electronic ballasts replaced T12 lamps with magnetic ballasts. The church is slowly replacing all of the lighting in the facility when they have funds available. The choir room is used in the afternoons on weekdays and mornings on the weekends. We installed four lighting meters to monitor lighting usage.

Table 188: Jeff Schmitt Auto Group (Mazda) (Project Number: 5IJG13GG)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Custom-Lighting Fixtures and Controls	Remove 26 fixtures and install 16 Maxlite 300 Watt LED MELR300U350(72284)MERAK ROADWAYLIGHT 300W	16	16	0
Custom-Lighting Fixtures and Controls	275 WATT CUSTOM LED	1	1	0

Notes: Cadmus verified the installed lot and sales lighting at the dealership. LED fixtures were installed on most of the exterior polelights. Prior to the project many of the poles required dual heads to maintain lighting coverage over the entire lot. Facilities had removed nine heads because the new LED heads had controllable lighting spread patterns allowing further optimization of installed wattage. A timeclock controlled all of the lot lighting. Cadmus installed a single lighting meter to record the pattern of usage.

Table 189: Kettering City Schools - J.E. Prass Elementary (Project Number: WB7H20PA)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Custom -Lighting Fixtures and Controls	New efficiency measure added to an existing system. Exterior ceiling Mounted 56W LED replacing 3 - 2 lamp 26W CFL boxes Acuity OLWCM 36.	1	1	0

Notes: Cadmus verified a single fixture project at the elementary school. A single 56 watt LED fixture was installed in the entry way of the south entrance of the school. The LED fixture is controlled by a photocell mounted on the roof of the building with an auxiliary photocell on the fixture. The light is activated by either photocell signal.

Table 190: Kettering City Schools - Van Buren Middle School (Project Number: 51ITXTTK)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	Relamping 28 watt	199	199	0
Rapid -Lighting Fixtures and Controls	Delamping T8 (# linear feet)	476	476	0
Rapid -Lighting Fixtures and Controls	Wall or Ceiling-mounted occupancy sensor	4	4	0
Rapid -Lighting Fixtures	Wall or Ceiling-mounted occupancy sensor	14	14	0

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
and Controls				
Rapid -Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W to 400W	1	1	0
Rapid -Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	5	5	0
Rapid -Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	3	3	0
Rapid -Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	2	2	0
Rapid -Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	1	1	0
Rapid -Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	11	11	0
Rapid -Lighting Fixtures and Controls	Low-watt T8 4-foot 2 lamp fixture replacing T8	7	7	0
Rapid -Lighting Fixtures and Controls	Low-watt T8 4-foot 3 lamp fixture replacing T8	110	110	0

Notes: Cadmus met with the facilities engineer onside and did a walkthrough of the building. A significant lighting retrofit was done at the school. Re-lamping to 28 watts was performed in;

- Cafeteria
- Hallways
- Band Room
- Orchestra Room
- Lockers Rooms
- Restrooms

Delamp from 4-3 lamps was performed some of those spaces as well as several classrooms. We verified the gym was operating with occupancy sensors on 6 lamp T8 fixtures. We verified LED wallpacks installed throughout the exterior of building.

Table 191: Kettering Medical Center (Project Number: NIGUTEVO & 6CPKYA5D)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	LED 4-ft 2-lamp tubes	54	54	0
Rapid-Lighting Fixtures and Controls	LED or Electroluminescent exit sign	102	102	0

Notes: Cadmus met with the facilities engineer for the hospital. He walked us through the hospital to view several of the exit signs. We verified the presence of LED exit signs and give this measures a 100% realization rate. In mechanical rooms in the penthouse we verified T-8 lighting retrofitted with linear LED lamps.

Table 192: KOHLER FOOD SERVICE (Project Number: V09AFRI9)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	60	60	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	48	48	0

Notes: Upon meeting with the owner of the facility it was apparent that they had submitted many rebate applications. Kohler provides banquet facilities for weddings and conferences. Their facility on Presidential Way contains 6 ballrooms complete with kitchens, bars and restaurant. The owner of the facility was unsure which rebate application corresponded to a specific area of the facility. We chose a large ballroom and preformed a full lighting audit of all fixtures.

The audit revealed that all 293 lamps in the room had been replaced with LED lighting. The owner confirmed that he had used exclusively incandescent lighting in the past because incandescent provided high light quality and were dimmable. It was not until recently when LED technology could provide cost effective replacements that he decided to retrofit with LED lighting. He mentioned his initial reason for the retrofit was to reduce maintenance cost since lamp replacements were a regular part of facility maintenance. He has been very happy with the light quality and low maintenance of the new lighting.

Table 193: Lexus of Dayton (Project Number: 4MH8BL6M)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED luminaires up to 18 watts (replacing incandescent)	10	10	0
Rapid – Lighting Fixtures and Controls	LED luminaires up to 18 watts (replacing incandescent)	12	12	0

Notes: Cadmus verified the installation of the MR16 LED lamps indicated by the specifications. We could not find a suitable location to monitor the installed lamps so a lamp on the same switch bank was monitored.

Table 194: McGohan Brabender (Project Number: D1UBN7RE & 76GREUKI)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	1	1	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	4	4	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	2	10	8

Notes: Cadmus verified the installation of the exterior landscape lighting and the screw in LED lamps. Several fixtures on the receipt provided with the application were also found to be installed however they were not tracked in the project number. The additional lamps were installed the small conference room in several sockets. The site contact is in the process of converting the entire office to LED lighting and is purchasing new lamps as they fail.

Table 195: PLAS-TIX USA INC (Project Number: 54MB1WYT& 43CJWHFU)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	T5 high-output high-bay 6 lamp fixture replacing HID	108	104	-2
Rapid – Lighting Fixtures and Controls	T5 high-output high-bay 6 lamp fixture replacing HID	24	0	-24

Notes: Cadmus verified 104 – 6 lamp T5 fixtures installed at Plas-tix in the warehouse and manufacturing area. A few of those fixtures could not be found. We also found an additional 14 2-lamp T5 recessed fixtures retrofitted in the office areas. We could not account for the missing 26 - 6 lamp fixtures. It's unknown if the rebate for the missing fixtures were miscategorized as the 2 lamp T-5 fixtures installed in the office area. Occupancy sensors were installed on 26 of the T5 fixtures in the warehouse.

Table 196: Prairie Farms Dairy Inc (Project Number: J19X7M94 & V1T0RM83)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	LED 4-ft 4-lamp tubes	41	0	-41
Rapid-Lighting Fixtures and Controls	LED 4-ft 2-lamp tubes	38	24	-14
Rapid-Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	5	5	0
Rapid-Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W or greater	6	6	0
Rapid-Lighting Fixtures	Delamping T12 (# linear feet)	960	960	0

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
and Controls				
Rapid-Lighting Fixtures and Controls	Delamping T12 (# linear feet)	36	36	0
Rapid-Lighting Fixtures and Controls	LED 4-ft 3-lamp tubes	1	24	23
Rapid-Lighting Fixtures and Controls	LED 4-ft 2-lamp tubes	6	0	0

Notes: Cadmus met with the electrical contractor who had performed the retrofit on the lighting fixtures in the facility. We found the bottling floor, mechanical room, offices and the exterior loading dock were all retrofitted with linear led lamps. The contractor was in the process of retrofitting several fixtures in the warehouse with the LED lamps. Several packs of LED lamps were onsite in the process of being installed in the near future. However we did not find any 4 lamp fixtures at the facility, all of the 4 lamp fixture had been retrofitted with only 3 lamps because of the high lighting output of the new LED lamps.

Table 197: Salvation Army (Project Number: EJF06NHK)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Custom -Lighting Fixtures and Controls	Replacing (17) 8' 2L T12 HO, (6) 8' 4L T12, (5) 4L T12, (37) 400w MH with (54) 6L T8 High Bays	54	54	0

Notes: Cadmus verified the installation of the 6 lamp T8 high bay lighting. We observed the installed fixture and installed lighting meters to monitor usage.

Table 198: XENIA WATER TREATMENT PLANT (Project Number: ZWTE836I)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	3	3	0

Notes: Cadmus verified the rebated fixtures were installed and installed lighting meters to verify hours of operation.

Table 199: Citgo Gas Station (Project Number: HRWS4VIL)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid-Lighting Fixtures and Controls	LED lighting in reach-in freezer/cooler case	15	15	0
Rapid-Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W or greater	19	19	0

Notes: Cadmus verified linear LED lamps installed in the refrigerated cases at the gas station and verified the LED canopy and walls packs installed on the exterior. The refrigerated case lighting is always on and the exterior lighting is controlled by a photocell.

Table 200: Roth and Company (Project Number: CCNJA9S7)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED 4-ft 2-lamp tubes	87	80	-7
Rapid – Lighting Fixtures and Controls	Delamping T12 (# linear feet)	696	640	-56

Notes: Cadmus verified the installation 80 of the 87 rebated fixtures in the facility. Cadmus performed a full lighting inventory of the building to verify the number of fixture installed and 7 fixtures were missing. The facility had converted the original 4 lamp T12 fixtures to 2 lamp LED fixtures.

Table 201: Greeneview School (Project Number: O5MFZQDA)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid - Lighting Fixtures and Controls	Relamping 28 watt	1,383	1,383	0
Rapid - Lighting Fixtures and Controls	Delamping T8 (# linear feet)	820	820	0
Rapid - Lighting Fixtures and Controls	Low-watt T8 4-foot 2 lamp fixture replacing T8	16	16	0
Rapid - Lighting Fixtures and Controls	Vending equipment controller	3	3	0
Rapid - Lighting Fixtures and Controls	ENERGY STAR CFL screw-in bulb or pin-based fixture 21W to 32W replacing incandescent	52	52	0
Rapid - Lighting Fixtures and Controls	ENERGY STAR CFL screw-in bulb or pin-based fixture > 32W replacing incandescent	1	1	0
Rapid - Lighting Fixtures and Controls	ENERGY STAR CFL screw-in bulb or pin-based fixture > 32W replacing incandescent	5	5	0
Rapid - Lighting Fixtures and Controls	T8 high-bay 4-foot 4 lamp fixture replacing HID	48	48	0
Rapid - Lighting Fixtures and Controls	LED or Electroluminescent exit sign	12	12	0
Rapid - Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	7	7	0
Rapid - Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	1	1	0

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid - Lighting Fixtures and Controls	Low-watt T8 4-foot 2 lamp fixture replacing T8	69	69	0
Rapid - Lighting Fixtures and Controls	ENERGY STAR CFL screw-in bulb or pin-based fixture up to 20W replacing incandescent	10	10	0
Rapid - Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	62	62	0

Notes: Cadmus was able to verify a large majority of the fixtures installed onsite. We were able to directly verify;

- 612 – 28watt de-lamp
- 3 - 11W CFL’s
- 54 – 6lamp T-8’s
- 7 – LED exterior fixtures

We talked with the janitor in-site and determined that an extensive retrofit of lighting had happened through the school. Through that interview we were able to verify the number of rebated fixtures was reasonable for the size of the school and found no inconsistencies. We give the fixture count a 100% realization rate.

Table 202: Continental Carbonic Products, Inc. (Project Number: SCKIXTVW)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid - Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W or greater	99	99	0

Notes: Cadmus verified the installation of the LED wall packs on the exterior of the manufacturing facility. The wall packs are controlled by a photocell. No lighting meters were installed.

Table 203: Osuwitt LLC (Project Number: QPOSDWKP)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	Led 12 Watt	60	60	0
Rapid – Lighting Fixtures and Controls	Led 9 Watt	20	14	-6

Notes: Milano’s restaurant, all dining room lighting changed to LED bulbs. 60, 12 watt bulbs installed and 14, 9 watt bulbs installed. It is noted on invoice that 10, 9 watt bulbs were left in box. There is one panel of on/off switches to control all lamps. Manager turns on all lights at opening and off at closing. Hours are 7:30am to midnight, 7-days a week, all lights are on when open.

Table 204: Todays Home Interiors (Project Number: PURLPH8D)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	CFL 23 Watt	24	24	24

Notes: Large showroom with track lighting, all bulbs converted to CFLs. Only 24 bulbs incented but 378 bulbs in facility. Controls on two boxes, all lights on at 9:45 am each morning to 5:30 pm 7-days a week.

Table 205: Production Tube Cutting (Project Number: ZGPU4BA4)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	Replace 2x4 lay-in fixtures with LED tubes	50	50	0

Notes: Office and reception area lamps (2x4) retrofitted with LED tube bulbs. Business hours are 7:30 to 5:30 pm Monday through Friday. There were 10 on/off switches and 1 occupancy sensor (located in entry lobby).

Table 206: Salem Bend Condos (Project Number: J219DBA0)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	Added LED exterior wall pack/ downlights on photocells to most buildings on property	31	31	0

Notes: Cadmus verified the installation of the LED exterior downlights. All are on photocells.

Table 207: Ready Technologies (Project Number: R4QL9HCN)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	Low-watt T8 4-foot 4 lamp fixture replacing T12	35	35	0
Rapid – Lighting Fixtures and Controls	Delamping T12 (#linear feet)	106	106	0

Notes: Cadmus confirmed the quantity of T12 lamps delamped. Lamps in the production and warehouse areas were re-ballasted and changed to t8s. All lamps on switches (12+), located in a central area. Hours are 6:30am to 6pm Monday to Friday.

Table 208: Autozone (Project Number: HW9GYTXC)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and	LED exterior wall pack/ downlights	3	2	-1

Controls				

Notes: Autozone Store #753 installed 2 LED exterior wall packs; both are on the same photocell.

Table 209: Garber Electrical (Project Number: IQP0GCK5)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED exterior wall pack/ downlights	5	5	0
Rapid – Lighting Fixtures and Controls	LED parking lights	7	7	0

Notes: Garber Electrical installed 5 exterior wall packs and seven LED parking lot lights. All lamps were on the same photocell.

Table 210: Huber Heights (Project Number: SCZFPIR8)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 176W to 250W	28	28	0
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 176W or less	129	129	0

Notes: Huber Heights underwent a significant lighting project replacing most lamps in City facilities with LEDs. A detailed audit was conducted in March 2015 and contains a lighting inventory. Cadmus verified all fixtures were installed and on switches. The Tom Cloud Maintenance building's hours are 7:30am to 1pm Monday to Friday. The Fire Office, City Hall, Senior Center, and Court Office's hours are 9am to 5pm Monday to Friday. The Police Office is open 24/7. The Fire Garage and Maintenance Garage operate from 7am to 3:30 pm, Monday to Friday, and at ad hoc hours during emergencies. The sign shop operates 3 to 4 hours a day, Monday to Friday.

Table 211: Trotwood Madison Schools (Project Number: QO0XIY19)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	Relamping 28 watt	2,556	2,556	0
Rapid – Lighting Fixtures and Controls	Delamping T8 (# linear feet)	160	160	0
Rapid – Lighting Fixtures and Controls	T8 high-bay 4ft 6 lamp fixture replacing HID	32	32	0
Rapid – Lighting Fixtures and Controls	Vending equipment controller	1	1	0
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W to 400W	26	26	0
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	24	24	0
Rapid – Lighting Fixtures and Controls	Wall or Ceiling-mounted occupancy sensor	6	6	0
Rapid – Lighting Fixtures and Controls	LED luminaires up to 18 watts (replacing incandescent)	9	9	0

Notes: School underwent significant lighting project switching almost all lighting to LED (exterior and interior). A detailed audit was conducted in January 2015 and contains a lighting inventory. Maintenance hours occur in two shifts 6am to 3pm and 3pm to 11:30pm; Monday to Friday. Maintenance staff is on site all summer, school operations run August 12th to late May (depending on snow season). Cadmus verified the fixtures and sensors were installed as described.

Table 212: Walgreens # 12832 (Project Number: EIABJMPY)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	6ft LED Refrigerator Lighting	19	9	10

Notes: LED refrigerator lighting installed in closed beverage fridge cases. Operating hours are 8am to 10pm 7-days a week. Central Office controls lighting controls, lights are on 20 minutes before 8am and 20 minutes after 10pm.

Table 213: Montgomery County ESC (Project Number: GEP077Z1)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	NC-LPD	1	1	0

Notes: School underwent significant lighting project switching almost all lighting to LED (interior and exterior). A detailed audit was conducted in May 2015 and contains a lighting inventory. Maintenance hours occur in two shifts 6am to 1:30pm and 1:30pm to 11:30pm; Monday to Friday. Maintenance staff is on site all summer, school operations run August 12th to the third week of May (depending on snow season). All fixtures verified appeared on occupancy sensors. Exterior Lighting was being trouble shot by staff while on site.

Table 214: Advanced Door and Hardware (Project Number: LZNWLYU7)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	8’ 4-lamp T8 Retrofit	78	78	0
Rapid – Lighting Fixtures and Controls	T8 high-bay 4-foot 6 lamp fixture replacing HID	5	5	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	10	10	0
Rapid – Lighting Fixtures and Controls	Delamping T12 (#linear feet)	288	288	0

Notes: All lighting at facility retrofitted to T8. Hours of operation are 7:30 to 5pm Monday to Friday. All lighting on switches. Offices are occupied during all hours of operations; warehouse and production areas likely have different hours of use.

Table 215: Dayton Fire (Project Number: 8LOLTQEY)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	Low-watt T8 4-foot 2 lamp fixture replacing T12	1	1	0
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 176W to 250W	2	2	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	1	1	0
Rapid – Lighting Fixtures and Controls	T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T12	16	16	0
Rapid – Lighting Fixtures and Controls	T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T12	2	2	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	3	3	0
Rapid – Lighting Fixtures and Controls	Low-watt T8 4-foot 2 lamp fixture replacing T12	45	35	-10
Rapid – Lighting Fixtures and Controls	Low-watt T8 4-foot 4 lamp fixture replacing T12	7	7	0

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	Delamping T12 (# linear feet)	136	136	0

Notes: Large retro-fit of aged fire station lighting to T8. The fire station was having trouble with the new ballasts and occupancy sensors and many of the bulbs had burned out. New T8 lighting was already being switched incrementally to LED (10 fixtures were already LED). The garage lights are on 24/7 and controlled by occupancy sensors. The remaining interior lights are on switches and hours of operation were unknown/ad-hoc.

Table 216: Marathon Food Center (Project Number: B88SQJ5L)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	4	4	0
Rapid – Lighting Fixtures and Controls	6ft LED Refrigerator Lighting	15	15	0

Notes: Owner Bob Patel said he received incentives for fridge LED and lay-in fixture LEDs. LED refrigerator lighting installed in closed beverage fridge cases. All interior lighting in showroom replaced with LEDs. All lighting controlled by on/off switches. Hours of operation are 6am to 11pm; Monday to Friday. Five lay-in lamps and all the fridge lights operate 24/7.

Table 217: City of Riverside (Project Number: 08HKRS1L)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 251W or greater	3	3	0
Rapid – Lighting Fixtures and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	8	8	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	4	4	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	3	3	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR CFL screw-in bulb or pin-based fixture 21W to 32W replacing incandescent	3	3	0
Rapid – Lighting Fixtures and Controls	Relamping 28 watt	46	46	0

Notes: City of Riverside underwent a significant lighting retrofit. All City Facilities upgraded interior lighting to T8. All fixtures were verified on site with no discrepancies. The Administration Office, Public Works Office, and Fire Station Dining operated on switches, Monday to Friday 8am to 5pm. The Police Road Room operates 24/7. All garages operate Monday to Friday from 7:30am to 3:30pm and ad-hoc during emergencies and weather events.

Table 218: Miami Outfitters (Project Number: P3Q8JHIM)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	Delamping T12 (# linear feet)	40	40	0
Rapid – Lighting Fixtures and Controls	T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T12	5	5	0
Rapid – Lighting Fixtures and Controls	ENERGY STAR LED luminaires or screw-in base lamps (replacing incandescent)	46	46	0

Notes: Basement conference area and office T8 lamps added. All fixtures were verified on site with no discrepancies. All lighting controlled by switches. Office (2 lamps) operates at estimated 54 hours a week. Conference room estimated to be open 35 hours a week.

Table 219: Cedar Hill Furniture (Project Number: 7Q9WKZAS)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Rapid – Lighting Fixtures and Controls	LED 60 Watt Equivalent Bulb	120	120	0

Notes: Large showroom with significant track lighting, 120 LED bulbs installed. Hours of operation are 10am to 8pm Monday to Friday, 10am to 6pm Saturday, and noon to 5pm Sunday.

December 2015 Site Specific Summary

Cadmus conducted a second round of site visits in December 2015. A sample of 18 projects were selected from a list of 2015 program participants. In addition to the rebate program evaluation, Cadmus is also responsible for calculating peak demand savings as part of the PJM analysis, so the sample was filtered for only PJM applicable projects. Each stratum was further classified as lighting (large, medium & small), HVAC, motors, air compressor and custom. Table 220 shows the list of projects Cadmus engineers verified during this December round of site visits for the 2015 program evaluation.

Table 220: December 2015 Nonresidential Site Visit Summary

#	Site Name	Verified Sampled Project #	Strata
1	Trotwood- Madison County Schools	EN90KRO7	P-Lighting
2	Miracle Corp	W9C51M7P	P-Lighting
3	Te-Co Manufacturing LLC	1TC7KLUF	P-Lighting

#	Site Name	Verified Sampled Project #	Strata
4	Green Tokai	Y1GT5G2R	P-Lighting
5	Country Inn and Suites	DSROT891	P-Lighting
6	Fuyao Glass America, INC	8MSBK0RZ	P-Lighting
7	Ferno Washington	YR0XPNRZ	P-Lighting
8	Ohio Realty Advisors	HOHRPLSN	P-Lighting
9	Millennium Reign Energy LLC	E93HO03X	P-Lighting
10	Koenig Farm Products	AWQ4A6IR	C-NC
11	Dollar Tree Stores, Inc.	GRQTWF69	C-NC
12	United Theological Seminary	HO7QEP1P	P-HVAC
13	Montgomery County ESC	FFSGRV0W	P-HVAC
14	Dayton Theatre Guild	HEF8X8LR	P-HVAC
15	Riverside Schools	CT0GP2XF	P-HVAC
16	Parkway Local School	U6FATYYR	P-HVAC
17	GE Aviation	2PCCG7YZ	P-HVAC
18	Miamisburg Moose Lodge	UHUF2RU8	P-HVAC

Table 221 shows the light meters installed at 7 sites and power meters installed at 5 sites.

Table 221. December 2015 Sites Selected for Light and Power Metering

#	Site Name	Project #	Meter Type and Quantity Installed
1	Trotwood- Madison County Schools	EN90KRO7	Light - 6
2	Miracle Corp	W9C51M7P	Light - 6
3	Te-Co Manufacturing LLC	1TC7KLUF	Light - 6
4	Country Inn and Suites	DSROT891	Light - 4
5	Fuyao Glass America, INC	8MSBK0RZ	Light - 6
6	Ferno Washington	YR0XPNRZ	Light - 3
7	Millennium Reign Energy LLC	E93HO03X	Light - 6
8	United Theological Seminary	HO7QEP1P	Power - 1
9	Montgomery County ESC	FFSGRV0W	Power - 2
10	Dayton Theatre Guild	HEF8X8LR	Power - 1
11	Parkway Local School	U6FATYYR	Power - 1
12	Miamisburg Moose Lodge	UHUF2RU8	Power - 1
Total			**Light – 37, Power - 6**

December 2015 Site Specific Findings

Table 222. Trotwood – Madison County Schools (Project Number: EN90KRO7)

Measure Type	Reported Measure	Reported	Verified	Difference
Lighting and Controls	Delamping T8 (# linear feet)	2612	2612	0
Lighting and Controls	Low-watt T8 4-foot 3 lamp fixture replacing T8	44	35	-9
Lighting and Controls	Low-watt T8 4-foot 2 lamp fixture replacing T8	629	629	0
Lighting and Controls	Relamping 28 watt	4302	4302	0
Lighting and Controls	T8 high-bay 4-foot 6 lamp fixture replacing HID	76	56	-20
Lighting and Controls	T8 high-bay 4-foot 8 lamp fixture replacing HID	6	6	0
Lighting and Controls	Vending equipment controller	5	5	0
Lighting and Controls	Wall or Ceiling-mounted occupancy sensor	19	19	0
Lighting and Controls	LED luminaires up to 18 watts (replacing incandescent)	8	8	0
Lighting and Controls	CFL screw-in bulb or pin-based fixture > 32W replacing incandescent	20	20	0
Lighting and Controls	LED or Induction (operating hours < 8,760) replacing 251W to 400W	80	50	0
Lighting and Controls	LED or Induction (operating hours < 8,760) replacing 175W or less	55	55	0
Lighting and Controls	LED or Induction (operating hours < 8,760) replacing 176W to 250W	1	1	0

Notes: This site is a large high school with many rooms, hallways and extracurricular areas, and site contact did not have the available time to verify all fixtures. The site contact was not able to verify the fixture wattages, but Cadmus was able to identify them with the invoices provided by DP&L. Six time of use light meters were installed using a ladder and installed in the fixtures.

Table 223. Miracle Corp. (Project Number: W9C51M7P)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Lighting and Controls	Low-watt T8 4-foot 2 lamp fixture replacing T12	9	9	0
Lighting and Controls	Low-watt T8 4-foot 1 lamp fixture replacing T12	2	2	0
Lighting and	Low-watt T8 4-foot 4 lamp fixture	104	104	0

Notes: Controls	replacing T12			
Lighting and Controls	T8 high-bay 4-foot 6 lamp fixture replacing HID	149	149	0
Lighting and Controls	T8 high-bay 4-foot 4 lamp fixture replacing HID	18	18	0
Lighting and Controls	LED High Bay Replacing 351 W to 500 W HID, T8 or T5	6	6	0

Notes: All of the fixtures at the site were counted. The site is used as a warehouse and storage area for the company's products. There are very tall shelving systems throughout the site. Cadmus verified the wattage and fixture type with the site contact and invoices. Time of use light meters were installed. All of the meters were installed using chairs, arm's length, and rolling ladders that were found on site. One meter was installed using a scissor lift.

Table 224. Te-Co Manufacturing (Project Number: 1TC7KLUF)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Lighting and Controls	T5 high-output high-bay 4 lamp fixture replacing HID	20	20	0
Lighting and Controls	Low-watt T8 4-foot 2 lamp fixture replacing T12	47	47	0
Lighting and Controls	Delamping HID	9492	9492	0
Lighting and Controls	Delamping T12 (# linear feet)	712	712	0

Notes: This site has retrofitted most of the lighting throughout the facility, which is outside the scope of these measures. It was confirmed with the site facility manager that all of the fixtures that were modified, were exchanges using the same pattern as the reported measures. Six time of use light meters were installed in areas of different operation times and purposes in order to get an accurate cross section of lighting operation on site.

Table 225. Green Tokai (Project Number: Y1GT5G2R)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Lighting and Controls	T5 high-output high-bay 4 lamp fixture replacing HID	300	300	0

Notes: This site is a manufacturing and warehouse facility. The warehouse is 625,000 square feet and the manufacturing area is 256,000 square feet. Counting the fixtures proved difficult in the manufacturing area, because the fixtures are not installed in a grid. Some rows of fixtures are staggered and do not share the same number of fixtures as the rows next to them, but 300 fixtures were counted during the visit. In the warehouse the fixtures are installed in a grid arrangement. Light meters were not installed at this site. The ceiling is 20 ft. high at its lowest point and then rises to form and angled roof. The apex is 50ft. The walkways are compact and it would have been difficult to maneuver a man lift in the environment. The site escort also requested that no light meters be installed.

Table 226. Country Inn & Suites (Project Number: DSROT891)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Lighting and Controls	Energy Star LED luminaires or screw-in base lamps (replacing incandescent)	740	740	0

Notes: Cadmus staff was only given access to five rooms. The contact noted that a lot of rooms were still occupied at the time of the visit and there are only five different room layouts, each of which are exact replicas of each other throughout the hotel. Cadmus was given access to one room of each layout type. In the rooms in which access was granted light meters were installed inside tabletop lamps. Also in the verification report the quantity of lamps in each room is listed and it was used to verify the correct quantity.

Table 227. Fuyao Glass America (Project Number: 8MSBK0RZ)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Lighting and Controls	LED High Bay Replacing 351 W to 500 W HID, T8 or T5	1400	1400	0
Lighting and Controls	Occupancy sensor controlling 100 watts or more	1400	1400	0

Notes: This site is a large manufacturing facility. It is not complete. Every fixture has its own occupancy sensor. Six time of use light meters were installed in various areas of the facility. Each area chosen has its own operation hours and process. The fixtures are installed through the entire facility.

Table 228. Ferno Washington (Project Number: YR0XPNRZ)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Lighting and Controls	T8 high-bay 4-foot 6 lamp fixture replacing HID	321	321	0

Notes: The lighting retrofit is within a manufacturing setting. The fixtures are all installed on the site. There are three main areas in the manufacturing area, including; the machine shop, the sheet metal area, and a testing area. Light meters were installed in each of the aforementioned spaces. All of the meters required a man lift to install.

Table 229. Ohio Realty Advisors (Project Number: YR0XPNRZ)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Lighting and Controls	T8 high-bay 4-foot 6 lamp fixture replacing HID	79	79	0
Lighting and Controls	T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T12	3	3	0
Lighting and Controls	T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T12	3	3	0
Lighting and Controls	Exterior - LED or Induction (operating hours < 8,760) replacing 175W or less	4	4	0
Lighting and Controls	Exterior - LED or Induction (operating hours < 8,760) replacing 176W to 250W	7	7	0

Notes: All fixtures were verified during site visit. Cadmus was not able to install time of use light meters at this site. A man lift is required to access the fixtures and there was not one available at the time of the visit.

Table 230. Millennium Reign Energy, LLC (Project Number: E93HO03X)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
Lighting and Controls	LED Replacing 201 W to 350 W HID or Fluorescent	175	175	0
Lighting and Controls	LED Replacing 151 W to 200 W HID or Fluorescent	48	48	0
Lighting and Controls	LED Replacing 101 W to 150 W HID or Fluorescent	12	12	0

Notes: The property manager escorted Cadmus staff through the site, and all fixtures were verified. The site is a two story building. There are three tenants Millennium Reign Energy, the property owner, Kokosin, and the Ohio Department of Transportation. Some of the areas that are listed in the documents on the DP&L site could not be identified by the site contact. The Cadmus staff person counted the fixtures and used the counts to identify potential areas, then used the recorded area names to infer the actual area counts. Cadmus installed six time of use light meters on site.

Table 231. Koenig Farm Products (Project Number: AWQ4A6IR)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
NC – Lighting	198W LED Bay Light	15	15	0
NC – Lighting	125W LED Bay Light	39	39	0

NC – Lighting	8’ Strip LED – 144	19	19	0
NC – Lighting	High Pressure LED – 152W	16	16	0
NC – Lighting	39W 2x4 Recessed LED	16	16	0
NC – Lighting	51W 2x4 Recessed LED	20	20	0
NC – Lighting	59W 2x4 Recessed LED	6	6	0
NC – Lighting	35W LED Down Light	2	2	0
NC – Lighting	258W LED Bay Light	60	60	0
NC – Lighting	104W LED Wall Pack	10	10	0
NC – Lighting	174W LED Pole Light	5	5	0
NC – Lighting	79W LED Flood Light	5	5	0

Notes: Cadmus verified all 213 fixtures at Koenig Farm Products. The hours of operation of this retail and farm equipment repair shop are M-F 8AM-5PM and Sat 8AM-12PM. During farming season, about 12 weeks, the shop is open from 7AM-7PM.

Table 232. Dollar Tree (Project Number: GRQTWF69)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
NC – Lighting	Sales Floor	117	117	0
NC – Lighting	Restroom Corridor	2	2	0
NC – Lighting	Vestibule	1	1	0
NC – Lighting	Breakroom	1	1	0
NC – Lighting	Stockroom	7	7	0
NC – Lighting	Men's RR	1	1	0
NC – Lighting	Women's RR	1	1	0
NC – Lighting	Office	2	2	0
NC – Lighting	Parking Lot	4	4	0

NC – Lighting	Parking Lot	2	2	0
NC – Lighting	Building Façade	10	10	0
NC – Lighting	Building Façade	4	4	0

Notes: Cadmus verified all 152 fixtures at Dollar Tree. Normal hours of operation M-S 8AM-9PM and Sun 9AM-8PM.The holiday hours of operation of this retail store are M-S 8AM-10PM and Sun 9AM-9PM.

Table 233. United Theological Seminary (Project Number: HO7QEP1P)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
P-HVAC	Unitary and split system A/C 136,000 - 240,000 BTUH (11.33-20 tons)	1	1	0

Notes: Cadmus visited the Seminary facility and confirmed the rooftop unit (RTU-3) was installed and matched the application description. One power meter was installed to verify equipment performance. No discrepancies were identified.

Table 234. Montgomery County ESC (Project Number: FFSGRV0W)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
P-HVAC	Variable Refrigerant Flow System 136,000 - 240,000 BTUH	4	4	0
P-HVAC	Unitary and split system A/C < 65,000 BTUH (<5.4 tons)	1	1	0
P-HVAC	Energy recovery ventilation > 450 CFM	1	1	0

Notes: Cadmus inspected the equipment serving the facility and confirmed the heat pumps, split system and ERU. Each of the four large heat pumps on the roof are actually dual 8-ton units. The total capacity matches the rebate application data. Two power meters were installed to verify equipment performance. No discrepancies were identified.

Table 235. Dayton Theatre Guild (Project Number: HEF8X8LR)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
P-HVAC	Unitary and split system A/C 136,000 - 240,000 BTUH (11.33-20 tons)	1	1	0

Notes: Cadmus inspected the equipment serving the theatre production and rehearsal building. The east RTU matches the rebate application data and appears to be in new condition. The equipment capacity and performance characteristics match the rebate application data. One power meter was installed to verify equipment performance. No discrepancies were identified.

Table 236. Riverside Schools (Project Number: CT0GP2XF)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
P-HVAC	Variable frequency drive up to 250 HP	1	1	0

Notes: Cadmus inspected the 7 HP variable frequency drive (VFD) controlling a kitchen exhaust fan serving the Riverside Schools building. The VFD size and controlled motor HP match the rebate application data. Cadmus was unable to de-energize the equipment to install power meters. Instead, Cadmus physically verified the equipment and interviewed kitchen staff to understand the equipment load profile and estimated hours of operation. No discrepancies were identified.

Table 237. Parkway Local School (Project Number: U6FATYYR)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
P-HVAC	Variable frequency drive up to 250 HP	1	1	0

Notes: Cadmus inspected the 15 HP variable frequency drive (VFD) controlling a boiler hot water pump located in the mechanical room of the high school. The VFD size and controlled motor HP match the rebate application data. Cadmus installed one power meter. No discrepancies were identified.

Table 238. GE Aviation (Project Number: 2PCCG7YZ)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
P-HVAC	Unitary and split system A/C 65,000 - 135,000 BTUH (5.4-11.25 tons)	1	1	0
P-HVAC	Unitary and split system A/C 136,000 - 240,000 BTUH (11.33-20 tons)	2	2	0
P-HVAC	Unitary and split system A/C 136,000 - 240,000 BTUH (11.33-20 tons)	2	2	0

Notes: Cadmus inspected the five air handling unites (AHUs) serving the GE facility. GE would not allow equipment panels to be open or power meters to be installed. Instead, Cadmus identified the rebated equipment and compared nameplate data to the rebate application data. The staff were interviewed to understand load profiles and estimated hours of operation. No power meters were installed. No discrepancies were identified.

Table 239. Miamisburg Moose Lodge (Project Number: UHUF2RU8)

Measure Type	Reported Measure	Reported Quantity	Verified Quantity	Difference
P-HVAC	Unitary and split system A/C 136,000 - 240,000 BTUH (11.33-20 tons)	1	1	0

Notes: Cadmus inspected the Rooftop Unit (RTU) serving the lodge from the rear of the building. The RTU matches the rebate application data and appears to be in new condition. The equipment capacity and performance characteristics match the rebate application data. One power meter was installed to verify equipment performance. No discrepancies were identified.

Appendix J. *Ex Ante* Measure Level Savings Documentation

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
Residential					
Lighting	CFL	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 are based on CleaResult's in-store shelf stocking study. These baseline wattages account for the availability of inefficient incandescent bulbs that are phased out by the EISA law.	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 are based on CleaResult's in-store shelf stocking study. These baseline wattages account for the availability of inefficient incandescent bulbs that are phased out by the EISA law.
	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 are based on CleaResult's in-store shelf stocking study. These baseline wattages account for the availability of inefficient incandescent bulbs that are phased out by the EISA law. The LED ISR of 0.96 is based on benchmarking LED ISR values from five studies.	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 are based on CleaResult's in-store shelf stocking study. These baseline wattages account for the availability of inefficient incandescent bulbs that are phased out by the EISA law. The LED ISR of 0.96 is based on benchmarking LED ISR values from five studies.
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
	13W CFLs	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.	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.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	Bathroom Faucet Aerators	ARP Participant Survey. 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. Installation rate determined from ARP participant survey.	ARP Participant Survey. 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. Installation rate determined from ARP participant survey.
	Kitchen Faucet Aerators	ARP Participant Survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 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. Installation rate determined from ARP participant survey.	ARP Participant Survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 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. Installation rate determined from ARP participant survey.
	Efficient Showerheads	ARP Participant Survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 93-96; 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. Installation rate determined from ARP participant survey.	ARP Participant Survey. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 93-96; 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. Installation rate determined from ARP participant survey.
Low-Income	Air Sealing Attic Insulation CFL 15 watt dimmable CFL 15 watt globe	Ex Ante kWh Savings are the same as the verified and adjusted gross savings.	Ex Ante kWh Savings are the same as the verified and adjusted gross savings.	Ex Ante kWh Savings are the same as the verified and adjusted gross savings.	Ex Ante kWh Savings are the same as the verified and adjusted gross savings.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	CFL 15 watt or less outdoor				
	CFL 16-20 watt floodlight				
	CFL 16-20 watt outdoor				
	CFL 16-20 watt spiral				
	CFL 21 watt or above sprial				
	CFL 3-way dimmable torchiere				
	CFL 3-way spiral				
	CFL 7-9 watt candelabra				
	CFL 9 watt globe				
	CFL 9-15 watt spiral				
	Duct Sealing				
	Faucet Aerator				
	Foundation Wall Insulation				
	Freezer Replacement				
	Freezer Retire				
	Heat Pump				
	HVAC				
	LED NightLight				
	Pipe Insulation				
	Refrigerator Replacement				
	Refrigerator Retire				
	Showerhead				
	Smart Strip				
	Wall Insulation				
	WH Tank Setback				
	WH Wrap				
Low-Income (PWC)	Central AC CFLs Faucet Aerator	Ex Ante kWh Savings are the same as the verified and adjusted gross	Ex Ante kWh Savings are the same as the verified and adjusted gross savings.	Ex Ante kWh Savings are the same as the verified and adjusted gross	Ex Ante kWh Savings are the same as the verified and adjusted gross savings.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	Freezer Replacement Heat Pump Pipe Insulation Refrigerator Replacement Showerhead WH Wrap	savings.		savings.	
HVAC Rebate	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.

Program	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 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.
	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-	Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation	2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-	Estimates calculated by Cadmus using draft Ohio TRM and primary data. Calculation methodology

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
		UNC.	methodology provided on pages 56 - 59 of Cadmus Annual EM&V Report filed May 15, 2013 under Case No. 13-1140-EL-POR.	GE-UNC. Pages 82 - 85.	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.
	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	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-

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
			Case No. 13-1140-EL-POR.		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.
	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.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	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.
	ECM with New AC	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.
	ECM	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.
	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.
	Programmable Thermostat with AC	Engineering calculations based on secondary data.	Estimates calculated by program implentor using engineering formulas.	No kW savings are claimed for thermostats.	No kW savings are claimed for thermostats.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	Programmable Thermostat with HP	Engineering calculations based on secondary data.	Estimates calculated by program implentor using engineering formulas.	No kW savings are claimed for thermostats.	No kW savings are claimed for thermostats.
	ProgrammableThermostat with GSHP	Engineering calculations based on secondary data.	Estimates calculated by program implentor using engineering formulas.	No kW savings are claimed for thermostats.	No kW savings are claimed for thermostats.
	Smart Thermostat with AC	Engineering calculations based on secondary data.	Estimates calculated by program implentor using engineering formulas.	No kW savings are claimed for thermostats.	No kW savings are claimed for thermostats.
	Smart Thermostat with HP or GSHP	Engineering calculations based on secondary data.	Estimates calculated by program implentor using engineering formulas.	No kW savings are claimed for thermostats.	No kW savings are claimed for thermostats.
	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 savngs 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 eletric heat pump heating. Measure data did not indicate whether the home was heated with electrici 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 eletric heat pump heating. Measure data did not indicate whether the home was heated with electrici resistance or heat pump systems.
Be E3 Smart	13W CFLs (4 Bulbs in each kit)	Parent follow-up survey with 2014-2015 participants. 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. Participation rate determined using Parent follow-up survey with 2014-2015 school year participants.	Parent follow-up survey with 2014-2015 participants. 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. Participation rate determined using Parent follow-up survey with 2014-2015 school year participants.
	Nightlights (1 in each kit)	Parent follow-up survey with 2014-2015 participants. Ohio TRM Draft 15 October 2009, pages 60-61	Calculated using the inputs and algorithms in the 2009 draft Ohio TRM. Participation rate determined using Parent follow-up survey with 2014-2015 school year participants.	Parent follow-up survey with 2014-2015 participants. Ohio TRM Draft 15 October 2009, pages 60-61	Calculated using the inputs and algorithms in the 2009 draft Ohio TRM. Participation rate determined using Parent follow-up survey with 2014-2015 school year participants.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	Bathroom Faucet Aerators (2 in each kit)	Family-Online Study Survey distributed during the September 2014-May 2015 Ohio School Year. Parent follow-up survey with 2014-2015 participants. 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. Participation rate determined using Parent follow-up survey with 2014-2015 school year participants.	Family-Online Study Survey distributed during the September 2014-May 2015 Ohio School Year. Parent follow-up survey with 2014-2015 participants. 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. Participation rate determined using Parent follow-up survey with 2014-2015 school year participants.
	Kitchen Faucet Aerators (1 in each kit)	Family-Online Study Survey distributed during the September 2014-May 2015 Ohio School Year. Parent follow-up survey with 2014-2015 participants. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 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. Participation rate determined using Parent follow-up survey with 2014-2015 school year participants.	Family-Online Study Survey distributed during the September 2014-May 2015 Ohio School Year. Parent follow-up survey with 2014-2015 participants. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 89-92; 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. Participation rate determined using Parent follow-up survey with 2014-2015 school year participants.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	Efficient Showerheads (1 in each kit)	Family-Online Study Survey distributed during the September 2014-May 2015 Ohio School Year. Parent follow-up survey with 2014-2015 participants. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 93-96; 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. Participation rate determined using Parent follow-up survey with 2014-2015 school year participants.	Family-Online Study Survey distributed during the September 2014-May 2015 Ohio School Year. Parent follow-up survey with 2014-2015 participants. 2010 draft Ohio TRM filed August 6, 2010 under Case No. 09-0512-GE-UNC Pages 93-96; 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. Participation rate determined using Parent follow-up survey with 2014-2015 school year participants.
Appliance Rebate	Refrigerators	2010 draft Ohio TRM pages 53-55	Deemed value taken from ENERGYSTAR Tier, side by side configuration.	2010 draft Ohio TRM pages 53-54	Deemed value taken from ENERGYSTAR Tier, side by side configuration.
	Washing Machines	2010 draft Ohio TRM pages 59-62	Deemed value taken from ENERGYSTAR Tier.	2010 draft Ohio TRM pages 59-62	Deemed value taken from ENERGYSTAR Tier.
	Wi-fi Thermostat	2015 Illinois TRM	Based on secondary data using methodology in the 2015 Illinois TRM	No kW savings are claimed for thermostats.	No kW savings are claimed for thermostats.
Non-Residential Prescriptive					
Non-Residential 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.
	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	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.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
			heating hours are 810.		
	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	2010 draft Ohio TRM, pages 194 - 196.	Baseline efficiencies from TRM unless otherwise known. Efficient SEER of 14.0 used in calculation.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
			hours are 942.		
	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.
	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	Base efficiency, new efficiency, and HOU are application specific.	Calculation savings methodology reflect similar methodology	Base efficiency, new efficiency, and HOU are application specific.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
		for heat pump systems: 2010 draft Ohio TRM, pages 197-200.		used for heat pump systems: 2010 draft Ohio TRM, pages 197-200.	
	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.
Non-Residential Prescriptive: Lighting	Central lighting control	2010 draft Ohio TRM with specific project HOU assumptions. Pages 149-152	2010 draft Ohio TRM with specific project HOU assumptions. Pages 149-152	2010 draft Ohio TRM. Pages 149-152	No demand savings are collected.
	CFL screw-in bulb or pin-based fixture > 32W replacing incandescent	2010 draft Ohio TRM, pages 153 - 156.	Assume 68 watts of savings. HOU is application specific.	2010 draft Ohio TRM, pages 153 - 156.	Assume 68 watts of savings. Coincidence factor is the average of the first 13 building type measures .732.
	CFL screw-in bulb or pin-based fixture 21W to 32W replacing incandescent	2010 draft Ohio TRM, pages 153 - 156.	Assume 20 watts of savings. HOU is application specific.	2010 draft Ohio TRM, pages 153 - 156.	Assume 20 watts of savings. Coincidence factor is the average of the first 13 building type measures .732.
	CFL screw-in bulb or pin-based fixture up to 20W replacing incandescent	2010 draft Ohio TRM, pages 153 - 156.	Assume 20 watts of savings. HOU is application specific.	2010 draft Ohio TRM, pages 153 - 156.	Assume 20 watts of savings. Coincidence factor is the average of the first 13 building type measures .732.
	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	2010 draft Ohio TRM, pages 169 - 172.	72 watts per 4-foot lamp is used to calculated savings. Coincidence

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
			application specific.		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 CFL screw-in bulb or pin-based fixture > 32W replacing incandescent	2010 draft Ohio TRM, pages 153 - 156.	Assume 55 watts of savings. HOU is application specific.	2010 draft Ohio TRM, pages 153 - 156.	Assume 55 watts of savings. Coincidence factor is the average of the first 13 building type measures .732.
	Energy Star CFL screw-in bulb or pin-based fixture 21W to 32W replacing incandescent	2010 draft Ohio TRM, pages 153 - 156.	Assume 20 watts of savings. HOU is application specific.	2010 draft Ohio TRM, pages 153 - 156.	Assume 20 watts of savings. Coincidence factor is the average of the first 13 building type measures .732.
	Energy Star CFL screw-in bulb or pin-based fixture up to 20W replacing incandescent	2010 draft Ohio TRM, pages 153 - 156.	Assume 20 watts of savings. HOU is application specific.	2010 draft Ohio TRM, pages 153 - 156.	Assume 20 watts of 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 or Induction (8,760 operating hours) replacing 175 W 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
	Exterior - LED or Induction	Simple savings formula	Efficient fixture wattage is	Simple savings formula.	Efficient fixture wattage is

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	(operating hours < 8,760) replacing 175W or less	using 4380 hours.	subtracted from baseline fixture including ballast wattage		subtracted from baseline fixture including ballast wattage
	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.
	Fixture-mounted occupancy sensor	2010 draft Ohio TRM method with adjusted controlled wattage on Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM.	Assumed controlled wattage is 204 watts. Assumed 200 sqft controlled to roughly have 1.0 watts/square foot lighting load.	2010 draft Ohio TRM method with adjusted controlled wattage on Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM.	Assumed controlled wattage is 204 watts. Assumed 200 sqft controlled to roughly have 1.0 watts/square foot lighting load.
	LED 4-ft 1-lamp tube	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.
	LED 4-ft 2-lamp tubes	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.
	LED 4-ft 3-lamp tubes	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

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
					of the first 13 building type measures .732.
	LED 4-ft 3-lamp tubes 1	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.
	LED 4-ft 4-lamp tubes	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.
	LED case lighting sensor controls	2010 draft Ohio TRM, pages 180 - 182.	Fixture savings is averaged between 5 and 6 foot lamps resulting in 52 watts of savings per door. Waste heat factor savings is averaged and results in .465. These savings are multiplied by a factor of 0.43.	2010 draft Ohio TRM, pages 180 - 182.	No demand savings are collected.
	LED High Bay Replacing 150 W or less HID, T8 or T5	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.
	LED High Bay Replacing 151 W to 200 W HID, T8 or T5	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.
	LED High Bay Replacing 201 W to 350 W HID, T8 or T5	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.
	LED High Bay Replacing 351 W to 500 W HID, T8 or T5	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

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
					measures .732.
	LED High Bay Replacing 501 W or greater HID, T8 or T5	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.
	LED lighting in reach-in freezer/cooler case	2010 draft Ohio TRM, pages 180 - 182.	Fixture savings is averaged between 5 and 6 foot lamps resulting in 52 watts of savings per door. Waste heat factor savings is averaged and results in .465.	2010 draft Ohio TRM, pages 180 - 182.	Fixture savings is averaged between 5 and 6 foot lamps resulting in 52 watts of savings per door. Waste heat factor savings is averaged and results in .465.
	LED lighting in reach-in freezer/cooler case (per tube)	2010 draft Ohio TRM, pages 180 - 182.	Fixture savings is averaged between 5 and 6 foot lamps resulting in 52 watts of savings per door. Waste heat factor savings is averaged and results in .465.	2010 draft Ohio TRM, pages 180 - 182.	Fixture savings is averaged between 5 and 6 foot lamps resulting in 52 watts of savings per door. Waste heat factor savings is averaged and results in .465.
	LED luminaires up to 18 watts (replacing incandescent)	Simple savings formula using specific project HOU assumptions.	Assume baseline of 75 watts and efficient wattage of 18 watts, or actual wattages if known.	Simple savings formula.	Assume baseline of 75 watts and efficient wattage of 18 watts, or actual wattages if known.
	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.
	LED or Induction (8,760 operating hours) replacing 175 W 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
	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
	LED or Induction (operating hours < 8,760) replacing 175W or less	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
	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
	LED or Induction	Simple savings formula	Efficient fixture wattage is	Simple savings formula.	Efficient fixture wattage is

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	(operating hours < 8,760) replacing 251W or greater	using 4380 hours.	subtracted from baseline fixture including ballast wattage		subtracted from baseline fixture including ballast wattage
	LED or Induction (operating hours < 8,760) replacing 251W to 400W	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
	LED pedestrian walk/don't walk sign	2010 draft Ohio TRM, pages 185 - 188.	Baseline and efficient wattages are averaged between the two sizes resulting in 109.5 baseline watts and 10.5 efficient watts.	2010 draft Ohio TRM, pages 185 - 188.	Baseline and efficient wattages are averaged between the two sizes resulting in 109.5 baseline watts and 10.5 efficient watts.
	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
	LED traffic signal - green	2010 draft Ohio TRM, pages 185 - 188.	No changes from TRM.	2010 draft Ohio TRM, pages 185 - 188.	CF is averaged between "Man" and "Hand" signals resulting in .48.
	LED traffic signal - red	2010 draft Ohio TRM, pages 185 - 188.	Baseline and efficient wattages are averaged between the two sizes resulting in 109.5 baseline watts and 6.5 efficient watts.	2010 draft Ohio TRM, pages 185 - 188.	Baseline and efficient wattages are averaged between the two sizes resulting in 109.5 baseline watts and 6.5 efficient watts.
	LED Traffic Signal (Arrow)	2010 draft Ohio TRM, pages 185 - 188.	Baseline wattage of 116; new wattage of 40.	2010 draft Ohio TRM, pages 185 - 188.	Baseline wattage of 116; new wattage of 40.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	Low-watt T8 4-foot 1 lamp fixture replacing T12	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 43W and new efficiency 22W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 43W and new efficiency 22W. Coincidence factor is the average of the first 13 building type measures .732.
	Low-watt T8 4-foot 2 lamp fixture replacing T12	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 72W and new efficiency 42W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 72W and new efficiency 42W. Coincidence factor is the average of the first 13 building type measures .732.
	Low-watt T8 4-foot 2 lamp fixture replacing T8	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 59W and new efficiency 42W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 59W and new efficiency 42W. Coincidence factor is the average of the first 13 building type measures .732.
	Low-watt T8 4-foot 3 lamp fixture replacing T12	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 115W and new efficiency 64W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 115W and new efficiency 64W. Coincidence factor is the average of the first 13 building type measures .732.
	Low-watt T8 4-foot 3 lamp fixture replacing T8	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 89W and new efficiency 64W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 89W and new efficiency 64W. Coincidence factor is the average of the first 13 building type measures .732.
	Low-watt T8 4-foot 4 lamp fixture replacing T12	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 144W and new efficiency 85W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 144W and new efficiency 85W. Coincidence factor is the average of the first 13 building type measures .732.
	Low-watt T8 4-foot 4 lamp fixture replacing T8	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 112W and new efficiency 85W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 112W and new efficiency 85W. Coincidence factor is the average of the first 13 building type measures .732.
	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.	Assumed controlled wattage is 332 watts.	2010 draft Ohio TRM method with adjusted controlled wattage on Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM.	Assumed controlled wattage is 332 watts.
	Occupancy sensor controlling less than 100 watts	2010 draft Ohio TRM method with adjusted controlled wattage on	Assumed controlled wattage is 50 watts.	2010 draft Ohio TRM method with adjusted controlled wattage on	Assumed controlled wattage is 50 watts.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
		Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM.		Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM.	
	Relamping 25 watt or less	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 31W and new efficiency 24W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 31W and new efficiency 24W. Coincidence factor is the average of the first 13 building type measures .732.
	Relamping 28 watt	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 31W and new efficiency 27W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 31W and new efficiency 27W. Coincidence factor is the average of the first 13 building type measures .732.
	T5 high-output high-bay 10 lamp fixture replacing HID	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 1,080W and new efficiency 585W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 1,080W and new efficiency 585W. Coincidence factor is the average of the first 13 building type measures .732.
	T5 high-output high-bay 2 lamp fixture replacing HID	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 190W and new efficiency 117W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 190W and new efficiency 117W. Coincidence factor is the average of the first 13 building type measures .732.
	T5 high-output high-bay 4 lamp fixture replacing HID	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 458W and new efficiency 234W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 458W and new efficiency 234W. Coincidence factor is the average of the first 13 building type measures .732.
	T5 high-output high-bay 6 lamp fixture replacing HID	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 458W and new efficiency 351W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 458W and new efficiency 351W. Coincidence factor is the average of the first 13 building type measures .732.
	T5 high-output high-bay 8 lamp fixture replacing HID	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 1,080W and new efficiency 468W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 1,080W and new efficiency 468W. Coincidence factor is the average of the first 13 building type measures .732.
	T8 (BF < 0.78) 4-foot 1 lamp fixture replacing T12	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 43W and new efficiency 25W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 43W and new efficiency 25W. Coincidence factor is the average of the first 13 building type measures .732.
	T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T12	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 72W and new efficiency 48W. HOU is	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 72W and new efficiency 48W. Coincidence

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
			application specific.		factor is the average of the first 13 building type measures .732.
	T8 (BF < 0.78) 4-foot 2 lamp fixture replacing T8	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 59W and new efficiency 48W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 59W and new efficiency 48W. Coincidence factor is the average of the first 13 building type measures .732.
	T8 (BF < 0.78) 4-foot 3 lamp fixture replacing T12	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 115W and new efficiency 73W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 115W and new efficiency 73W. Coincidence factor is the average of the first 13 building type measures .732.
	T8 (BF < 0.78) 4-foot 3 lamp fixture replacing T8	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 89W and new efficiency 73W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 89W and new efficiency 73W. Coincidence factor is the average of the first 13 building type measures .732.
	T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T12	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 144W and new efficiency 96W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 144W and new efficiency 96W. Coincidence factor is the average of the first 13 building type measures .732.
	T8 (BF < 0.78) 4-foot 4 lamp fixture replacing T8	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 89W and new efficiency 64W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 89W and new efficiency 64W. Coincidence factor is the average of the first 13 building type measures .732.
	T8 high-bay 4-foot 3 lamp fixture replacing HID	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 190W and new efficiency 112W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 190W and new efficiency 112W. Coincidence factor is the average of the first 13 building type measures .732.
	T8 high-bay 4-foot 4 lamp fixture replacing HID	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 295W and new efficiency 151W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 295W and new efficiency 151W. Coincidence factor is the average of the first 13 building type measures .732.
	T8 high-bay 4-foot 6 lamp fixture replacing HID	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 458W and new efficiency 226W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 458W and new efficiency 226W. Coincidence factor is the average of the first 13 building type measures .732.
	T8 high-bay 4-foot 8 lamp fixture replacing HID	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 458W and new efficiency 288W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 458W and new efficiency 288W. Coincidence factor is the average of the first 13 building type measures .732.

Program	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.
	Wall or Ceiling-mounted occupancy sensor	2010 draft Ohio TRM method with adjusted controlled wattage on Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM.	Assumed controlled wattage is 658 watts.	2010 draft Ohio TRM method with adjusted controlled wattage on Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM.	Assumed controlled wattage is 658 watts.
Non-Residential 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.
Non-Residential Prescriptive: Motors & Drives	Barrel wraps	Deemed savings based on a custom engineering study.	Controlled tons multiplied by .0075 and HOU.	Deemed savings based on a Custom Rebate engineering study.	Controlled tons multiplied by .0075.
	CEE premium efficiency motor 20HP	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.
	CEE premium efficiency motor 30HP	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.
	Premium Efficiency Motor 125HP	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.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	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.
Non-Residential Prescriptive: Midstream Lighting	CFL Pin	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Deemed lamp wattage and wattage multiplier are used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Deemed lamp wattage and wattage multiplier are used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.
	CFL Screw-in 20 watts or less	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Deemed lamp wattage and wattage multiplier are used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Deemed lamp wattage and wattage multiplier are used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
	CFL Screw-in 21-32 watts	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Deemed lamp wattage and wattage multiplier are used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Deemed lamp wattage and wattage multiplier are used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.
	CFL Screw-in greater than 32 watts	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Deemed lamp wattage and wattage multiplier are used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Deemed lamp wattage and wattage multiplier are used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.
	LED Screw-in	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Actual lamp wattage is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Actual lamp wattage is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.
	LED Exit	Calculations are based on the Ohio 2010 TRM. HOU and CF are measure specific and are derived from previous evaluation data.	Actual lamp wattage is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 184. ISR is assumed to be 98% (Ohio TRM, Page 184).	Calculations are based on the Ohio 2010 TRM. HOU and CF are measure specific and are derived from previous evaluation data.	Actual lamp wattage is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 184. ISR is assumed to be 98% (Ohio TRM, Page 184).
	Re-lamp 25 watt	Calculations are based on the Ohio 2010 TRM. HOU and CF are measure specific and are derived from previous evaluation	A deemed wattage savings is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	Calculations are based on the Ohio 2010 TRM. HOU and CF are measure specific and are derived from previous evaluation	A deemed wattage savings is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
		data.		data.	
	Re-lamp 28 watt	Calculations are based on the Ohio 2010 TRM. HOU and CF are measure specific and are derived from previous evaluation data.	A deemed wattage savings is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	Calculations are based on the Ohio 2010 TRM. HOU and CF are measure specific and are derived from previous evaluation data.	A deemed wattage savings is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.
	LED T8	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Actual lamp wattage is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Actual lamp wattage is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.
	Eatons Cooper LED Fixtures	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Actual lamp wattage is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Actual lamp wattage is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.
	Eatons Cooper LED Fixtures with Integrated Sensors	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Actual lamp wattage is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	Calculations are based on the Ohio 2010 TRM and include the impact of the Energy Independence and Security Act. HOU and CF are measure specific and are derived from previous evaluation data.	Actual lamp wattage is used. HOU is measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.
	Wall Pack	Calculations are based on the Ohio 2010 TRM and baseline estimates from	Actual lamp wattage is used, and baseline values are from the Minnesota TRM. HOU is	Calculations are based on the Ohio 2010 TRM and baseline estimates	Actual lamp wattage is used, and baseline values are from the Minnesota TRM. HOU is measure

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
		the Minnesota TRM. HOU and CF are measure specific and are derived from previous evaluation data.	measure specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.	from the Minnesota TRM. HOU and CF are measure specific and are derived from previous evaluation data.	specific. WHF is from 2010 draft Ohio TRM, page 171. ISR is assumed to be 100%.
	Midstream VFDs	Calculations are based on the Ohio 2010 TRM.	Inputs were provided by the implementation team.	Calculations are based on the Ohio 2010 TRM.	Inputs were provided by the implementation team.
	Lighting Adjustment	These are savings adjustments from the 2014 Program Year. The implementer realized that an error had been made in their savings calculation and is claiming those savings in this year.	All adjustments made were for Screw-Base CFL and Screw-Base LED measures. Please see those measures for savings documentation.	These are savings adjustments from the 2014 Program Year. The implementer realized that an error had been made in their savings calculation and is claiming those savings in this year.	All adjustments made were for Screw-Base CFL and Screw-Base LED measures. Please see those measures for savings documentation.
Non-Residential 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.
	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	Custom engineering calculation	Depending on project size and scope, a full impact analysis report is completed. Specific to each

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
			each project, the impact analysis may include pre- and post- metering, billing analysis, and custom engineering calculations.		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.
Small Business	LED, CFL, LED exit signs, Vending miser direct install measures	see Non-Residential prescriptive measure documentation	see Non-Residential prescriptive measure documentation	see Non-Residential prescriptive measure documentation	see Non-Residential prescriptive measure documentation
	2- 8 lamp T8 replacements	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 144W and new efficiency 112W. HOU is application specific.	2010 draft Ohio TRM, pages 169 - 172.	Baseline efficiency 144W and new efficiency 112W. Coincidence factor is the average of the first 13 building type measures .732.
	9 - 15 watt LED	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.
	45 - 131 watt LED Area/Parking Head	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.
	21 - 158 watt LED Flood	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.
	Motion sensors	2010 draft Ohio TRM method with adjusted controlled wattage on	Assumed controlled wattage is 658 watts.	2010 draft Ohio TRM method with adjusted controlled wattage on	Assumed controlled wattage is 658 watts.

Program	Measure	Ex Ante kWh Savings Documentation	Ex Ante kWh Savings Documentation Detail	Ex Ante kW Savings Documentation	Ex Ante kW Savings Documentation Detail
		Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM.		Cadmus engineering assumptions. Pages 149 - 152 2010 draft Ohio TRM.	

Appendix K. Low-Income (OPAE) Billing Analysis

Detailed Methodology

Comparison Group

As an important aspect of a billing analysis' quasi-experimental design, a billing analysis should use a comparison group of "nonparticipants" to account for exogenous factors that may have occurred simultaneous to program activity. These factors can include macroeconomic effects, increases or decreases in energy rates, or other interactions that could have affected energy consumption outside of the program's influence. For this program, comparison groups could be identified using samples of future program participants who participated after the analysis period.

Using future participants as a comparison group for similar analyses offers several advantages compared to selecting randomly from the customer population:

First, future participants prove more representative of the participant treatment group than a random sample of residential customers (as being more likely to closely resemble participants from previous years in terms of energy awareness and pre-program building characteristics).

Second, as this population received program measures, Cadmus could control and isolate comparison group's installation period to ensure program impacts did not influence the analysis period.

As the comparison group's pre-period usage might not be identical to participant pre-usage, a "percent of pre" approach provides the adjusted gross participant savings. The following formula depicts this specific calculation for adjusted gross participant savings:

$$Adj.Gross\ Savings = (Pre\ Part\ Usage)\left(\frac{Part\ Change\ In\ Usage}{Pre\ Part\ Usage} - \frac{NonPart\ Change\ In\ Usage}{Pre\ NonPart\ Usage}\right)$$

Through this process, rather than taking the difference between the participant savings delta and the nonparticipant savings delta (i.e., a difference-of-differences approach), the percentage reduction of participant and nonparticipant groups could be obtained. The percentage reduction, representative of adjusted gross savings, provides the participant percentage-change reduction minus the nonparticipant percentage reduction. This adjusted gross percentage reduction can then be multiplied by participant pre-period usage to obtain the adjusted gross participant savings, thus effectively accounting for differences in pre-period usage between participants and nonparticipants.

Cadmus defined the "future" nonparticipant group as participants installing measures from May 2015 through December 2015. Though this group of customers did not have sufficient post-period billing data, it produced sufficient pre-participation billing data.

The study used the following definitions:

- Participant pre-installation period as one year before the first measure installation
- The post-installation period as one year after the last measure installation
- The nonparticipant pre-period as the period from May 2013–April 2014
- The post-period as May 2014–April 2015

Cadmus primarily relied on the PRInceton Scorekeeping Method (PRISM) to develop savings estimates. A Conditional Savings Analysis (CSA) fixed-effects modeling approach also was used to corroborate PRISM findings only at the overall program level. Cadmus selected the PRISM modeling approach as these models are easier to summarize across various groups, and they yield nearly identical precisions to the more complex CSA method.

PRISM Modeling Approach

Cadmus estimated PRISM models for pre- and post-installation billing data. These models provided weather-normalized, pre- and post-installation, annual usage for each account and an alternate check to savings obtained from the fixed-effects model.

For each participant and nonparticipant home, Cadmus estimated a heating and cooling PRISM model in both the pre- and post-installation periods to weather-normalize raw billing data. Each model allowed the heating reference temperature to range from 45°F to 85°F and the cooling reference temperature to range from the heating reference temperature to 85°F.

The PRISM electric model used the following specification:

$$ADC_{it} = \alpha_i + \beta_1 AVGHDD_{it} + \beta_2 AVGCDD_{it} + \varepsilon_{it}$$

Where for each customer i and month t:

ADC_{it}	=	Average daily kWh consumption in the pre-/post-installation period
α_i	=	Participant intercept; represents the average daily kWh base load
β_1	=	Model space heating parameter value
β_2	=	Model cooling parameter value
$AVGHDD_{it}$	=	Base 45-85 average daily HDDs for the specific location
$AVGCDD_{it}$	=	Base 45-85 average daily CDDs for the specific location
ε_{it}	=	Error term

Using this model, Cadmus computed weather-normalized annual consumption (NAC) for each heating and cooling reference temperature, as follows:

$$NAC_i = \alpha_i * 365 + \beta_1 LRHDD_i + \beta_2 LRCDD_i + \varepsilon_i$$

Where for each customer 'i':

NAC_i	=	Normalized annual kWh consumption
α_i	=	Intercept is the average daily or base load for each participant; it represents the average daily base load from the model
$\alpha_i * 365$	=	Annual base load kWh usage (non-weather sensitive)
β_1	=	Heating parameter value; in effect, this is usage per heating degree day from the model above
$LRHDD_i$	=	Annual, long-run HDDs of a typical meteorological year (TMY3) in the 1991–2005 series from NOAA, based on the home location
$\beta_1 * LRHDD_i$	=	Weather-normalized annual weather sensitive heating usage, also known as HEATNAC
β_2	=	Cooling parameter value; in effect, this is usage per CDD from the model above
$LRCDD_i$	=	Annual, long-run CDDs of a typical meteorological year (TMY3) in the 1991–2005 series from NOAA, based on home location
$\beta_2 * LRCDD_i$	=	Weather-normalized annual weather sensitive cooling usage, also known as COOLNAC
ε_i	=	Error term

Furthermore, if the heating and cooling models above yielded negative intercepts, negative heating parameters, or negative cooling parameters, Cadmus estimated additional models that only included the cooling usage (i.e., cooling only models) or the heating usage (i.e., heating only models). From these models with correct signs on all parameters, the best model chosen for each participant for the pre- and post-installation periods was the one with the highest R-square.

Upon obtaining pre- and post-installation usage for each customer, Cadmus applied other PRISM-based screening steps:

- Accounts where post-installation weather-normalized (POSTNAC) usage was 70% higher or lower than pre-installation weather-normalized (PRENAC) usage. Such large changes could indicate property vacancies or addition/removal of other electric equipment unrelated to the program.
- Accounts with missing PRENAC or POSTNAC estimates (due to negative heating/cooling slopes or negative intercepts) as they likely indicated problems with billing data.
- Accounts receiving additional measures through other programs in the analysis period, based on tracking data (e.g., participation in Ohio's HWAP).
- Electric accounts with PRENAC or POSTNAC less than 1200 kWh.

Finally, Cadmus performed a billing data screen that examined monthly billing data for one customer at a time and plotted average monthly usage. To avoid confounding the billing analysis, Cadmus removed accounts with outliers, vacancies, seasonal usage, and equipment changes in the pre- or post-installation periods.

Table 240 summarizes the participant (Jan 2012–April 2015) account attrition from the various screens. The tracking data indicated 2,062 participant accounts receiving measures. Approximately 68% of the attrition resulted from insufficient months of billing data as well as the inability to match billing data and participant account numbers.[42] The process removed: another 6% from PRISM screening, large percent changes, and individual billing review problems; and 4% due to participation in other programs.[43]

Table 240. Participant Account Attrition

Screen	Participants Remaining	Percent Remaining	Number Dropped	Percent Dropped
Original Accounts	**2,062**	**100%**	**0**	**0%**
Matched to Billing Data Provided*	1,426	69%	636	31%
Less than 10 months of pre or post period billing data	662	32%	764	37%
Usage/Percent Change Screens + PRISM Screening	650	32%	12	1%
Individual Customer Bill Review: Outliers, vacancies, seasonal usage, and equipment changes	555	27%	95	5%
Participated In Other Programs	471	23%	84	4%
Final Analysis Group	**471**	**23%**	**1,591**	**77%**

*Of the accounts that did not match up, 89% were 2012 participants. As the first July 2014 extract only went back to July 2012, the billing analysis did not include 2012 participants due to insufficient pre-period billing data (see footnote 42).

Table 241 summarizes nonparticipant (May 2015–Dec 2015) account attrition from the various screens. Of 404 nonparticipant accounts, approximately 58% of attrition resulted from an inability to match billing data and insufficient months of billing data. Another 5% required removal due to participation in other programs, less than 1% from PRISM Screening, large percent changes, and individual billing review problems.

[42] The high attrition rate primarily resulted from insufficient pre-period billing data. As the July 2014 extract only went back to July 2012, this left all participants from 2012 to mid-2013 without pre-period data. The primary participant group included in the billing analysis ranged from mid-2013 through early-2015.

[43] Program tracking data included flags for other program participation, including: HWAP, Electric Partnership Program, Warm Choice, and other miscellaneous programs.

Table 241. Nonparticipant Account Attrition

Screen	Participants Remaining	Percent Remaining	Number Dropped	Percent Dropped
Original Accounts	**404**	**100%**	**0**	**0%**
Matched to Billing Data Provided	383	95%	21	5%
Less than 10 months of pre or post period billing data*	168	42%	215	53%
Usage/Percent Change Screens + PRISM Screening	166	41%	2	less than 1%
Individual Customer Bill Review: Outliers, vacancies, seasonal usage, and equipment changes	165	41%	1	less than 1%
Participated In Other Programs	143	35%	22	5%
Final Analysis Group	**143**	**35%**	**261**	**65%**

*Availability of billing data from 1/2014–1/2016 resulted in this high attrition: Cadmus required billing data back to May 2013. This left only a few nonparticipants passing these criteria.

Following these screens, the model analysis group included 471 participants (23%) and 143 nonparticipants (35%). From the above PRISM models, the average Difference in Normalized Annual Consumption (DNAC = PRENAC – POSTNAC) yielded the average program savings. The PRISM method also provide the weather-normalized, pre-installation period usage (PRENAC) used to determine the percent savings.

Detailed Results

This appendix includes billing analysis results at various detailed levels (e.g., at the quartile level and for other subgroup savings results). All savings summaries presented here represent net savings after accounting for the nonparticipant change in usage.

Cadmus also separated PRENAC usage into four usage quartiles. The program achieved a percent of savings between 16% and 19% for the various quartile levels. As expected, the greater the usage, the higher the savings (i.e., ranging from 878 kWh in Q1 to 4,173 kWh in Q4). Larger homes in Q3 and Q4 achieved targeted savings or achieved higher savings than expected (i.e., realization rates of 99%, 121%). This would be expected as *ex ante* estimates sometimes take on only one value, regardless of pre-period usage level. An improvement on the savings estimate calculation might account for pre-period usage or square footage of a home. Conversely, smaller homes in Q1, Q2 overstated *ex ante* estimates with realization rates of 44%, 63%.

Table 242. OPAE Net Quartile Level Energy Savings from Billing Analysis

Group	n	Model Savings	*Ex Ante* Savings	Realization Rate	Relative Precision 90% Confidence Level	Pre Period NAC	Percent Savings	*Ex Ante* Percent Savings
Overall	**471**	**2,157**	**2,461**	**88%**	**19%**	**12,700**	**17.0%**	**19.4%**
Q1: <6,491 kWh	**117**	878	1,992	44%	45%	4,638	18.9%	42.9%
Q2: 6,491-10,761 kWh	**118**	1,376	2,181	63%	31%	8,354	16.5%	26.1%
Q3: 10,762 – 17,013 kWh	**118**	2,190	2,210	99%	22%	13,150	16.7%	16.8%
Q4: >17,013 kWh	**118**	4,173	3,458	121%	14%	24,590	17.0%	14.1%

Table 243 summarizes savings for various other categories, used as an indication of accurate *ex ante* estimates or those underperforming or over performing. Some results with small sample sizes are not statistically significant. Though this report presents these results for informative purposes, they should not necessarily be used to make program decisions.

The following is a summary of interesting findings found in Table 243:

- Factors that produced savings as expected included baseload jobs. Heating customer and water-heating jobs underperformed—a finding consistent with measure category results indicating insulation, air sealing, and water-heating savings may be overstated.
- The summary by agency suggests Community Action Partnership of Greater Dayton (the primary agency) achieved its expected savings. The Highland County Community Action Organization and Tri-County CAC: Champaign, Logan, Shelby slightly underperformed, though these clearly installed higher-usage homes, and the discrepancy may be related to the measure mix.
- The income level summary suggests the lower-income group (0%–100%) of poverty achieved more of their savings than participants with higher incomes. The income source summary suggests that customers unemployed or on public assistance realized fewer of their savings than expected.
- Homeowners achieved more savings (92%) than renters (70%).
- In terms of home types, multifamily homes achieved a lower 62% realization rate, while—on average—single-family homes achieved all of their *ex ante* savings. As pre-period usage for multifamily homes was only 8,243 kWh, using lower savings estimates for multifamily homes (or for lower-usage homes) could help fine-tune the savings estimates.
- In terms of county distributions, Montgomery County (the primary county) achieved its expected savings with a 97% realization rate, while Greene, Highland, Logan, and Preble counties achieved lower realization rates in the 64%–75% range.
- Distributions by heating types indicated customers with electric heat underperformed (e.g., electric furnaces [73%] and electric baseboards [46%]). Again, these could be the same customers receiving insulation or air-sealing measures, and the lower realization rates could

result from high *ex ante* estimates for these measures. Customers using gas, oil, and other heating sources achieved their savings, with realization rates running from 93%–212%.

- Finally, the water heat fuel summaries indicated customers with electric water heating achieved a lower realization rate of 77%, compared to natural gas (93%), fuel oil (116%), and propane customers.

Table 243. OPAE Net Quartile Level Energy Savings from Billing Analysis

Variable	Category	n	Model Savings	*Ex Ante* Savings	Realization Rate	Relative Precision 90% Confidence Level	Pre Period NAC	Percent Savings	*Ex Ante* Percent Savings
Overall	**Overall**	**471**	**2,157**	**2,461**	**88%**	**19%**	**12,700**	**17.0%**	**19.4%**
Job Type	Baseload Job	405	2,019	2124	95%	21%	11170	18.1%	19.0%
Job Type	Heating Customer/Water Heating	54	3,322	5085	65%	21%	22789	14.6%	22.3%
Job Type	Heating Job	1	4,988	1712	291%	8%	26642	18.7%	6.4%
Job Type	Water Heating Job	11	1,245	2082	60%	81%	18230	6.8%	11.4%
Agency	Clinton County Community Action Program	2	1511	6602	23%	90%	5762	26.2%	114.6%
Agency	Community Action Commission of Fayette County	6	897	3044	29%	97%	16753	5.4%	18.2%
Agency	Community Action Partnership of Greater Dayton	425	2232	2462	91%	19%	12310	18.1%	20.0%
Agency	Highland County Community Action Organization	24	1596	2204	72%	43%	18479	8.6%	11.9%
Agency	Tri-County CAC: Champaign, Logan, Shelby	14	1466	2025	72%	39%	13889	10.6%	14.6%
Income Level	0-100% of Federal Poverty Level	226	2388	2480	96%	19%	13535	17.6%	18.3%
Income Level	101-150% of Federal Poverty Level	153	1949	2438	80%	24%	11644	16.7%	20.9%
Income Level	151-200% of Federal Poverty Level	91	1893	2460	77%	27%	12427	15.2%	19.8%
Income Level	201 -300% of Federal Poverty Level	1	5733	1957	293%	7%	10375	55.3%	18.9%
Income	Disability	82	2501	2631	95%	22%	14601	17.1%	18.0%

Variable	Category	n	Model Savings	*Ex Ante* Savings	Realization Rate	Relative Precision 90% Confidence Level	Pre Period NAC	Percent Savings	*Ex Ante* Percent Savings
Source									
Income Source	Employment	169	2202	2364	93%	22%	14153	15.6%	16.7%
Income Source	Other - must provide notes	131	1980	2433	81%	24%	10639	18.6%	22.9%
Income Source	Pension/Retirement	59	1877	2123	88%	30%	8714	21.5%	24.4%
Income Source	Public Assistance	13	1571	2674	59%	55%	15703	10.0%	17.0%
Income Source	Unemployment	17	2829	3836	74%	37%	16511	17.1%	23.2%
Own/Rent	Own	359	2375	2577	92%	18%	13048	18.2%	19.7%
Own/Rent	Rent	112	1458	2092	70%	30%	11585	12.6%	18.1%
House Type	Multi-Fam. i.e. condo or apt. up to 4 units	50	1321	2119	62%	37%	8243	16.0%	25.7%
House Type	Other	50	2245	2083	108%	28%	10650	21.1%	19.6%
House Type	Single Fam. 1-1/2, 2 or more story	231	2208	2569	86%	20%	14143	15.6%	18.2%
House Type	Single Fam. Bi-level or Split-level	4	6460	5872	110%	38%	22010	29.3%	26.7%
House Type	Single Fam. Duplex(Semi-Det.)2-unit side-by-side	6	913	2033	45%	74%	7766	11.8%	26.2%
House Type	Single Fam. Mobile Home	22	2510	2298	109%	35%	13906	18.0%	16.5%
House Type	Single Fam. Ranch, single level	108	2232	2495	89%	23%	12310	18.1%	20.3%

Variable	Category	n	Model Savings	*Ex Ante* Savings	Realization Rate	Relative Precision 90% Confidence Level	Pre Period NAC	Percent Savings	*Ex Ante* Percent Savings
County	ADAMS	2	818	2665	31%	62%	10200	8.0%	26.1%
County	AUGLAIZE	4	273	2295	12%	354%	10107	2.7%	22.7%
County	BUTLER	1	3169	746	425%	12%	16580	19.1%	4.5%
County	CLARK	1	597	3842	16%	64%	3369	17.7%	114.1%
County	CLINTON	1	2425	9362	26%	16%	8155	29.7%	114.8%
County	DARKE	47	1671	2283	73%	32%	9719	17.2%	23.5%
County	FAYETTE	6	897	3044	29%	97%	16753	5.4%	18.2%
County	GREENE	28	2054	2759	74%	33%	12789	16.1%	21.6%
County	HIGHLAND	24	1596	2204	72%	43%	18479	8.6%	11.9%
County	LOGAN	13	1513	2021	75%	39%	13802	11.0%	14.6%
County	MERCER	1	5004	966	518%	8%	15965	31.3%	6.1%
County	MONTGOMERY	328	2364	2449	97%	18%	12468	19.0%	19.6%
County	PREBLE	14	1945	3037	64%	51%	16904	11.5%	18.0%
County	WARREN	1	-128	1904	-7%	-296%	12415	-1.0%	15.3%
Heating Type	Electric Baseboard	26	1769	3868	46%	41%	18884	9.4%	20.5%
Heating Type	Electric Boiler	1	4825	1506	320%	8%	27916	17.3%	5.4%
Heating Type	Electric Furnace	53	3073	4184	73%	21%	21534	14.3%	19.4%
Heating Type	Electric Heat Pump	8	5269	4641	114%	47%	18888	27.9%	24.6%
Heating Type	Electric Radiant	1	45	3177	1%	843%	13204	0.3%	24.1%
Heating Type	Electric Wall Blowers	2	836	3553	24%	208%	11944	7.0%	29.7%
Heating	Gas Boiler	7	2134	1988	107%	56%	14981	14.2%	13.3%

Variable	Category	n	Model Savings	*Ex Ante* Savings	Realization Rate	Relative Precision 90% Confidence Level	Pre Period NAC	Percent Savings	*Ex Ante* Percent Savings
Type									
Heating Type	Gas Furnace	357	1923	2074	93%	22%	10377	18.5%	20.0%
Heating Type	Oil Boiler	3	4853	2286	212%	65%	23600	20.6%	9.7%
Heating Type	Oil Furnace	9	3265	2062	158%	29%	20415	16.0%	10.1%
Heating Type	Other - must provide notes	4	3221	2054	157%	89%	17349	18.6%	11.8%
Water Heat Type	Bottle gas/propane	4	5028	2685	187%	62%	26565	18.9%	10.1%
Water Heat Type	Electric	125	2725	3552	77%	20%	19066	14.3%	18.6%
Water Heat Type	Fuel Oil	3	2092	1803	116%	60%	24114	8.7%	7.5%
Water Heat Type	Other - must provide notes	1	883	2254	39%	43%	4245	20.8%	53.1%
Water Heat Type	Utility gas	338	1917	2062	93%	22%	10106	19.0%	20.4%

Commercial Midstream Incentive Project Cogged V-belt Pilot Program Evaluation

2015 Evaluation Report

Prepared for: AEP Ohio and Dayton Power and Light

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Submitted by:
Navigant Consulting, Inc.
30 S Wacker Drive
Suite 3100
Chicago, IL 60606

312.583.5700
navigant.com

Submitted to:

AEP Ohio
850 Tech Center Drive
Gahanna, Ohio 43230

Dayton Power & Light
1900 Dryden Road
Moraine, OH 45439

Presented by:

Randy Gunn
Managing Director
Navigant Consulting, Inc.
30 S Wacker Drive, Suite 3100
Chicago, IL 60606

Contact:

Randy Gunn, Managing Director
312.583.5714
randy.gunn@navigant.com

Stu Slote, Associate Director
802.526.5113
stu.slote@navigant.com

Prepared by:

Keith Levenson, Managing Consultant
802.526.5109
keith.levenson@navigant.com

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EXECUTIVE SUMMARY

Introduction

The Commercial Midstream Incentive Program (CMIP) Cogged V-Belt Pilot was a collaboration between Argonne National Laboratory (Argonne), the Midwest Energy Efficiency Alliance (MEEA), AEP Ohio, Dayton Power & Light (DP&L), Go Sustainable Energy (Go Sustainable), and the Ohio Manufacturer's Association (OMA) in order to pilot an upstream incentive concept in Ohio aimed at business-to-business distributors and suppliers. The cogged V-belt CMIP was modeled after a similar pilot in the Pacific Northwest promoting the sales of low wattage T-8 fluorescent lighting..

The V-Belt CMIP launched in May 2015 with three locations of one distributor enrolled. Another distributor launched in June of 2015 with one location. Per-unit incentives were offered only to cogged V-belts sold above a predetermined monthly sales baseline. One distributor passed along most of the incentives to the customer (in the form of reduced purchase prices) and the other kept the incentives in-house as bonuses to motivate sales staff. Training stipends were offered on a per attendee basis, and each distributor was given a monthly data collection stipend to defray the cost of record-keeping and point-of-sale survey data entry.

Summary of Results

Sales Impact

The increase in cogged V-belt sales over baseline is summarized in the Table ES-1 for each participating distributor and for the Pilot Program as a whole.

Table ES-1. Sales Impact – Participating Distributors

Sales Impact – Participating Locations	Distributor #1	Distributor #2	Program Totals
Program Test locations	3	1	4
Total tracking data cogged V-belt sales	5405	1273	6678
Total reported cogged V-belt sales	5332	908	6240
Total baseline cogged V-belt sales	5114	390	5504
Cogged V-belt sales above baseline	218	518	736
Percentage increase in sales	4.3%	132.8%	13.4%

Increases in cogged V-belt sales over baseline were also observed in the non-participating branches for each distributor as summarized in the Table ES-2. This data would indicate cogged V-belts are gaining market share with or without the influence of the Pilot Program, however without a detailed field study, it is difficult to draw any conclusions as to the influence of the Pilot Program on cogged V-belt sales.

Table ES-2. Sales Impact – Control Locations

Sales Impact – Control Locations	Distributor #1	Distributor #2	Program Totals
Number of Control locations	3	3	6
Control locations baseline cogged V-belt sales	1,945	1,976	3,921
Control locations reported cogged V-belt sales	2,885	2,125	5,010
Control location sales above baseline	940	149	1,089
Percentage increase in sales - control locations	48.3%	7.5%	27.8%

Energy Savings Impact and Attribution

Navigant applied the deemed savings algorithm developed by Go Sustainable and the average HVAC hours of use by building type from the Illinois TRM to calculate the *ex ante* energy and demand savings. The limited scope of this evaluation made verification of the *ex post* energy savings, and hence the determination of the cost-effectiveness of the Pilot, unfeasible.

Nearly all of the cogged V-belt purchasers who filled out the data collection forms reported the cogged V-belts would be used in HVAC applications. This would support the use of a deemed savings algorithm which is based on HVAC hours of use and loadshape. (See Deemed Savings Algorithm Review in Appendix B) This assumption was incorporated into the savings algorithm developed by Go Sustainable and used for the *ex ante* savings analysis of the Cogged V-belt Pilot Program.

As with the verification of program *ex post* savings, the attribution of savings to the respective utility territories will require a statistically designed field study which is beyond the scope of this evaluation. For purposes of the Pilot Program savings attribution, Navigant recommends the *ex ante* savings from the one participating distributor branch in the DP&L service territory be attributed to DP&L, and the remainder of the pilot program savings be attributed to AEP Ohio with a reasonable deduction for “leakage” into neighboring utility service areas. The *ex ante* energy and demand savings and attribution are presented in Table ES-3 without the Table ES-3 adjustment for leakage. These impacts are discussed in greater detail in Section 2.2.3.

Table ES-3. Energy Savings Attribution

CMIP Pilot Energy Savings Attribution	Program Total	DP&L	AEP Ohio
Ex Ante Energy Savings (kWh)	4,253,883	2,052,583	2,201,300
Ex Ante Demand Savings (kW)	1034.55	499.89	534.66
Percentage of savings over baseline	13.4%	14.8%	11.9%
Net *Ex Ante* Energy Savings (kWh)	568,833	274,473	294,360
Net *Ex Ante* Demand Savings (kW)	138.34	66.85	71.50
Peak Coincidence Factor (Ohio TRM)	0.74	0.74	0.74
Net *Ex Ante* Peak Demand Savings (kW)	102.37	49.47	52.91

Market Transformation

It is clear from a comparison of the sales data from participating and non-participating (control) branches that cogged V-belts are gaining in market share with or without the influence of the Pilot Program, however the Program has demonstrated that the combination of training and incentives at the mid-stream level can accelerate the growth in market share, and may eventually achieve full market transformation. Participating Distributors have reported changing their stocking practices to accommodate the increased demand for cogged V-belts. There was a consensus among those interviewed that cogged V-belts will eventually garner a majority of the V-belt market, and that the CMIP model can help accelerate that Market Transformation.

Process and Participant Satisfaction

Navigant investigated the Pilot Program process through in-depth interviews with participating distributors and Program Managers to elicit their satisfaction with the Program and their ideas on process improvements.

- Both participating distributors were enthusiastic about the program and would likely participate in a relaunch of the program.
- Both had qualms about the data collection aspect of the Pilot, and suggested reducing or eliminating this requirement.
- Both participating distributors reported that the Pilot Program was effective in boosting sales, and that the program was a net positive for their businesses from both a financial and customer relations standpoint.
- Both distributors were satisfied with the per-unit incentives, and the data collection stipend. They both appreciated the training stipend as well, although one of the distributors used that for in-house staff only, and the other used it to train contractors and large customers as well as their sales staff.

Although the scope of this evaluation did not allow for a follow-up survey of end-users, the anecdotal evidence suggests purchasers of cogged V-belts were receptive to the information they were given regarding the durability and potential energy savings of the cogged V-belts compared to standard V-belts. It was apparent to both distributors that the durability factor was the primary motivator for purchasing cogged V-belts rather than the energy benefits, although durability can also be a disincentive to purchasers who are maintenance contractors that have a regular belt replacement schedule. A majority of respondents to the point-of-sale survey were purchasing V-belts for regular maintenance contracts.

The biggest barrier to participation in the Pilot from the perspective of the distributors was the customer data collection requirements. It was reported that many purchasers refused to fill out the survey or were not even asked by the salesperson in the interest of time. The overall survey response rate was around eight percent.

Recommendations

The preponderance of evidence suggests that the midstream incentive mechanism would be an effective tool for a full scale energy efficiency incentive program. Thus, the primary recommendation from this early EM&V assessment is to continue offering midstream incentives at the distributor level.

The design of the program is generally sound, however Navigant recommends the following changes to ensure the cost-effectiveness of a full-scale program:

1. **Reduce or eliminate the point-of-sale Data Collection requirements** and reallocate that stipend toward a rigorous field verification study for impact and attribution. If Data Collection is still necessary, require it be done via a verbal survey with responses recorded digitally rather than on paper. (See also recommendation #4)
2. **Require participating distributors to apply a portion of the program incentives to reduce the price of cogged V-belts.**
3. **Recruit V-belt manufacturers to collaborate on training and outreach efforts** as their expertise and business interests coincide with the program goals.
4. **Expand the training eligibility to include large customers as well as HVAC contractors and front end staff, and tailor specific presentations to those audiences.**
5. **Standardize tracking data systems between participating utilities.** This is a logistical problem that should be addressed before re-launch if the program is to go beyond the pilot stage or include other Ohio utilities.
6. **Ensure that end user contact information is captured for as many facilities as possible that receive cogged V-belts through participating distributors.** This information is critical to the EM&V effort that will need to include a large number of end users to meet requirements for confidence and precision.
7. **Increase the program budget or reallocate funds to allow for a rigorous M&V study in the initial year after program launch.** This field verification should begin as soon after the launch as possible and include a market saturation study to determine how many of the existing belt drive systems are already using cogged V-belts.
8. **Require participating distributors to use a month-by-month baseline for calculating incentives.**
9. **Include all sales at each participating location in the *ex ante* savings claim, but reduce that total savings by a saturation factor to be determined by a field study.**
10. In parallel with the program, and using program EM&V results, **pursue the development of a measure characterization and deemed savings algorithm for inclusion in the Ohio TRM**.

1. EVALUATION APPROACH

1.1 Introduction

AEP Ohio and Dayton Power and Light (DP&L) contracted Navigant Consulting, Inc. ("Navigant") in February 2014 to conduct an assessment of the Commercial Midstream Incentive Project (CMIP) Cogged V-Belt Pilot Program, a collaboration between Argonne National Laboratory (Argonne), the Midwest Energy Efficiency Alliance (MEEA), AEP Ohio, Dayton Power & Light (DP&L), Go Sustainable Energy, and the Ohio Manufacturer's Association (OMA). The CMIP Cogged V-belt Pilot Program is referred to as the "Pilot Program" throughout this report.

According to the Implementation Proposal, the intent of the Pilot Program is to "encourage not just [cogged V-belt] sales, but to drive sales above historical sales levels." To achieve this, the Pilot Program provides per-unit incentives to distributor-level suppliers for sales of cogged V-belts *above baseline levels*. The intention of the Program Partners was that the incentives would be used to motivate the internal staff to boost sales. Also, the incentives would not be passed along to the customers, however, it was decided to not require this as part of the Participation Agreement. One of the two participating distributors passed most of the incentive along to the commercial customer in the form of reduced purchase price, while the other distributor used all of the per-unit incentive for sales bonuses and other internal costs.

The Pilot Program offered training stipends for each person trained on the characteristics and benefits of cogged V-belts, and helped organize and present the training for the participating distributors. As part of the Pilot Program, participating distributors were required to ask each of the cogged V-belt purchasers to fill out a short survey to help to characterize the locations and applications where the cogged V-belts were being installed. The Pilot Program contributed a monthly data collection stipend to defray the costs of collecting that survey data at the point of sale.

1.2 Research Objectives and Overview of Approach

The main objectives of this evaluation include the following:

- Study the feasibility of the Pilot Program's design;
- Determine the effectiveness of midstream incentives and training stipends;
- Consolidate feedback from participating distributors and Program Managers;
- Characterize, and where possible, quantify the impacts of the Program;
- Gauge participating distributor satisfaction

In addition to the research objectives listed above, the evaluation set out to inform the following key research questions:

- How can the Program improve its deemed savings algorithms to more accurately calculate program energy and demand savings?
- What are end-user motivations for switching to cogged V-belts and what is the importance of the Pilot in their decision?

- How likely are additional (i.e., non-participating) distributors and contractors to participate in a midstream incentive program, if the Pilot Program is expanded?
- How does the Pilot Program change the trajectory toward Market Transformation?
- How can the results of this Pilot Program contribute to the development of a TRM Measure Characterization for cogged V-belts?
- Is this Program design and delivery mechanism appropriate for scaling up?

To answer these research questions, Navigant

- Reviewed the program proposal and other documentation,
- Performed a literature review on cogged V-belts,*
- Performed a review of deemed savings algorithms for cogged V-belts,*
- Analyzed Pilot Program tracking data, including sales data and historic sales data,
- Conducted in-depth interviews with participating distributors and Program management

*Results presented separately

Informed by these research results, Navigant developed recommendations to assist the program team in its decision whether to continue, and if so, what improvements could be made to support the full-scale program design, implementation and evaluation.

1.3 Research Approach

This section describes the approaches for each of the key research tasks.

1.3.1 Review of Program Documentation

Navigant reviewed all available Pilot Program documentation, including the CMIP Program Implementation Proposal, customized Distributor Launch webinars, and the Cogged V-belt technical training presentation. Findings from this review are incorporated into the findings in Section 2.

1.3.2 Literature Review

Navigant performed a comprehensive review of cogged V-belt articles and studies relating to cogged or notched V-belts turned up industry sponsored and third party research and supporting documentation from a variety of sources that was submitted previously.

1.3.3 Tracking Data Analysis and Program Comparisons

Navigant analyzed sales data and point-of-sale survey responses from the Cogged V-belt CMIP Pilot. The analyzed data included sales records supplied by each of the participating distributors. The data covered May through November 2015 for Distributor #1, and June through July 2015 for Distributor #2.

As discussed earlier, the CMIP Pilot evaluation did not include any *ex post* savings verification since this would involve a large field and phone survey which is beyond the scope of this study. Navigant did review the sales data, and applied our recommended savings algorithm to all the sales data from participating distributor locations to develop an audited *ex ante* savings estimate.

To accomplish this, Navigant used the power savings tables from the Go Sustainable paper[1], analyzed the monthly sales data for each participating Distributor location, applied the savings algorithm (as described in Appendix B) and then subtracted the appropriate baseline sales on a monthly basis.

Another goal of this research task was to attribute the estimated savings to the two participating utilities based on installation location. Again, an accurate estimate of the savings attribution would require a large field or phone survey which is beyond the scope of this evaluation, however, Navigant reviewed the reported attribution formula and offers recommendations based on that review.

1.3.4 In-Depth Interviews with Participating Distributors and Program Staff

This section describes the objectives and results of in-depth interviews conducted with participating distributors and the CMIP Program managers.

1.3.4.1 In-depth Interview with Participating Distributors

Navigant conducted interviews with each of the participating distributors to solicit their feedback on the program processes and qualitative impacts on their business.

For the participating distributor interviews, Navigant developed an in-depth interview guide (included in Appendix A) with the goal of covering the following topics:

- **Distributor and Customer Characteristics** – What range of products do the participating distributors currently sell, and what type of customers do they serve? What kinds of customers purchase V-belts?
- **Value of the Program to Customers and Participating Distributors** – What are the main benefits of the program?
- **Influence of the Program:** To what extent would participating distributors sell/specify cogged V-belts even if there were no program? What is the **effectiveness of the incentives and training** in making the customers aware of the benefits of cogged V-belts and in boosting sales of cogged V-belts? Are there **other ways to motivate contractors and participating distributors** to promote efficient equipment or measures?
- **Program process:** Feedback on the implementation process and administration of the program.
- **Program Satisfaction:** How might the CMIP Program be improved going forward?

[1] Sever, F. A.Q.Mohammed, S.Ritchey, and J.Seryak. 2015, *Deemed Power Savings of Cogged V-belts versus Smooth V-Belts*, White Paper - Go Sustainable Energy.

1.3.4.2 Cogged V-Belt CMIP Program Manager Interview

The Navigant team developed a Program Manager Interview Guide (included in Appendix B) with the goal of improving our understanding of the following aspects of the Pilot Program:

- **Origin of Pilot concept and program design** – How did the Program Manager envision the program design, its rebate structure, application process, and inspection requirements? How much did that initial design change due to the input of stakeholders?
- **Goals and Objectives** – What were the initial goals and objectives of the program? Did the program meet those goals?
- **Effectiveness of the incentives and training** in making the customers aware of the benefits of cogged V-belts and in boosting sales of cogged V-belts.
- **Value of the Program to Distributors and Customers** – What are the main benefits of the program? Were the incentives too high? Too low? What was the value of the staff training provided by the program?
- **Market Transformation:** To what extent would distributors sell/specify cogged V-belts even if there were no program? Are there **other ways to motivate contractors and participating distributors** to promote cogged V-belts or other energy-efficient measures?
- **Attribution and Evaluation:** How does the program calculate energy savings and how does it plan to attribute utility savings claims between AEP Ohio, DP&L and other neighboring utilities?
- **Program Process and Lessons Learned:** How would the Program Manager change the Program design or implementation based on the outcome of the Pilot?

The full interview guides can be found in Appendix A.

1.3.5 Researchable Issues

The main objectives of this study were to:

1. Study the feasibility of the Pilot Program's design
2. Determine the effectiveness of offering midstream incentives
3. Review the energy saving impact and attribution to the participating utilities
4. Offer recommendations for improving the program design and implementation

These detailed objectives are described in section 1.2 of the report.

1.3.6 Data Collection and Analysis Methods

To inform the research objectives, Navigant analyzed Pilot Program sales data, compared the sales data with baseline sales data provided by the participating distributors, reviewed savings algorithms and *ex ante* savings calculations. Navigant also reviewed the program documentation including the Program

Implementation Proposal and the customer point-of-sale survey responses, and conducted in-depth interviews with participating distributors and Program Managers. Finally, Navigant developed Process and Program Design recommendations regarding implementation of a full-scale program.

2. EVALUATION RESULTS AND FINDINGS

This section summarizes the results and key findings from the research activities described in Section 1.3.

2.1 Market Barriers and Pilot Program Theory

This section explains the Pilot Program theory, rationale and strategy as determined from the program documentation and in-depth interviews with the Program Management. We also discuss other program design issues, such as the target audience, market barriers, incentive structure and the desired outcomes the Pilot Program aims to address.

2.1.1 Market Barriers

The Cogged V-belt CMIP Pilot was designed to address the perceived barriers to adoption of the cogged V-belt technology, to boost sales of this product, and to develop end-user energy and demand savings.

Although the Pilot Team did not explicitly lay these out, the market barriers for most energy efficient equipment are similar. These barriers include:

- Higher initial cost;
- Minimal end-user and contractor/purchaser awareness of the technology;
- Low end user and contractor knowledge; and,
- Existing market structures and relationships ("status quo")

The CMIP team developed a plan for the Pilot Program in order to overcome the barriers listed above and have a significant, cost-effective impact on the Cogged V-belt market.

Through the course of the pilot, it became clear there were other market barriers in the V-belt market to address before a full-scale program relaunch. Most importantly, HVAC contractors with maintenance contracts account for a large portion of the purchase decisions in the V-belt market. Additionally, HVAC contractors have several disincentives to purchase cogged V-belts under their maintenance contracts.

The results of the Pilot Program demonstrated that the following key aspects of the V-belt market are not being addressed by the current program design:

- Commercial building owners and other end-users are typically not well-informed about Cogged V-belt products and often rely on their HVAC contractors for product purchase decisions
- HVAC Contractors tend to focus on first cost, especially in the case of purchases for fixed-price maintenance contracts
- Energy savings benefits from cogged V-belts do not accrue to the installers, who make up the majority of V-belt purchasers

- The improved durability of cogged V-belts means the belts will need to be replaced less often, reducing the demand for maintenance services

In summary, HVAC contractors are responsible for most of the purchase decisions in this market, yet neither the incentives nor the energy benefits of the program accrue to them. The program does not reduce the higher first cost of cogged V-belts unless the Distributor chooses to pass along mid-stream incentives to the purchaser. Even then, those incentives would presumably only apply to sales above baseline. The improved durability of cogged V-belts is a disincentive which may reduce the need for the HVAC contractor's services.

From the perspective of these HVAC contractors, the Pilot Program is trying to promote the purchase of a more expensive product that does not provide them any direct benefit, and in the long term may reduce the demand for their services. This is not a compelling value proposition for this important segment of the cogged V-belt market.

2.1.2 Pilot Program Theory

The motivation for the CMIP Pilot Program approach stemmed from the team's understanding that "utility EE programs have had challenges engaging Small Buildings/Small Portfolio (SBSP) audiences" with EE improvements. The CMIP design attempts to "encourage the adoption of cogged V-belts as the default choice and to shift the perception of cost versus value."[2]

Although Navigant was not provided with a formal Theory and Logic model for the Pilot Program, we were able to discern the outline of the program model from the details of the Pilot Program design and implementation. The general theory of the Pilot Program was that financial incentives, education and training provided to V-belt distributors can positively influence contractors and customers to adopt cogged V-Belts.

The target market for this program were commercial and small industrial businesses that use belt-drives for HVAC and process applications, and the HVAC contractors who perform maintenance for the end users of V-belts. The Pilot Program theory posited that applying incentives and training at the distribution/wholesaler level of the V-belt market was the most cost-effective way to influence the V-belt market and overcome the market barriers previously described. In other words, influencing distributors through training and incentives can in turn change the purchasing decisions of many HVAC contractors, commercial building owners and other end users.

The desired outcome was an increased awareness, sales and an increased market share for cogged V-belts. In the long term, the program would ideally contribute to transformation of the V-belt market to where cogged V-belts are the overwhelming product of choice over smooth V-belts

2.1.3 Pilot Program Goals and Objectives

The Pilot Program did not have specific goals for either claimed savings or cost effectiveness, but was designed to maximize the influence of the program within a limited budget, while proving the applicability of the CMIP model to this technology in the Mid-west region of the country. Program Managers reported

[2] *CUIP Ohio Notched V-Belt Pilot ImplementationProposal*, MEEA and Argonne National Laboratory, July 2014.

that budget setting before knowing the baseline sales numbers was a challenge. They estimated an incentive budget based on a "reasonable goal" of 10 to 20 percent sales boost above baseline with a significant buffer.

In the final analysis, the sales at participating distributors increased approximately 13 percent, which was within the range projected, and Pilot Program expenditures did not reach the cap set by the two participating utilities. Although this outcome was fortunate, the sales results from the participating and control locations vary widely from location to location, and the program could very well have resulted in a much greater increase in sales than projected, resulting in significant budget overruns. This variability raises the concern that as designed, there was no mechanism to throttle the program spending up or down if results varied from projections.

2.2 Tracking Data Analysis and Program Performance

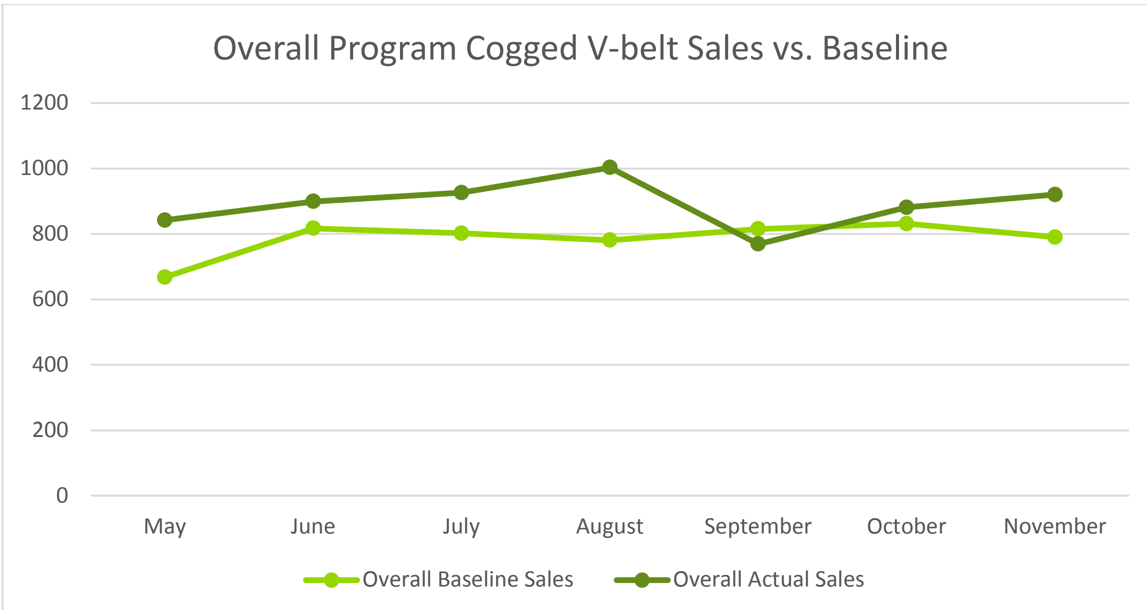
Table 2-1 presents overall statistics for the Pilot Program for the period May through November 2015. As shown, two distributors participated in the Pilot Program with Distributor #1 starting in May and Distributor #2 in June. Distributor #1 provided sales data for three program locations and three control locations. Distributor #2 had one program location and three control locations. All locations were within the contiguous AEP Ohio and DP&L service territories.

Table 2-1. Overall Midstream Pilot Program Statistics – Test Locations

	Distributor #1	Distributor #2	Program Totals
Program Test locations	3	1	4
Total tracking data cogged V-belt sales	5405	1273	6678
Total reported cogged V-belt sales	5332	908	6240
Total baseline cogged V-belt sales	5114	390	5504
Cogged V-belt sales above baseline	218	518	736
Percentage increase in sales	4.3%	132.8%	13.4%

There are small discrepancies between the reported sales (which were used to calculate incentives) and the sales totals drawn from the tracking data. There was no systematic reason for these discrepancies, and the tracking data showed higher sales than reported; hence the analysis presented herein uses the more conservative reported numbers unless otherwise noted. Figure 2-1 shows the overall V-belt sales by month for the program period.

Figure 2-1. Overall Pilot Program Cogged V-belt Sales by Month vs. Baseline



Per-unit incentives were awarded based on the additional sales of cogged V-belts over baseline sales. Baseline sales could be defined in one of two ways:

- flat baseline representing the average monthly sales for 2014, or
- month by month baseline, which represents the sales of cogged V-belts in the corresponding month from 2014.

The Program administrators gave the participating distributors the choice of the type of baseline to use. Distributor #1 chose the flat baseline and Distributor #2 chose the month-by-month baseline.

Figure 2-2, below, shows the combined monthly Cogged V-belt sales over the course of the Pilot Program for Distributor #1 which used the flat baseline for each of its three participating branches. (The baseline sales for May were prorated for a partial month based on delayed launch.) Figure 2-3 shows the same data for Distributor #2.

Figure 2-2. Pilot Program Cogged V-belt Sales by Month – Distributor #1

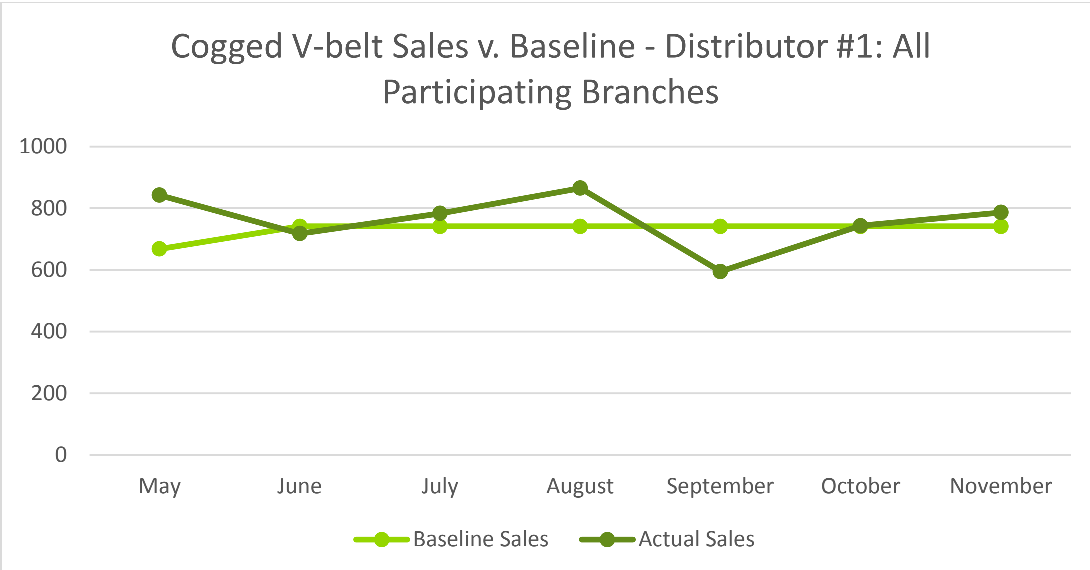
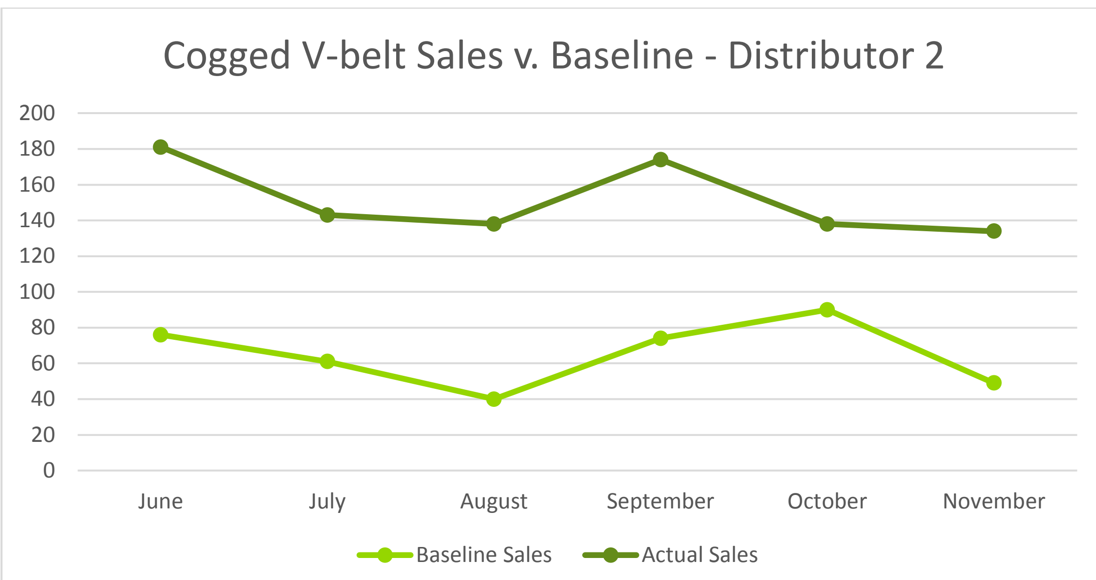


Figure 2-3. Pilot Program Cogged V-belt Sales by Month – Distributor #2



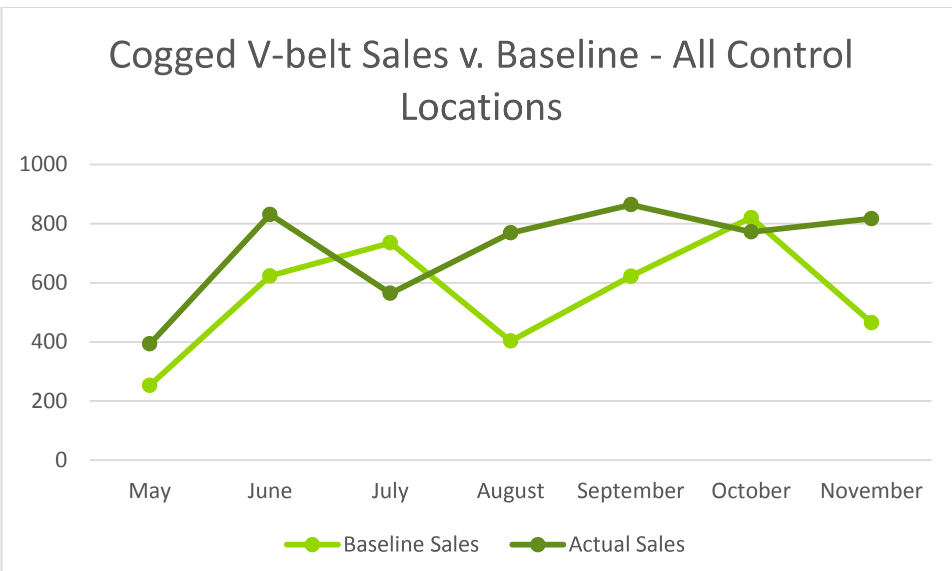
Each Distributor also supplied data for three "control" locations that did not participate in the Program. Table 2-2 presents the overall sales results for the control locations – outlets that did not participate in the formal Program training, data collection or receive incentives.

Table 2-2. Overall Midstream Pilot Program Statistics – Control Locations

	Distributor #1	Distributor #2	Program Totals
Control locations	3	3	6
control locations baseline cogged V-belt sales	1,945	1,976	3,921
control locations reported cogged V-belt sales	2,885	2,125	5,010
control location sales above baseline	940	149	1,089
Percentage increase in sales - control locations	48.3%	7.5%	27.8%

Figure 2-4 shows the cogged V-belt sales by month for the control locations. As with the participating locations, one of the distributors used the flat baseline and the other used a month-by-month baseline from 2014. In aggregate, cogged V-belt sales for the program period were above the previous year's sales even in the control (non-participant) locations.

Figure 2-4. Cogged V-belt Sales compared to Baseline for Control Locations



2.2.1 Impact Analysis

The CMIP Pilot had mixed results based on the tracking data analyzed by Navigant. Table 2-3 shows the high-level statistics of the Pilot locations and appears to show a significant increase in cogged V-belt sales compared to baseline.

Table 2-3. Overall Pilot Program Cogged V-belt Sales Statistics

	Distributor #1	Distributor #2	Program Totals
Program Test locations	3	1	4
Total tracking data cogged V-belt sales	5405	1273	6678
Total reported cogged V-belt sales	5332	908	6240
Total baseline cogged V-belt sales	5114	390	5504
Cogged V-belt sales above baseline	218	518	736
Percentage increase in sales	4.3%	132.8%	13.4%

However there is wide variability in the results at the two participating distributors and even among the three Distributor #1 branches. Table 2-4 below presents the sales data for each of the participating locations. The three Distributor #1 locations vary between 89 percent higher and 24 percent lower sales compared to the flat 2014 average monthly sales. Cogged V-belt sales for the one Distributor #2 location were 133 percent greater than the corresponding 6-month period last year.

Table 2-4. Pilot Program Cogged V-belt Sales Statistics by Location

	Distributor #1			Distributor #2
Branch location	**Columbus**	**Dayton**	**Lima**	**Columbus**
Total tracking data cogged V-belt sales	625	3242	1538	1273
Total reported cogged V-belt sales	613	3194	1525	908
Total baseline cogged V-belt sales	324	2782	2008	390
Cogged V-belt sales above baseline	289	412	-483	518
Percentage increase in sales	89.2%	14.8%	-24.1%	132.8%

Over the course of the Pilot Program, the number of units sold varied significantly from month to month. The V-belt market is seasonal, as maintenance on HVAC systems is normally done in shoulder seasons, so sales of replacement V-belts tend to peak in spring and fall to meet that maintenance schedule. However the sales profiles do not show the expected clear seasonality.

It is important to point out the implications of using a flat baseline vs. a month-by-month baseline. Since the program does not penalize the participating distributor for cogged V-belt sales *below* baseline, the flat baseline can result in a greater incentive payment than a variable month-by-month baseline. This is because in a month where there is typically a seasonal dip in sales, it will be difficult to surpass a flat baseline, and the flat baseline could become a disincentive in slow sales months.

2.2.2 Ex Ante Program Impact

Estimating the energy impacts of the Cogged V-belt CMIP Pilot is challenging for several reasons:

- Energy and demand savings depends on unique parameters of each installation including
    - Motor horsepower
    - Motor hours of use
    - System load factor
    - Other details such as the pulley sizes, belt tension, etc.
- V-belt purchasers often don't know the specific parameters of the system where the belts will be installed
- Savings for fan and pump systems can sometimes be realized only by reducing motor speed or changing pulley sizes
- Energy and demand savings can be zero if the existing V-belt is a cogged belt already.

The algorithm presented in the Go Sustainable white paper is the most suited to the cogged V-belt CMIP based on the fact that it estimates savings based on known characteristics of the belt (cross-section and length) rather than site-specific inputs. (See Navigant's "Review of Deemed Savings Algorithms," submitted to the CMIP team on February 18, 2016) The algorithm uses typical engineering design formulas to predict the average horsepower of the appropriate system application for each belt cross section and length. The algorithm is summarized in tables that estimate *power* savings based on the V-belt cross section and length (included in Appendix B.) The power savings would then presumably be multiplied by the annual hours of use to estimate the annual energy savings. This is the algorithm the two participating utilities proposed to use for their *ex ante* savings estimates.

Navigant used the Go Sustainable power savings tables with one modification to estimate ex ante savings for the Pilot Program. The power savings tables were based on an assumed energy savings of three percent compared to smooth V-belts. Navigant modified the power savings tables by assuming power savings of two percent rather than three percent based on the consensus of other deemed savings algorithms reviewed.

To estimate the annual energy savings, Navigant multiplied the power savings from the modified Go Sustainable power savings tables by the deemed Hours of Use (HOU) for HVAC measures in the "Notched V Belts for HVAC Systems" draft measure in the Illinois TRM, listed in Table 2-5. ("Notched V-belt" is another term for cogged V-belt). The formulae for the annual energy and peak demand savings are then:

Annual Energy savings (kWh) = Deemed power savings (kW) * Annual HOU

Peak demand savings (kW) = Deemed power savings (kW) * CF

Where CF = coincidence factor = 0.74

Table 2-5. Cogged V-belt Deemed Annual Hours of Use by Building Type

Building Type	Pumps & Fans (annual Hours of operation)[5]	EUL (Years)
College/University	4216	5.7
Grocery	5840	4.1
Heavy Industry	3585	6.7
Hotel/Motel	6872	3.5
Light Industry	2465	9.7
Medical	6871	3.5
Office	1766	13.6
Restaurant	4654	5.2
Retail/Service	3438	7.0
School(K-12)	2203	10.9
Warehouse	3222	7.4
Average=Miscellaneous	4103	5.8

Navigant performed this savings calculation on each line item in the full tracking system data set. Unless the point-of-sale data survey for a given line item indicated a listed building type, Hours of use (HOU) for each line item defaulted to 4,103 hours per year (corresponding to “Average=Miscellaneous” in Table 5).

Although the point-of-sale data survey asked the purchaser for an estimate of *daily* hours of use, Navigant elected to ignore those responses for the following reasons:

- Self-reported HOU are often inaccurate, whereas the deemed HOU in Table 2-5 are based on objective studies of a broad sample of different building types
- Self-reported HOU typically do not account for weekend or seasonal usage patterns
- Self-reported HOU typically do not account for duty cycling or load factors both of which reduce the equivalent full load hours

The results of these savings and demand savings calculations for all sales at participating locations are summarized in Table 2-6.

Table 2-6. Program Total *Ex Ante* Energy and Demand Savings

	Program Total
Ex Ante Energy Savings (kWh)	4,253,883
Ex Ante Demand Savings (kW)	1034.55
Percentage of savings over baseline	13.4%
Share of *Ex Ante* Energy Savings (kWh) Attributed to Sales Above Baseline	568,833
Share of *Ex Ante* Demand Savings (kW) Attributed to Sales Above Baseline	138.34
Peak Coincidence Factor (Ohio TRM)	0.74
Ex Ante Peak Demand Savings (kW)	102.37

The third line of Table 2-6 is the share of the total savings associated with the sales *above baseline.* It could be argued that the savings from sales up to the historic baseline is a rough estimate of the proportion of installation locations that have already switched to cogged V-belts, resulting in zero energy or demand savings. For a full-scale launch of the cogged V-belt CMIP, Navigant recommends all sales at each participating location be included in the savings claim, with those savings reduced by a saturation factor to be determined by a field study. The reasoning behind this is further described in the Recommendations Section, 3.2. (See Recommendations #2 and #9)

2.2.3 Attribution of Savings

Table 2-7 presents the proportion of total program savings attributed to each of the participating utilities.

Table 2-7. Attribution of Total Pilot Program Savings

	Program Total	DP&L	AEP Ohio
Ex Ante Energy Savings (kWh)	4,253,883	2,052,583	2,201,300
Ex Ante Demand Savings (kW)	1034.55	499.89	534.66
Percentage of savings over baseline	13.4%	14.8%	11.9%
Incremental Ex Ante Energy Savings (kWh)	568,833	274,473	294,360
Incremental *Ex Ante* Demand Savings (kW)	138.34	66.85	71.50
Peak Coincidence Factor (Ohio TRM)	0.74	0.74	0.74
Net *Ex Ante* Peak Demand Savings (kW)	102.37	49.47	52.91

Without a rigorous field study, it is unfeasible to accurately measure the proportion of sales at each location installed in each utility service territory (See Recommendations, Section 3.2). In lieu of such a study, Navigant has apportioned the savings from the one participating location in Dayton Power & Light service territory to DP&L, and the remainder of the program energy savings to AEP Ohio. This does not account for “leakage” of program sales to locations outside the two participating utilities’ service territory. Determining that leakage factor would require a rigorous field study that is beyond the scope of this evaluation. Navigant recommends such a study be included in the EM&V plan for a full-scale relaunch of the Cogged V-belt CMIP.

2.3 In-depth Interview Findings

In this section we present findings from in-depth interviews with the two participating distributors and the Program Managers.

2.3.1 Distributor In-Depth Interview Findings

Navigant interviewed two participating distributors to elicit their perspectives and experiences with the Cogged V-belt CMIP Pilot Program. The overall objective of this research task was to elicit information from distributors that would help improve the design and implementation of a full-scale re-launch of the Cogged V-belt CMIP. The interview also asked about the distributor’s satisfaction with the Pilot Program, and probed for details on how each implemented the program internally.

2.3.1.1 Characteristics of V-belt Market and Customer Base

Both distributors carry HVAC and Refrigeration parts and equipment, and the majority of their clientele are HVAC and Refrigeration contractors. This applies to all of the participating branches and all six control locations, therefore, Navigant would not expect any variation based on the customer base or product offerings at any location.

V-belt Customers. Distributor #1 estimated 30 percent of the V-belt customers were staff of the V-belt end users and 60 percent were HVAC contractors who install V-belts at their customers’ facilities. The remaining 10 percent were either wholesalers, buying groups, or residential HVAC contractors. Distributor #2 also said 60 percent of their V-belt customers were HVAC contractors, with the rest Facilities Managers, mechanical contractors and other miscellaneous customers.

Typical Building types where V-belts are installed. Distributor #2 reported that there were a wide variety of building types where V-belts are installed, but singled out schools and universities as a large part of the market. Distributor #2 reported government and institutional buildings, (including universities) comprised 20 to 30 percent of the installation locations, while retail stores and restaurants comprised another 50 percent.

Training. Distributor #2 reported nearly all of the customer-facing staff at both the participating and control locations were trained on the benefits of cogged V-belts by the belt manufacturer before the program started so the program-sponsored training was supplemental. The distributor was very satisfied with the quality of training offered through the Pilot Program, and would like to see the customers, especially decision makers at their key accounts, have exposure to the same training.

Distributor #1 also reported their belt manufacturer had trained twelve of their sales staff, including outside sales on cogged V-belts, and the CMIP-sponsored training included another 18 sales staff. This distributor also was very satisfied with the training and saw a need to train all of its staff to maximize the influence on sales of cogged V-belts. Distributor #1 mentioned it had “a ton of cogged belts on display and literature from [the manufacturer] in our showroom”, including thermal imaging and a flyer created by AEP Ohio. But the biggest thing was our people’s knowledge.” This distributor mentioned one large order was a result of its sales team convincing the customer to switch to cogged V-belts.

When asked if their staff was informing customers that if they switched from smooth to cogged V-belts, they may have to reduce the speed of fans/motors or even change the pulleys in order to get energy savings, Distributor #2 said they did not remember hearing that. Distributor #1, however said that “yes, that message did get through” to the customer.

Distributor #2 said that the timing of the training would have been best before June, when contractors are doing maintenance. Distributor #1 also mentioned the fact that the timing of the Pilot Program launch and training sessions was not ideal. The program “started during the busy season,” they said. “Some of our customers do semi-annual or even quarterly maintenance contracts, so it’s a matter of timing. [The program] kicked off too late.”

Access to decision makers. Distributor #2 estimated 50 percent of their V-belt customers had the decision-making authority to switch from smooth to cogged V-belts. The rest were contractors or parts runners. Distributor #1 had a similar observation, saying that a “minimal percentage” were decision-makers, however it said its outside sales staff sometimes had success in nailing down the decision-makers for their larger customers. “Getting in front of the right people is just harder nowadays,” the distributor said.

Market Transformation. Distributor #1 noted “sales of cogged V-belts have increased dramatically” and it is changing its stocking practices as a result. When asked if it could foresee a time when it would no longer need to stock smooth belts, the answer was “I don’t see that happening, to be honest.” The distributor has been noting a lot of equipment with manufacturer-installed cogged V-belts, which is a sign of market transformation. However it predicts HVAC contractors doing regular maintenance will always be in the market for the cheaper belts. The only suggestion the distributor had to get around this barrier to market transformation was to offer a point-of-sale rebate or buy-down of the cogged V-belts to match the price of smooth belts.

Distributor #2 said, when asked about Market Transformation, that “without the program we wouldn’t have even been talking about that.” Ordering and stocking decisions follow demand, and the distributor projects “in a couple years” stocking will have become mostly cogged V-belts. The distributor thinks relaunching the CMIP would speed that process up.

Energy Savings. . When asked if the customers knew it may have to reduce the speed of fans/motors or even change the pulleys in order to get energy savings from cogged V-belts, Distributor #1 said “yes, that message did get through.” Distributor #2, however, said it “[did] not remember hearing that.

2.3.1.2 Participating Distributor Pilot Program Experience and Satisfaction

Data Collection. Both distributors reported the data collection requirements of the program were a barrier to participation both for the customer and to a lesser extent for the distributors themselves. Distributor #1 reported the Data Collection form was “definitely a big barrier [to participation]. If you’re buying something, you want to get in and out." One Distributor said "many of [the customers] didn't have the information anyway." "During busy season with the phones ringing, they didn't have the time" to worry about the Data Collection form. Distributor #2 was able to develop a data collection form in its computer sales system that prompted the sales person to ask the survey questions verbally when a customer purchased a cogged V-belt, which reduced the time it took for a customer to respond to the survey and complete the sale. (See Recommendation #1, Section 3.2)

Incentives and Stipends. Both distributors were satisfied with the per-unit incentive and the training stipend. Both believed the sales incentive was enough of an incentive to motivate them and their sales staff, and that the training stipend was enough to defray their internal costs, and the time it took was easy to work into their regular training program.

Distributor #1 passed along a portion of the per-unit incentive to the purchaser and said this was effective in boosting sales of cogged V-belts. The remainder was used internally to cover the added cost of administering the program. The distributor commented that the Data Collection stipend was "a little low… it could be increased."

Distributor #2, on the other hand, used the per-unit incentive to motivate its sales staff and offered a portion of the per-unit incentive as a commission to sales people, with bonuses each month for the top cogged V-belt salesperson.

The distributors' opinion of the data collection stipend was mixed since it was designed to defray the costs of both reporting the point-of-sale customer survey results and the administrative cost to generate baseline sales and monthly program sales data. Distributor #2 lumped the data collection stipend in with the per-unit incentive and used that pool of money to pay sales staff bonuses and administer the program with the goal of breaking even.

Customer decision-making and motivation. Distributor #2 thought the motivation behind purchasing decisions of its customers varied depending on whether they were HVAC contractors or facilities managers. It said contractors are mostly motivated by avoiding callbacks, so the durability of the cogged V-belt was its primary selling point. The energy savings of the cogged V-belt was the primary motivator for facilities managers, since those benefits accrue to them. [Distributor #2 did not pass along any of the incentives to the customer.]

Distributor #1 said there really wasn't any motivation besides the incentive. When prompted to ascribe any other motivation besides the incentive, Distributor #1 said that "it might be that it would run cooler, quieter."

Benefits to Participating Businesses. Both Distributors said that the program has increased staff and customer awareness of cogged V-belts, improved their product selection and promoted a message that this is a higher quality product, all of which benefit their businesses. One Distributor mentioned that "Anytime you do education, value-add it's a plus." Their stocking practices have changed as cogged V-belts take over a greater market share.

2.3.2 Program Manager In-Depth Interview Findings

Navigant interviewed the Program Managers from MEEA and Argonne to get their perspective on the design and implementation of the CMIP Pilot Program.

2.3.2.1 Program Background

The CMIP model was adapted from a similar pilot in the Pacific Northwest for linear fluorescent lamps. The Project team from the Pacific Northwest pilot wanted to test the same approach for a DOE-funded pilot for a different measure in a different region. Argonne contacted MEEA with the idea, and MEEA found local utility partners AEP Ohio and DP&L.

Meanwhile, Go Sustainable, which has collaborated with the DOE's Industrial Assessment Center (IAC) in the past, had looked at the top ten most commonly recommended measures in the IAC database to find ones that were not being addressed by Utility EE/DSM Programs, and settled on cogged V-belts. Because of the sheer number and magnitude of variables that go into the savings calculation for this measure, it had only been incentivized on a custom basis. Go Sustainable developed a simpler algorithm to estimate the savings from switching to cogged V-belts based only on the belt cross-section and length. The CMIP team saw this as a way to change this measure from a custom to more of a prescriptive treatment. Go Sustainable was already in contact with AEP Ohio regarding its research on cogged V-belts when the CMIP proposal was brought to its attention.

2.3.2.2 Program Design and Implementation

According to the Program Managers, the initial plan was to launch a six-month Pilot for an energy efficient product that is simple to communicate and understand. The participating utilities had a parallel interest in developing their relationships with HVAC equipment distributors, and that collaboration would be used to increase market share for cogged V-belts.

Regardless of whether the program continued or not, the program team believed sales force awareness would drive sales after the pilot was over, so training became a significant part of the program design. Rather than awarding incentives for all cogged V-belt sales, the Pilot Program team decided to award incentives based on sales *growth* above a defined baseline to be more cost efficient. Market Transformation was "a hope rather than a goal."

The Program Managers tried to keep the incentive structure simple, but setting a budget before knowing the numbers was challenge. The CMIP team settled on sales of 10 to 20 percent above baseline as a reasonable projection, but they did not yet know the volume of business they were dealing with. In the end, their projection was about right, and the funding utilities did not reach their budget cap. However, this situation pointed out the fact there is little that could be done to control the program spending if it was more successful than expected.

Data collection turned out to be a large investment of resources for both the distributors and the Program Managers. The Program Managers believe there are ways to calculate savings without point-of-sale data collection using the industry data they were able to obtain.

2.3.2.3 Participating Distributors

Because the midstream incentive model was relatively new to this market, the recruitment and enrollment of distributors took some time which delayed the launch of the Pilot Program. Ultimately, two distributors with several branches in the AEP Ohio and DP&L service territories were enrolled.

The Pilot Program's incentive structure was kept simple to allow the distributors to do what they believed was best with the incentive money. Although they had not envisioned the incentives going to the customer, the Program Managers felt that letting each distributor decide how to allocate the incentives allowed creativity and could generate new ideas on program design. One Distributor was adamant there is no way to motivate the customer without providing some financial incentive, so that was allowed.

The Program Managers said that although the Training was an important element of the Pilot Program, it would be difficult to execute on a broader scale.

The Program Managers said they received feedback from the Distributors that the time between the submitting of sales data and receiving the incentives was too long. They agree that this lag between invoice and payment will need to be reduced to maintain a good relationship with the distributors.

The Program Managers agree that the month-by-month baseline is preferable to the flat baseline, but they didn't want to use a clawback, so as not to lose one of the two participating distributors.

2.3.2.4 Lessons Learned

Large Customers. The Program Managers said that their biggest lesson was not to under-estimate the influence of large customers. If the program is designed to target larger customers, that would boost sales greatly. The feedback from distributors said training sessions for big customers' facilities staff would really help.

Data Collection. The Program Managers also realized early on that this particular measure is not particularly suited to this Pilot Program design model, as it is not easily reduced to a prescriptive energy savings calculation. It is an inexpensive upgrade, but estimating the energy savings requires gathering and analyzing a large amount of data, which can be expensive. The team settled on trying to gather information through a point-of-sale survey, but the response rate was low; the purchasers often did not know anything about the details of where each belt would be installed, and the distributors commented that this was the aspect of the Pilot Program they would most like to do away with because of the disruption and annoyance it caused for their staff and customers.

The Program Managers agreed the Data Collection stipend should be discontinued and recommended the data collection requirements of the program should be reduced or eliminated and any stipend could be rolled into the per unit incentive. They believed the training stipend was a good idea, but should be available one time only.

V-belt Manufacturers. The Program Managers also agreed that V-belt Manufacturer buy-in is critical. The utilities and the Program Managers can mitigate their risk and training burden by involving industry representatives. The belt manufacturer for the two participating distributors offered to help with training for free. According to the Program Managers, this manufacturer "basically said, 'what do you need?'" This could eliminate the need for a training stipend, however competition and territorialism between belt manufacturers could be an issue if the program expands.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

The results of this evaluation, including the tracking data analysis and in-depth interviews with participating distributors and Pilot Program staff lead to the following conclusions:

Incentive Allocation. Distributor #1 passed along a portion of the per-unit incentive to the purchaser, while Distributor #2 used the per-unit incentive internally to motivate the sales staff. While we note that Distributor #2 one participating location was the top performer as far as sales over baseline of any location we investigated, the wide disparity in performance among the participating and non-participating (control) locations makes it difficult to draw any conclusions on performance based on how the per-unit incentive was allocated.

Effectiveness of incentives on purchase decisions. HVAC contractors are responsible for most of the purchase decisions in this market, yet neither the incentives nor the energy benefits of the program accrue to them. Unless the Distributor chooses to pass along mid-stream incentives to the purchaser, the program does not reduce the higher first cost of cogged V-belts, and even then, those incentives would presumably only apply to sales above baseline. The improved durability of cogged V-belts is also a disincentive to HVAC contractors in that it may reduce the need for the HVAC contractor's services.

Program budget. As designed, there is no mechanism to throttle the program spending up or down if results vary from projections. Although the incentive expenditures were below the budget cap set by the participating utilities for the Pilot, the program results show wide variability in performance across the ten different locations, so the outcome could have been very different depending on which locations were enrolled in the program.

Pilot Program Effect on Cogged V-belts Sales Trends. Sales of cogged V-belts increased 13.4 percent over baseline at participating distributor locations. However sales of cogged V-belts increased 27.8 percent over baseline at the six control locations. This seems to indicate **cogged V-belts are gaining in market share across the region** regardless of the Pilot Program's influence, and that market share is unlikely to contract. Future program designs should focus on accelerating this market transformation that is already gaining momentum.

Participating Distributors' Satisfaction. Overall, participating distributors and contractors were very satisfied with the Pilot Program and both would participate enthusiastically if the program as it is designed were to relaunch. Both cited the data collection requirements as the first thing they would like to see changed or eliminated as it slows participation by their salespeople and is an annoyance for the customer. One distributor noted the long turnaround time for reimbursement for participating in the program as a minor point of dissatisfaction.

Training. Both distributors and their staff were very satisfied with the training offered through the program, but one of the distributors in particular said it had already been trained on cogged V-belts by the belt manufacturer, thus the training may have been review for many of their staff. That distributor said that using the training materials to target large customers and decision-makers at key accounts would be a more effective use of resources. The V-belt manufacturers were also willing to provide training for free or whatever other assistance they can if it would boost V-belt sales.

Energy Savings Message It is not clear that the message about energy savings is getting across to customers and end-users. While we cannot be sure without a rigorous field study, it is likely some of the potential energy savings from this measure is being lost when cogged V-belts are installed on HVAC fan drives and the motor speed is not turned down.

Questions for Further Research. Because of the limited scope of this evaluation, we were unable to survey the purchaser or end-users of cogged V-belts. In consideration of that, Navigant suggests future research to explore the following questions:

- **Are current participating distributors and contractors unique from the general pool of distributors and contractors that sell V-belts to local businesses?**
- **What are end-user motivations for changing their purchasing decisions and what is the importance of the Pilot Program and incentives in their decision?**
- **What is the verified *ex post* energy savings of the program?**
- **What proportion of the Pilot Program energy savings can be attributed to each participating utility?**
- **What is the cost-effectiveness of the program?**

3.2 Recommendations

The CMIP model is a viable model for influencing the V-belt market towards a greater market share for cogged V-belts, and would contribute to market transformation if re-launched at full scale. It remains to be seen whether the program is cost-effective, but full-scale relaunch with the reallocations of budget dollars recommended below would enable the rigorous M&V, including field studies, needed to determine the *ex post* energy impacts of the Pilot Program. Those field studies could contribute to the characterization of the cogged V-belt measure and its inclusion in the Ohio TRM, reducing the need for expensive field studies.

Specifically, Navigant recommends the following:

1. **Reduce or eliminate the point-of-sale Data Collection requirements.** If Data Collection is still necessary, require it be done via a verbal survey with responses recorded digitally rather than on paper. Instead of point-of-sale data collection, customer and installation data can be collected using a rigorous field verification study that could begin soon after launch.
2. **Require participating distributors to apply a portion of the program incentives to reduce the price of cogged V-belts.** This should apply to all cogged V-belt sales, not just those above baseline and would help alleviate the "first cost" market barrier inhibiting cogged V-belt sales, especially among HVAC contractors fulfilling maintenance contracts. The

incentive level should be highest in the initial phase of the program and tapered off as the cogged V-belt market share increases.

3. **Recruit V-belt manufacturers to collaborate on training and outreach efforts** as their expertise and business interests coincide with the program goals. This could also reduce the training budget for the program.
4. **Expand the training eligibility to include large customers as well as HVAC contractors and front end staff, and tailor specific presentations to those audiences. .** The training was effective for the limited audiences it reached, but does not necessarily reach the key people making purchasing decisions.
5. **Standardize tracking data systems between participating utilities.** This is a logistical problem that should be addressed before re-launch if the program is to go beyond the pilot stage or include other Ohio utilities.
6. **Ensure that end-user contact information is captured for as many facilities as possible that receive cogged V-belts through participating distributors**. This information is critical to the EM&V effort that will need to include a large number of end users to meet requirements for confidence and precision.
7. **Increase the program budget or reallocate funds to allow for a rigorous M&V study, at least in the initial year after program launch.** This field verification should begin as soon after the launch as possible and include a market saturation study to determine how many of the existing belt drive systems are already using cogged V-belts. This study will help utilities project and track the progress towards market transformation as a part of the program plan. The field verification study should also measure leakage of program cogged V-belts to non-participating utility territories.
8. **Require participating distributors to use a month-by-month baseline for calculating incentives.** This will eliminate the need for clawbacks and prevent the possible disincentive to promote cogged V-belt sales in seasonally slow sales months.
9. **Include all sales at each participating location in the *ex ante* savings claim, but reduce that total savings by a saturation factor to be determined by a field study.** (See also Recommendation #2 and #7) This saturation factor serves to estimate the number of cogged V-belts that are being used to replace existing cogged V-belts and thus not realizing any energy savings. Considering that once a belt drive has been switched to cogged V-belts it is unlikely to be switched back, the previous year's baseline sales for a given month could serve as a rough approximation of this saturation factor, but a field verification study would be much more accurate, and give utilities a measure of the progress toward market transformation.
10. **Using program EM&V results, pursue the development of a measure characterization and deemed savings algorithm for inclusion in the Ohio TRM**. Once a state-wide deemed savings algorithm is adopted, this would reduce the EM&V burden for the program and enable recruitment of other Ohio utilities to join the cogged V-belt CMIP.

APPENDIX A. SURVEY AND INTERVIEW GUIDES

This appendix contains the survey and interview guides developed and used as part of this evaluation.

Cogged V-belt CMIP Participating Distributor Interview Guide

Name of Interviewee: ____ Date: ______________________

STATEMENT OF PURPOSE

This Interview Guide is directed at participant Distributors of the Cogged V-belt midstream incentive pilot program. The guide allows for a "free-flowing" conversation between the evaluation team and the participating Distributors in order to solicit constructive feedback on the program, and to pursue relevant issues raised during the discussion. The interview is meant to collect intelligence about the program design and implementation to inform the possible launch of a full-fledged version of the program in the future.

Questions in this guide will cover the following topics:

- **Distributor and Customer Characteristics –** What range of products do the Participating Distributors currently sell, and what type of customers do they serve? What kinds of customers purchase V-belts?
- **Value of the Program to Customers and Participating Distributors –** What are the main benefits of the program?
- **Influence of the Program:** To what extent would Participating Distributors sell/specify cogged V-belts even if there were no program? What is the **effectiveness of the incentives and training** in making the customers aware of the benefits of cogged V-belts and in boosting sales of cogged V-belts. Are there **other ways to motivate contractors and Participating Distributors** to promote efficient equipment or measures?
- **Program process:** Feedback on the implementation process and administration of the program.
- **Program Satisfaction:** How might the Program be improved going forward?

Pilot locations	Columbus, Dayton, Lima
Control locations	Mansfield, Toledo, Cincinnati

Introduction

Navigant is conducting an evaluation of the Cogged V-belt pilot program. As part of the evaluation of the program we are speaking with the participating distributors like you to understand their perceptions of the program and its effectiveness.

Do you have about 45 minutes to answer some questions for us?

Distributor and Customer Characteristics

1. First, let me get some information about your company and your customers. How would you describe the scope of your business?
   a. Plumbing and Heating?
   b. Electrical?
   c. (Probe: do you specify, install, sell or other types of supplies or equipment?)

2. [For Distributor #1] Just so I'm sure I have this straight, there were 3 pilot branch locations: Dayton, Lima, and Columbus, and 3 "control" locations: Mansfield, Toledo, Cincinnati, is that correct?

3. In general, (over all 6 branches) what types of customers account for most of your V-belt purchases? [If needed, read listed types of customers]
   a. Facilities Managers
   b. HVAC contractors
   c. Other [Record here] ___

4. Does this mix vary at the pilot branches compared to the control locations?

5. For the facilities managers that are your customers, what types of buildings do they operate?
   a. Schools
   b. Government buildings
   c. Colleges or Universities
   d. Multifamily buildings
   e. Retail stores or restaurants
   f. Office buildings
   g. Industrial buildings (chemical, primary metals, etc.)
   h. Healthcare
   i. Other [Record here]

Value and Effectiveness of the Program

6. How many of your customer-facing staff were trained in the benefits of cogged V-belts?

7. Did any of the staff at the *control* locations receive training on cogged V-belts, either through the Program or otherwise? Had anyone been trained on the benefits of cogged V-belts *before* the Pilot Program started?

8. How much do you feel the training was effective in influencing the *customers* to purchase cogged V-belts as opposed to standard V-belts?

9. Have you received any training from the belt manufacturers concerning cogged V-belts? If so, were there any significant differences in the content of that training v. the training your staff received through the program?

10. What do you think was the most effective way to motivate the *purchaser* to opt for cogged V-belts over the less expensive standard V-belts? Was this learned as part of the training your staff received?

11. Did you get the sense that the customers/purchasers had the decision-making authority to switch from smooth to cogged V-belts? Or were they mostly parts runners who were told to get the exact same thing?

12. Were your sales personnel were informing customers that if they switched from smooth to cogged V-belts, they may have to reduce the speed of fans/motors or even change the pulleys in order to get energy savings?

13. What other ways are there to motivate contractors and Participating Distributors to promote cogged V-belts to their customers? (GET AS MUCH DETAIL AS POSSIBLE HERE. PROBE: ANY OTHER WAYS?)

14. What effect, positive or negative, do you think the data collection form had on your sales staff? On the customers?

15. What is your general feedback on the training your staff received? Was anything missing that you would like to have added? Was anything irrelevant or not useful?

16. Was the stipend ($15 per student) adequate?

17. What is your opinion on the incentives you received for …

    a. Each cogged V-belt sold v. baseline ($5)
    b. Data collection stipend ($500/month)
    c. Training stipend ($15/student)

18. How did the incentives get distributed? Sales Staff? Admin costs?

19. Did any of the incentives get passed along to the customer in any way?

20. What do you think was the primary motivator for the customer to switch to cogged V-belts:

    a. Reliability/durability
    b. Energy savings
    c. Reduced noise
    d. Other ___________________________

Program Satisfaction

21. How might the Program be improved going forward?

22. Do you think the program brings value or provides benefits to your company?
    a. (IF YES) How does it bring your company value or provide benefits?

23. Are there any barriers to your participation in the program? To the customer's participation - that is switching from standard to cogged V-belts?

24. Are there motives for your company to promote cogged V-belt sales besides the incentives and training from the Pilot Program?

25. How much of an effect did the data collection aspect of the cogged V-belts purchase process have on your ability to influence the customer's decision? In other words, if the data collection were not a part of the program, how much do you think that would have changed the results?

26. In your opinion, has the Cogged V-belt Pilot program affected the way you conduct your business? [Yes/No]
    a. [Probe if necessary] Has it changed the way you approach marketing or sales? [IF YES] How?
    b. [Probe if necessary] Has it affected your inventory or ordering process? [IF YES] How?
27. What is your opinion regarding the effectiveness of the program? Is the program's value proposition compelling to your customers and to equipment distributors like you?

28. What do you think the Program could do to improve customer participation?

29. And are there other ways besides incentives to motivate companies like yours to recommend such equipment?

Conclusion

Thank you for your time and valuable feedback.

Cogged V-belt CMIP Program Manager

Interview Guide

Name of Interviewee: ____ Date:__________________

STATEMENT OF PURPOSE

This Interview Guide is directed at the Program Manager of the Cogged V-belt midstream incentive pilot program. The guide allows for a "free-flowing" conversation between the evaluation team and the Program Manager in order to solicit constructive feedback on the program, and to pursue relevant issues raised during the discussion. The interview is meant to collect intelligence about the program design and implementation to inform the possible launch of a full-fledged version of the Program in the future.

Questions in this guide will cover the following topics:

- **Origin of Pilot and program design** – How did the Program Manager envision the program design, its rebate structure, application process, and inspection requirements? How much did that initial design change due to the input of stakeholders?
- **Goals and Objectives** – What were the initial goals and objectives of the Program? Did the Program meet those goals?
- **Effectiveness of the incentives and training** in making the customers aware of the benefits of cogged V-belts and in boosting sales of cogged V-belts.
- **Value of the Program to Distributors and Customers** – What are the main benefits of the program? Were the incentives too high? Too low? What was the value of the staff training provided by the Program?
- **Market Transformation:** To what extent would distributors sell/specify cogged V-belts even if there were no program? Are there **other ways to motivate contractors and Participating Distributors** to promote cogged V-belts or other energy-efficient measures?
- **Attribution & Evaluation:** How does the Program calculate energy savings and how does it plan to attribute utility savings claims between AEP OH, DP&L and other neighboring utilities?
- **Program Process and Lessons Learned:** How would the Program Manager change the Program design or implementation based on the outcome of the Pilot?

Introduction

Navigant is conducting an evaluation of the Cogged V-belt pilot program. As part of the evaluation of the program we are speaking with the Program Managers to understand their perceptions of the program and its effectiveness. We are speaking with you to get a better understanding of how the Program was conceived, designed and implemented, what changes were made along the way compared to your initial concept, and what lessons were learned from the implementation of the Pilot.

Do you have about 45 minutes to answer some questions for us?

Background and History of the CMIP

30. First, let me ask you about the origin of the CMIP. Who was the first to propose the Pilot? How did the final group of stakeholders get assembled?

31. What was the original design concept for the CMIP and what other programs was it modeled after? Do you have any Program Theory or Logic Model that you could share?

32. How did the original concept differ from the Program as it was implemented?

33. Can you give me the reasons why each of the changes was made? With the benefit of hindsight, would you have made a different decision?

Goals and Objectives

34. What were the initial goals for the program as far as:
    a. Sales increase over baseline
    b. Savings attributable to the program
    c. Savings attributable to each utility
    d. Cost per MWh saved
35. Were there other less quantitative objectives? [i.e. Market Transformation? Number of sales people/contractors trained? Awareness of the technology?]

36. How successful was the program in meeting those goals?

Recruiting and Participation

37. How did you go about recruiting Distributors to participate in the Pilot Program?

38. Do you provide marketing materials or any other assistance to the Participating Distributors? If so, how effective do you feel those materials were?

39. What other ways are there to motivate the Distributors to promote cogged V-belts to their customers? (GET AS MUCH DETAIL AS POSSIBLE HERE. PROBE: ANY OTHER WAYS?)

Effectiveness and Influence of the Program

40. How effective do you feel the staff training was in boosting cogged V-belt sales (absent any financial incentive)?

41. How much influence did each of the following incentives have on the impact of the CMIP?

    a. Training stipend ($15/student)
    b. Sales per unit incentive ($5 for each cogged V-belt sold v. baseline)
    c. Data collection stipend ($500/month)

42. With hindsight, do you think each of these incentives were too low, too high or just about right?

43. How much do you feel the training was effective in influencing the *customers* to purchase cogged V-belts as opposed to standard V-belts? What was the principal motivating factor, do you think?

Value of the Program to Participating Distributors and Customers

44. What do you think were the main benefits of the program to the Participating Distributors? Are there any downsides to participation that you see?

45. What is the value of the program to the purchasers of cogged V-belts?

46. What do you see as the barriers to participation in the program for distributors? For the customers?

Market Transformation

47. Would you say the Distributors were generally aware of the energy benefits of cogged V-belts *before* they signed on to the program? How about the staff?

48. In your opinion, to what extent would distributors sell cogged V-belts even if there were no program?
49. How long do you think it will take for cogged V-belts to become the standard choice for customers of Distributors *without the CMIP*?
50. How much quicker do you think that transformation will happen if the CMIP were available to all V-belt distributors?
51. Are there other ways to motivate Participating Distributors to promote cogged V-belts?

Program Process

52. Which Distributors other than XX, YY, ZZ did you approach about participating in the CMIP Pilot?
53. Why do you think that distributors declined to participate in the Pilot (ZZ, others you approached)
54. What is your opinion regarding the effectiveness of the program? Is the program's value proposition compelling to the Distributors?

Attribution & Evaluation:

55. How does the Program calculate energy savings?
56. How do you plan to attribute utility savings claims between AEP OH, DP&L and other neighboring utilities?
57. Do you have any thoughts on how to streamline this process?

Lessons Learned

58. If you were to implement the Cogged V-belt CMIP again, what changes would you make in the Program Design?

59. … to the incentive structure?

60. How would you handle the data collection and reporting aspects of the Program differently?

Conclusion

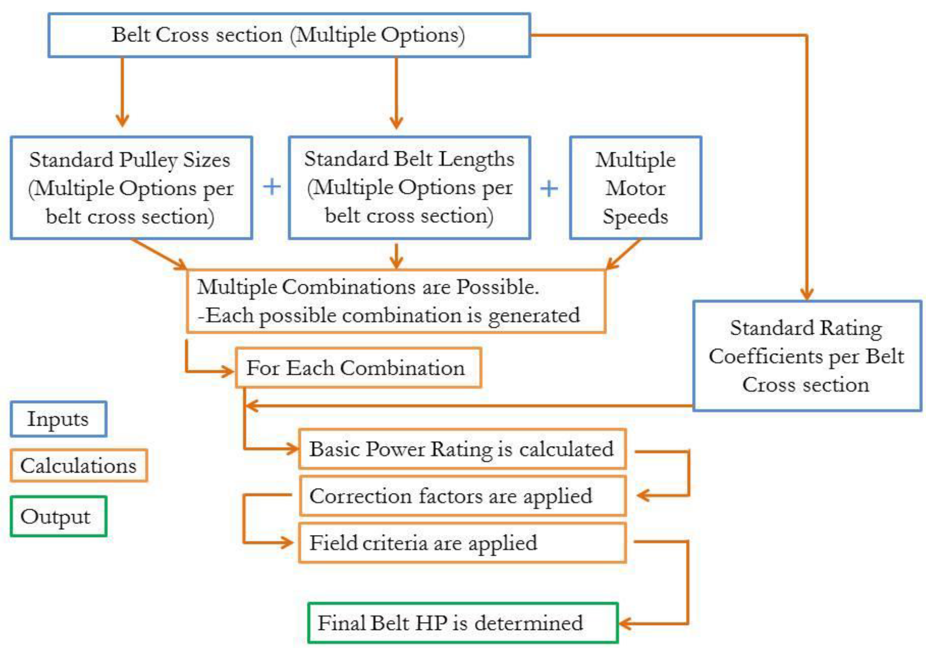
Thank you for your time and valuable feedback.

APPENDIX B. DEEMED SAVINGS ALGORITHM

The deemed savings algorithm used for the impact analysis of the Cogged V-belt CMIP was derived from the Go Sustainable white paper entitled "*Deemed Power Savings of Cogged V-belts versus Smooth V-Belts*"[3] as well as the "Notched V Belts for HVAC Systems" draft measure in the Illinois TRM.

The Go Sustainable paper presents a methodology to predict the motor horsepower of a belt drive system based on the cross section and length of a V-belt. The methodology is graphically represented in Figure B-1.

Figure B-1. Deemed Savings Methodology



The result of these deemed savings calculations is a series of tables that list a typical motor horsepower and a deemed power savings for each belt cross section at a variety of lengths. These tables are presented on the following pages. Using the Deemed power savings from the tables, the annual energy savings and peak demand savings can be calculated using the following formulae:

Annual Energy savings (kWh) = Deemed power savings (kW) * Annual HOU

Peak demand savings (kW) = Deemed power savings (kW) * CF

Where CF = coincidence factor = 0.74
Annual HOU = Annual Hours of Use from Table A-1, below.

[3] Sever, F. A.Q.Mohammed, S.Ritchey, and J.Seryak. 2015, *Deemed Power Savings of Cogged V-belts versus Smooth V-Belts*, White Paper - Go Sustainable Energy.

Table A-1. Cogged V-belt Deemed Annual Hours of Use by Building Type

Building Type	Pumps & Fans (annual Hours of operation)[5]	EUL (Years)
College/University	4216	5.7
Grocery	5840	4.1
Heavy Industry	3585	6.7
Hotel/Motel	6872	3.5
Light Industry	2465	9.7
Medical	6871	3.5
Office	1766	13.6
Restaurant	4654	5.2
Retail/Service	3438	7.0
School(K-12)	2203	10.9
Warehouse	3222	7.4
Average=Miscellaneous	4103	5.8

Belt Cross Section	Belt Length (inches)	Power Rating (HP)	Power saved (kW)
3V	25	5.0	0.14
3V	26.5	5.2	0.15
3V	28	5.3	0.15
3V	30	5.4	0.15
3V	31.5	5.5	0.16
3V	33.5	5.6	0.16
3V	35.5	5.7	0.16
3V	37.5	5.7	0.16
3V	40	5.8	0.17
3V	42.5	5.9	0.17
3V	45	6.0	0.17
3V	47.5	6.0	0.17
3V	50	6.2	0.18
3V	53	6.4	0.18
3V	56	6.6	0.19
3V	60	6.8	0.19
3V	63	6.9	0.20
3V	67	7.0	0.20
3V	71	7.2	0.20
3V	75	7.4	0.21
3V	80	7.6	0.22
3V	85	7.8	0.22
3V	90	8.0	0.23
3V	95	8.1	0.23
3V	100	8.3	0.24
3V	106	8.6	0.24
3V	112	8.8	0.25
3V	118	9.0	0.26
3V	125	9.2	0.26
3V	132	9.4	0.27
3V	140	9.5	0.27

Table 6: 3V Narrow V-belt Ratings©

Belt Cross Section	Belt Length (inches)	Estimated Power Rating (HP)	Estimated Power Saved (kW)
5V	50	14.8	0.42
5V	53	15.3	0.43
5V	56	15.5	0.44
5V	60	15.8	0.45
5V	63	16.0	0.45
5V	67	16.2	0.46
5V	71	16.5	0.47
5V	75	16.9	0.48
5V	80	17.5	0.50
5V	85	17.7	0.50
5V	90	18.0	0.51
5V	95	18.3	0.52
5V	100	18.7	0.53
5V	106	19.1	0.54
5V	112	19.6	0.56
5V	118	19.9	0.57
5V	125	20.2	0.57
5V	132	20.4	0.58
5V	140	20.6	0.59
5V	150	21.0	0.60
5V	160	21.4	0.61
5V	170	21.8	0.62
5V	180	22.1	0.63
5V	190	22.4	0.64
5V	200	22.6	0.64
5V	212	22.9	0.65
5V	224	23.2	0.66
5V	236	23.5	0.67
5V	250	23.9	0.68
5V	265	24.3	0.69
5V	280	24.6	0.70
5V	300	24.9	0.71
5V	315	25.0	0.71
5V	335	25.2	0.72
5V	355	25.6	0.73

Table 7: 5V Narrow V-belt Ratings©

Belt Cross Section	Belt Length (inches)	Estimated Power Rating (HP)	Estimated Power Saved (kW)
8V	100	34.7	0.99
8V	106	35.9	1.02
8V	112	37.1	1.05
8V	118	38.0	1.08
8V	125	38.4	1.09
8V	132	39.0	1.11
8V	140	39.4	1.12
8V	150	40.1	1.14
8V	160	40.6	1.15
8V	170	41.1	1.17
8V	180	41.7	1.19
8V	190	42.0	1.19
8V	200	42.4	1.21
8V	212	43.1	1.23
8V	224	43.8	1.25
8V	236	44.5	1.27
8V	250	45.2	1.29
8V	265	46.0	1.31
8V	280	46.6	1.33
8V	300	47.3	1.35
8V	315	47.6	1.35
8V	335	47.8	1.36
8V	355	48.5	1.38
8V	375	49.3	1.40
8V	400	49.8	1.42
8V	425	49.8	1.42
8V	450	50.4	1.43
8V	475	51.3	1.46
8V	500	51.7	1.47
8V	560	52.2	1.48

Table 8: 8V Narrow V-belt Ratings©

Belt Cross Section	Belt Length (inches)	Estimated Power Rating (HP)	Estimated Power Saved (kW)
A	26	4.1	0.12
A	31	4.5	0.13
A	35	4.6	0.13
A	38	4.7	0.13
A	42	4.9	0.14
A	46	4.9	0.14
A	51	5.3	0.15
A	56	5.6	0.16
A	60	5.8	0.17
A	68	6.1	0.17
A	75	6.6	0.19
A	80	6.9	0.20
A	85	7.1	0.20
A	90	7.4	0.21
A	95	7.6	0.22
A	105	7.9	0.23
A	112	8.2	0.23
A	120	8.4	0.24
A	128	8.6	0.24

Table 9: A Classic V-belt Ratings©

Belt Cross Section	Belt Length (inches)	Estimated Power Rating (HP)	Estimated Power Saved (kW)
B	35	5.3	0.15
B	38	5.4	0.15
B	42	5.6	0.16
B	46	5.8	0.16
B	51	9.9	0.28
B	55	10.2	0.29
B	60	10.4	0.30
B	68	10.7	0.30
B	75	11.1	0.32
B	81	11.5	0.33
B	85	11.6	0.33
B	90	11.8	0.34
B	97	12.0	0.34
B	105	12.4	0.35
B	112	12.8	0.36
B	120	13.0	0.37
B	128	13.2	0.38
B	144	13.5	0.39
B	158	13.9	0.39
B	173	14.3	0.41
B	180	14.4	0.41
B	195	14.7	0.42
B	210	15.0	0.43
B	240	15.6	0.44
B	270	16.1	0.46
B	300	16.5	0.47

Table 10: B Classic V-belt Ratings©

Belt Cross Section	Belt Length (inches)	Estimated Power Rating (HP)	Estimated Power Saved (kW)
C	51	11.3	0.32
C	60	12.1	0.34
C	68	12.5	0.36
C	75	13.2	0.38
C	81	13.9	0.40
C	85	14.1	0.40
C	90	14.4	0.41
C	96	14.8	0.42
C	105	15.5	0.44
C	112	16.2	0.46
C	120	16.6	0.47
C	128	16.8	0.48
C	144	17.4	0.50
C	158	17.9	0.51
C	173	18.6	0.53
C	180	18.8	0.54
C	195	19.2	0.55
C	210	19.7	0.56
C	240	20.6	0.58
C	270	21.4	0.61
C	300	21.8	0.62
C	330	22.0	0.63
C	360	22.9	0.65
C	390	23.3	0.66
C	420	23.8	0.68

Table 11: C Classic V-belt Ratings©

Belt Cross Section	Belt Length (inches)	Estimated Power Rating (HP)	Estimated Power Saved (kW)
D	120	25.4	0.72
D	128	25.9	0.74
D	144	26.5	0.75
D	158	27.1	0.77
D	173	27.7	0.79
D	180	28.0	0.80
D	195	28.3	0.81
D	210	28.9	0.82
D	240	30.1	0.86
D	270	31.2	0.89
D	300	31.8	0.91
D	330	32.1	0.91
D	360	32.7	0.93
D	390	33.4	0.95
D	420	33.6	0.96
D	480	34.5	0.98
D	540	35.1	1.00
D	600	35.4	1.01
D	660	37.4	1.06

Table 12: D Classic V-belt Ratings©

BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of The Dayton Power and Light Company's Portfolio Status Report.	)))	Case No. 16-0851-EL-POR

Affidavit of Thomas A. Raga

State of Ohio	)	
	)	SS:
County of Montgomery	)	

I, Thomas A. Raga, being first duly cautioned and sworn, do hereby swear and affirm the following to the best of my knowledge and belief:

1. I have attained the age of eighteen and have personal knowledge of the matters set forth herein.

2. I am the President and Chief Executive Officer of The Dayton Power and Light Company ("DP&L"). As part of my overall responsibilities, I am responsible for ensuring DP&L's compliance with statutorily imposed energy efficiency and peak demand reduction requirements.

3. DP&L has met its statutory benchmarks for energy efficiency and peak demand reduction as set forth in the Portfolio Status Report being filed contemporaneously with this Affidavit.

FURTHER AFFIANT SAYETH NAUGHT.

Thomas A. Raga

Sworn to and subscribed in my presence on this 20th day of April, 2016.

NOTARY PUBLIC STATE OF OHIO

JOYA L. MURR, Notary Public
In and for the State of Ohio
My Commission Expires May 31, ~~2014~~ 2019

Notary Public