CADMUS

2022 CenterPoint Energy Demand-Side Management Portfolio Electric Evaluation Key Findings, Conclusions, and Recommendations Memo

April 25, 2023

Prepared for:

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Acronyms

Acronym	Definition
AFUE	Annual fuel utilization efficiency
AHRI	Air Conditioning, Heating, & Refrigeration Institute
AMI	Advanced metering infrastructure
ASHP	Air source heat pump
BTUH	British thermal units per hour
C&I	Commercial and industrial
CAC	Central air conditioner
CADR	Clean air delivery rate
CDD	Cooling degree days
CLSD	Calibrated DSMore Load-Shape Differences
CEF	Combined energy factor
CF	Coincidence factor
CFL	Compact fluorescent lamp
CFM	Cubic feet per minute
COP	Coefficient of performance
CVR	Conservation voltage reduction
DHP	Ductless heat pump
DHW	Domestic hot water
DK/RF	Don't know/refused
DOE	U.S. Department of Energy
DSF	Demand savings factor
DSM	Demand-side management
ECM	Electronically commutated motor
EER	Energy efficiency ratio
EFLH	Equivalent full load hours
EISA	Energy Security and Independence Act of 2007
ERI	Energy Rating Index
ESF	Energy saving factor
EUL	Effective useful life
FLH	Full load hours
FPL	Federal poverty level
GSL	General service LED
HDD	Heating degree days
HER	Home energy report
HERS	Home Energy Rating System
HEW	Home Energy Worksheet
HOU	Hours of use

Acronym	Definition
hp	Horsepower
HSPF	Heating seasonal performance factor
IHCDA	Indiana Housing and Community Authority
IMEF	Integrated modified energy factor
IQW Program	Income Qualified Weatherization Program
IPLV	Integrated part load value
IRC	Indiana Residential Code
ISR	In-service rate
IWF	Integrated water factor
kBtu	Kilowatt per British thermal unit
kBtuh	Kilowatt per British thermal unit per hour
KPI	Key performance indicator
kSF	Thousand square feet
Kw	Kilowatt
kWh	Kilowatt per hour
LED	Light-emitting diode
MMBTU	One million British thermal units
MFDI Program	Multifamily Direct Install Program
NEF	National Energy Foundation
NTG	Net to gross
OLS	Ordinary least square
QA/QC	Quality assurance/quality control
RBS Program	Residential Behavioral Savings Program
RECS	Residential Energy Consumption Survey
RESNET	Residential Energy Services Network
RNC Program	Residential New Construction Program
SBES Program	Small Business Energy Solutions Program
SEER	Seasonal energy efficiency ratio
SKU	Stock keeping unit
TMY3	Typical meteorological year
TRM	Technical reference manual
UMP	Uniform Methods Project
VFD	Variable frequency drive
VVO	Volt/var optimization
WHF	Waste heat factor

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Executive Summary

CenterPoint Energy in Indiana has a demand-side management (DSM) portfolio containing 14 programs, 11 of which contribute electric energy savings and demand reductions to the portfolio.[1] CenterPoint Energy administers the portfolio in conjunction with several third-party implementers. The programs serve the residential, income-qualified, multifamily, commercial, and industrial sectors.

CenterPoint Energy tasked Cadmus with evaluating its 2022 DSM programs, which involved conducting process and impact evaluations and a market performance indicator assessment for the programs:

- Through the ***process evaluation***, Cadmus examined the program from the perspective of customers, trade allies, and program staff and sought to determine the aspects of the program that worked well, areas that may need improvement, and recommendations to refine the program.
- Through the ***impact evaluation***, Cadmus verified measure installation, determined freeridership and spillover (net-to-gross [NTG] ratio), and reviewed deemed savings and assumptions. Cadmus calculated electric impacts for all programs and measures.
- To assess ***market performance indicators,*** Cadmus reviewed and updated logic models to map each program's activities and established key performance indicators (KPIs) to track market trends over time.

This memo provides the key findings, conclusions, and recommendations of Cadmus' evaluation of CenterPoint Energy's 2022 DSM electric portfolio.[2] Full impact evaluation and market performance indicator analysis results are contained in the online CenterPoint Energy evaluation dashboard.

Table 1 shows the evaluation tasks completed for each of CenterPoint Energy's programs.

[1] The Targeted Income, Energy Efficient Schools, and Multifamily Direct Install programs contribute natural gas savings only.

[2] Natural gas impacts are reported separately in the *2022 CenterPoint Energy Demand-Side Management Portfolio Natural Gas Evaluation Key Findings, Conclusions, and Recommendations Memo.*

Table 1. 2022 Evaluation Tasks by Program

Program	Process Evaluation	Impact Evaluation	Market Performance Indicators
Residential Programs			
Residential Specialty Lighting	✓	✓	✓
Residential Prescriptive [a]	✓	✓	✓
Residential New Construction		✓	
Income Qualified Weatherization	✓	✓	✓
Residential Behavioral Savings	✓	✓	✓
Appliance Recycling	✓	✓	✓
Smart Cycle [b]	✓	✓	
Community Based LED Specialty Bulb Distribution	✓	✓	✓
Commercial and Industrial Programs			
C&I Prescriptive	✓	✓	✓
C&I Custom [c]	✓	✓	✓
Small Business Energy Solutions	✓	✓	✓

[a] CenterPoint Energy's Residential Prescriptive Program includes Standard, Midstream, Online Marketplace, and Instant Rebates delivery channels.

[b] For this evaluation, Cadmus estimated savings for year-round use of Smart Cycle direct install thermostats; Cadmus estimated savings from summer peak load control events in a separate evaluation.

[c] CenterPoint Energy's C&I Custom program includes Commercial New Construction, Building Tune-Up, and Strategic Energy Management as program subcomponents.

Portfolio-Level Impacts

Table 2 and Table 3 present the electric savings and demand reduction achieved by the 2022 CenterPoint Energy DSM Portfolio.[3] Overall, the portfolio achieved 23,782,930 kWh of evaluated, net electric savings and 5,072 kW evaluated, net demand reduction.

Table 2. 2022 CenterPoint Energy DSM Program Portfolio Electric Savings[a]

Program	*Ex Ante* Savings (kWh)			Evaluated *Ex Post* Savings (kWh)	Realization Rate (kWh)	NTG Ratio	Evaluated Net Savings (kWh)	Net Savings Goal (kWh)	Percent Net Savings Goal Achieved
	Reported	Audited	Verified						
Residential Programs									
Residential Specialty Lighting	5,880,095	5,880,095	5,056,881	5,209,860	89%	35%	1,838,599	3,255,801	56%
Residential Prescriptive	2,727,710[b]	2,781,468	2,612,382	2,460,580	90%	60%	1,469,508	3,008,150	49%
Residential New Construction	21,997	21,997	21,997	20,933	95%	57%	11,932	N/A	N/A
Income Qualified Weatherization	245,248	245,222	244,136	182,201	74%	100%	182,201	383,102	48%
Residential Behavioral Savings	3,948,025	3,948,025	3,948,025	5,396,100	137%	N/A	5,396,100	7,100,000	76%
Appliance Recycling	1,017,988	1,013,628	1,013,628	1,009,663	99%	52%	521,359	830,212	63%
Smart Cycle	43,593	43,593	40,513	39,550	91%	94%	37,277	259,484	14%
Community Based LED Specialty Bulb Distribution	2,011,495	2,011,495	1,507,113	1,353,085	67%	100%	1,353,085	1,133,354	119%
Commercial and Industrial Programs									
C&I Prescriptive	10,339,350	10,339,350	10,339,350	10,641,878	103%	63%	6,704,383	8,600,000	78%
C&I Custom	1,671,771	1,496,924	1,482,488	1,444,307	87%	58%	837,698	3,360,000	25%
Small Business Energy Solutions	5,521,287	5,521,287	5,521,287	5,557,142	101%	88%	4,890,285	3,720,000	131%
Total	**33,428,559[b]**	**33,303,084**	**31,787,800**	**33,315,299**	**100%**	**70%**	**23,242,427**	**31,650,103**	**73%**
Nonparticipant Spillover	N/A	N/A	N/A	N/A	N/A	5%	540,503	N/A	N/A
Total Adjusted Portfolio	**33,428,559[b]**	**33,303,084**	**31,787,800**	**33,315,299**	**100%**	**71%**	**23,782,930**	**31,650,103**	**75%**

[a] Nonparticipant spillover is included as informational only and is not included in CenterPoint Energy Lost Revenues and Performance Incentive calculations.

[b] This reported value does not match the value found in the DSM scorecard because of a discrepancy with Residential Prescriptive program's Standard component subtotal. The subtotal contained a formula error that excluded heat pump water heater. The reported values shown in the table include heat pump water heater.

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3 Reported *ex ante* electric and demand savings are derived from CenterPoint Energy's 2022 Electric DSM scorecard.

Table 3. 2022 CenterPoint Energy DSM Program Portfolio Demand Reduction

Program	*Ex Ante* Savings (Coincident Peak kW)			Evaluated *Ex Post* Savings (Coincident Peak kW)	Realization Rate (Coincident Peak kW)[1]	NTG Ratio	Evaluated Net Savings (Coincident Peak kW)	Net Savings Goal (Coincident Peak kW)	Percent Net Savings Goal Achieved
	Reported	Audited	Verified						
Residential Programs[a]									
Residential Specialty Lighting	838	908	781	718	86%	35%	253	448.0	56%
Residential Prescriptive	1,024	1,026	1,011	1,024	100%	54%	553	524.3	105%
Residential New Construction	16.20	5.76	5.76	8.26	51%	57%	4.71	N/A	N/A
Income Qualified Weatherization	52.42	85.98	85.95	43.67	83%	100%	43.67	96.4	45%
Residential Behavioral Savings	2,025	2,025	2,025	1,684	83%	N/A	1,684	2,025.0	83%
Appliance Recycling	158	157	157	155	98%	54%	83	132.9	62%
Smart Cycle	92	92	0	0	0	0	0	550.0	0%
Community Based LED Specialty Bulb Distribution	313	312	241	160	51%	100%	160	156.6	102%
Commercial and Industrial Programs									
C&I Prescriptive	1,493	1,493	1,493	1,532	103%	63%	965	2,425.20	40%
C&I Custom	426	370	398	367	86%	58%	213	653.1	33%
Small Business Energy Solutions	1,126	1,126	1,126	1,106	98%	88%	973	414.1	235%
Total	**7,564**	**7,601**	**7,324**	**6,798**	**90%**	**73%**	**4,932**	**7,426**	**66%**
Nonparticipant Spillover	N/A	N/A	N/A	N/A	N/A	5%	139	N/A	N/A
Total Adjusted Portfolio	**7,564**	**7,601**	**7,324**	**6,798**	**90%**	**75%**	**5,072**	**7,426**	**68%**

[a] CenterPoint Energy forecasts demand reductions using a program average for the residential portfolio. Because forecasting is at the program level rather than the measure level, kW realization rates are expected to fluctuate more than energy realization rates (kWh). CenterPoint Energy uses evaluated kW for planning purposes only.

Summary of Recommendations

Based on the findings from the 2022 evaluation, Cadmus proposed several recommendations to enhance CenterPoint Energy's DSM portfolio (Table 4).

Table 4. 2022 Program Recommendations

Program	Recommendations
Residential Programs	
Residential Specialty Lighting	None
Residential Prescriptive	Consider recruiting experienced trade allies familiar with the residential midstream channel for the electric commercial midstream channel. The implementers said they receive feedback of high satisfaction from contractors and distributors, especially once they are set up and familiar with the program. To improve performance tracking in the Online Marketplace, consider asking the implementer EFI to categorize sales using the measure names in the DSM scorecard instead of measure description. To improve data consistency and comparability, consider working with CLEAResult and EFI to improve the data structure so it is easier to reconcile variances across quarterly and final data, and ensure all vital program data is included in all datasets. In addition, include equipment efficiency and size for each record so savings can be calculated more accurately for each measure.
Residential New Construction	None
Income Qualified Weatherization	Where possible, prioritize homes with electric resistance heat for weatherization measures such as attic insulation. Additional research could be conducted to identify high electric energy using customers that could be targeted by the program. Add questions to the 2023 participant evaluation survey to better understand customer motivation for participation and use the findings to inform recruitment approaches in subsequent program years. Explore partnership opportunities with community action agencies, even just to help promote or raise awareness for the program. Continue to offer but do not claim savings for measures like air purifiers and dehumidifiers when they are offered due to environmental concerns as they are new and adding load (instead of replacing an existing inefficient or inoperable model). Savings can and should be claimed when new equipment is replacing old inefficient equipment. Tracking when old equipment is replaced will be required to fully claim the savings. Work with the evaluator to determine information that should be tracked.
Residential Behavioral Savings	Work with implementer to determine if savings for the dual fuel waves could be increased with different messaging or targeted recommendations in 2023.
Appliance Recycling	None
Smart Cycle	For planning purposes, assume no coincident peak demand savings for normal use of smart thermostats until the new Indiana TRM is released and provides updated guidance.
Community Based LED Specialty Bulb Distribution	None

Program	Recommendations
Commercial and Industrial Programs	
C&I Prescriptive	To increase confidence in the reported savings of chiller tune-ups and compressed air leak repairs, conduct sample desk reviews in next year's evaluation.
C&I Custom	Provide supporting documentation such as trend data, photos, equipment specifications, or investigation reports to justify energy use characteristics or equipment control for all projects.
Small Business Energy Solutions	Ensure that, where appropriate, ex ante thermostat savings account for cooling savings as well as fan energy savings for both the heating and cooling seasons.

Key Findings, Conclusions, and Recommendations

This section summarizes the key findings, conclusions, and recommendations for each program. Additional details for measure-level savings can be found in *Appendix A. Impact Evaluation Methodology.*

Residential Programs

Residential Specialty Lighting Program

Through the ***Residential Specialty Lighting Program***, CenterPoint Energy provides upstream discounts on a variety of ENERGY STAR®-certified lighting products (specialty and reflector bulbs). CenterPoint Energy works with retailers and manufacturers to offer reduced prices at the point of sale. In 2022, CLEAResult, the program implementer, worked with 12 retailers and 25 store locations, including big box stores, discount stores, wholesale stores, hardware stores, and general retailers.

Program Delivery

In 2022, program activities bounced back with more retailers, in-store pop-up events, and a new product offering. The implementer reported that 25 storefronts across 12 different retailers participated in 2022. After two years with no in-store events due to the COVID-19 pandemic, the program resumed in-store pop-up events in 2022. The list of qualifying program measures was also expanded to include outdoor sensor lights.

Baseline Changes

U.S. Department of Energy (DOE) regulatory rule has had an impact on the Residential Specialty Lighting Program and CenterPoint Energy's efforts to discontinue the program. The Office of Energy Efficiency and Renewable Energy proposed to codify the 45 lumen per watt standard for all medium screw-based lamps, set under the Energy Security and Independence Act of 2007 (EISA) backstop, to require that applicable reflector and specialty lamps follow the same efficiency standards as general service LEDs. This new and stricter minimum efficiency standard means that, starting in 2023, the sale of incandescent or halogen lamps would be prohibited.

According to the implementer, the Residential Specialty Lighting Program will soon be discontinued as a stand-alone program. Meanwhile, the program will continue to offer reduced prices for energy-efficient lighting at the point of purchase.

In response to the new rule, the implementer emailed retailers to promote purchases of energy-efficient light bulbs before the EISA backstop goes into effect, otherwise, retailers could see financial penalties if they are non-compliant by June 30, 2023. It also reduced its efforts to further expand its retailer network. The implementer plans to explore the possibility of integrating the Residential Specialty Lighting Program's reduced prices of lighting equipment into other similar programs offered by CenterPoint Energy.

Impact Evaluation Overview

Table 5 lists evaluated savings for the Residential Specialty Lighting Program. Cadmus reviewed the 2022 program tracking database to check savings estimates and calculations against CenterPoint Energy's reported savings from the 2022 Electric DSM Scorecard and to confirm the accurate application of the savings assumptions. Cadmus exactly matched energy savings and total program lamps in the tracking data to the DSM scorecard but found that the tracking data showed 70 kW (8.4%) more total demand savings than reported.

Table 5. 2022 Residential Specialty Lighting Program Electric Savings

Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rate	NTG Ratio	Evaluated Net Savings
	Reported	Audited	Verified				
Total kWh	5,880,095	5,880,095	5,056,881	5,209,860	89%	35%	1,838,599
Total kW	838	908	781	718	86%	35%	253

Variance in realization rates is largely because of differences in *ex post* and *ex ante* savings. To determine *ex ante* savings, CenterPoint Energy applied fixed per-unit kWh and kW for each bulb category based on 2020 evaluated savings. To determine *ex post* savings, Cadmus used the ENERGY STAR lumens binning approach recommended in the Uniform Methods Project to determine replacement baseline wattages for each program lamp.[4]

Table 6 provides per-unit annual gross savings for each program measure. Both reflector and specialty LEDs had, in aggregate, per-unit evaluated savings that closely matched reported savings and historical savings.

Table 6. 2022 Residential Specialty Lighting Program Per-Unit Gross Savings

Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
	Reported	Evaluated	Reported[a]	Evaluated
LED Reflector	49.5	48.9	0.006	0.007
LED Specialty	29.0	32.3	0.006	0.004

[a] CenterPoint Energy's 2022 Electric DSM Scorecard reported an averaged, per-unit kW savings value.

Residential Prescriptive Program

Through the ***Residential Prescriptive Program,*** CenterPoint Energy seeks to achieve energy savings by influencing residential customers to purchase energy-efficient residential equipment and products. The program includes four channels: ***Standard***, ***Residential Midstream, Online Marketplace***, and ***Instant Rebates***. All residential customers are eligible to participate through these channels and receive rebates

[4] Dimetrosky, S., K. Parkinson, and N. Lieb. October 2017. "Chapter 6: Residential Lighting Evaluation Protocol." *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* https://www.nrel.gov/docs/fy17osti/68562.pdf

or discounts that vary by measure. CLEAResult is the program implementer for the Standard and Midstream channels. EFI is the implementer for the Online Marketplace and Instant Rebates channels.

The following describes the four channels:

- Through the ***Standard*** channel, CenterPoint Energy offers downstream prescriptive rebates for a variety of measures, such as smart thermostats, HVAC equipment, appliances, and insulation. Projects are eligible for a rebate after a customer installs qualifying equipment. CenterPoint Energy provides the rebate either directly to the customer or to the project contractor if authorized to do so by the customer. To receive the rebate directly, customers complete and submit a rebate application through an online portal, by email, or by mail. Some contractors give customers the option of including the rebate as a discount in their project cost. In these cases, the customer authorizes the contractor to submit the rebate application and receive the rebate payment.
- Launched in mid-2020, the ***Residential Midstream*** channel provides incentives directly to distributors for qualifying HVAC equipment sales. Participating distributors collect the required information directly from their customers, which allows them to confirm eligibility and provide an instant discount on eligible equipment. Distributors are then reimbursed by CenterPoint Energy for the incentive amount. These distributors are required to pass at least some of the incentive onto their customers (typically contractors, but occasionally end users) and inform them of their rebate from CenterPoint Energy. The channel focuses primarily on higher-efficiency HVAC equipment models than those available in the Standard channel.
- CenterPoint Energy launched the ***Online Marketplace*** channel in 2021. Through this channel, customers can purchase measures including specialty LEDs, smart thermostats, and advanced power strips online to receive an instant discount.
- CenterPoint Energy launched its ***Instant Rebates*** channel in 2022. The channel offers customers a point-of-sale discount when they use a rebate coupon. The coupon is accessible online through a portal that verifies customers eligibility. The verification process happens quickly, giving customers the option to access the coupon through a smartphone while in the store.

Customer Satisfaction

The program achieved high customer satisfaction from participants in the Standard and Online Marketplace channels. From customer surveys, 97% of Standard respondents and 96% of Online Marketplace respondents were satisfied with the program overall, and respondents also gave high satisfaction ratings across all categories (88% and above). These categories included navigating the store to find products, completing the order, the selection of products, the time it took for shipping/delivery and the amount of the discount.

Midstream Trade Ally Engagement

Residential Midstream contractors and distributors showed strong interest in participating in a commercial HVAC midstream program. Cadmus asked if they were likely to participate due to CenterPoint Energy's plans to add an electric commercial channel in 2023. Of the 14 residential midstream contractors interviewed, 11 said they were likely or very likely to participate in a commercial HVAC midstream program. Of the eight distributors interviewed, five were interested. Reasons for not wanting to participate in the commercial channel were because the contractor or distributor did not work in the commercial space and not because they were unfamiliar with the residential rebates channel.

Recommendation: Consider recruiting experienced trade allies familiar with the residential midstream channel for the electric commercial midstream channel. The implementers said they receive feedback of high satisfaction from contractors and distributors, especially once they are set up and familiar with the program.

Online Marketplace

Online Marketplace program data are inconsistent from the scorecard and program data channel. Various quarterly and final program data contained different data and data structures and did not include system efficiency and system size for measures across multiple channels.

Residential Prescriptive program data for the Online Marketplace did not completely align with the scorecard due to measure categorization inconsistencies. For example, the final data contained no data regarding night lights, but the electric DSM scorecard showed 27 night lights. Cadmus found that the data for night lights varied across quarterly reports and was difficult to verify. In addition, manufacturer and model data can be used to ascertain system efficiency and size, but Cadmus found that some measures, such as aerators, did not have these data.

Recommendation: To improve performance tracking in the Online Marketplace, consider asking the implementer EFI to categorize sales using the measure names in the DSM scorecard instead of measure description. To improve data consistency and comparability, consider working with CLEAResult and EFI to improve the data structure so it is easier to reconcile variances across quarterly and final data, and ensure all vital program data is included in all datasets. In addition, include equipment efficiency and size for each record so savings can be calculated more accurately for each measure.

Impact Evaluation Overview

Table 7 lists the evaluated savings summary for the Residential Prescriptive Program. Cadmus evaluated savings for each measure in the tracking database using savings analyses derived primarily from the 2015 Indiana TRM v2.2 and participant survey data. *Appendix A. Impact Evaluation Methodology* provides additional details for the calculations and assumptions used to estimate gross savings.

Table 7. 2022 Residential Prescriptive Program Electric Savings

Component	Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rates	NTG Ratio	Evaluated Net Savings
		Reported	Audited	Verified				
Standard	Total kWh	1,383,325[b]	1,383,325	1,298,189	1,347,462	97%	64%	856,726
	Total kW	820.09	820.09	808.61	879.66	107%	55%	482.34
Online Marketplace	Total kWh	554,931	603,107	530,945	393,760	71%	77%	304,362
	Total kW	34.93	36.95	35.61	16.99	49%	75%	12.74
Midstream	Total kWh	783,431	783,431	771,909	705,938	90%	42%	298,259
	Total kW	168.02	168.02	165.55	126.08	75%	45%	56.81
Instant Rebates	Total kWh	6,024	11,605	11,338	13,421	251%	76%	10,161
	Total kW	0.70	1.40	1.39	1.39	198%	75%	1.04
Total[a]	**Total kWh**	**2,727,710**[b]	**2,781,468**	**2,612,382**	**2,460,580**	**90%**	**60%**	**1,469,508**
	Total kW	**1,024**	**1,026**	**1,011**	**1,024**	**100%**	**54%**	**553**

[a] Totals do not represent sum of the parts due to rounding.
[b] This reported value does not match the value found in the DSM scorecard because of a discrepancy with the Standard component subtotal. The subtotal contained a formula error that excluded heat pump water heater, but aligns with the sum of all the Standard measures in the DSM scorecard when heat pump water heaters are included.

CenterPoint Energy's *ex ante* savings for the Standard, Midstream, Online Marketplace, and Instant Rebates channels are derived primarily from 2021 program-evaluated savings. For most measures, Cadmus' 2022 evaluation used the same methodology as in 2021, so differences between *ex ante* and *ex post* are largely due to differences in participant survey results and program tracking data.[5] Instant Rebates *ex ante* savings were based primarily on 2019 and 2021 evaluated savings from various CenterPoint Energy programs.

Table 8 through Table 11 provide per-unit annual gross savings for each program measure by channel.

Table 8. 2022 Residential Prescriptive Program Per-Unit Gross Savings – Standard Channel

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
HVAC	AC Tune-Up	89.44	109.68	0.15	0.18
Appliance and Plug Load Reduction	Air Purifier	680.73	236.86	0.08	0.03
Weatherization	Attic Insulation (Electric)	4041.01	4,409.15	0.43	0.44
HVAC	Central Air Conditioner 16 SEER	376.84	398.92	0.47	0.48
HVAC	Central Air Conditioner 18 SEER	695.39	848.54	0.59	0.70
Appliance and Plug Load Reduction	Clothes Dryer	160.00	162.00	0.02	0.02
Appliance and Plug Load Reduction	Clothes Washer	202.00	164.86	0.03	0.02
Appliance and Plug Load Reduction	Dehumidifier	273.00	97.78	0.06	0.01

5 Changes in year-to-year program tracking data include installed equipment efficiencies, equipment age, home square footage, installation location, baseline information (i.e., programmable thermostat prevalence and usage patterns), percentage of installs considered to be early replacements, etc.

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
Weatherization	Attic Insulation (Dual Fuel)	450.84	428.74	0.38	0.36
HVAC	HP Tune-up	288.86	412.23	0.14	0.19
Other	Pool Heater COP >= 6	1233.74	1,254.50	-	-
Other	Pool Heater COP 5.5-5.9	899.94	1,087.70	-	-
Thermostats	Smart Programmable Thermostat - South (Dual)	282.31	253.93	-	-
Thermostats	Smart Programmable Thermostat - South (Electric)	887.94	935.52	-	-
Other	Variable Speed Pool Pump	1172.57	1,755.31	-	1.72
Weatherization	Wall Insulation - All EL	868.76	843.05	0.07	0.06
Weatherization	Wall Insulation - Dual Fuel	94.40	109.68	0.09	0.09
Thermostats	Wi-Fi Thermostat - South (Dual)	281.90	265.09	-	-
Other	HP Water Heater	2505.10	2,574.99	-	0.35
Weatherization	Duct Sealing South	0.00	-	-	-
Thermostats	Wi-Fi Thermostat - South (Electric)	443.85	471.95	-	-

Table 9. 2022 Residential Prescriptive Program Per-Unit Gross Savings – Midstream Channel

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
HVAC	Air Source HP 16 SEER	828.06	594.37	0.45	0.25
HVAC	Air Source HP 18 SEER	1,474.78	1,334.63	0.25	0.24
HVAC	Ductless HP 19 SEER 9.5 HSPF	2,910.73	2,997.69	0.34	0.35
HVAC	Ductless HP 21 SEER 10 HSPF	3,300.64	3,019.95	0.39	0.36
HVAC	Ductless HP 23 SEER 10 HSPF	2,614.09	2,377.64	0.36	0.35
Other	HP Water Heater	0.00	0.00	0.34	0.00

Table 10. 2022 Residential Prescriptive Program Per-Unit Gross Savings – Online Marketplace Channel

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
Water-Saving Devices	Aerator (Dual)	88.39	25.93	0.01	0.36
Appliance and Plug Load Reduction	Air Purifier	210.34	60.67	0.09	0.01
Appliance and Plug Load Reduction	Dehumidifier	273.00	98.48	0.06	0.01
Other	EE Kits	670.03	199.58	0.00	0.03
Lighting	LED Night Light	13.14	0.00	0.00	0.00
Lighting	LED Reflector	49.09	42.45	0.01	0.01
Lighting	LED Specialty	28.73	39.21	0.00	0.00
Water-Saving Devices	Showerhead	321.14	0.00	0.01	0.00
Appliance and Plug Load Reduction	Smart Power Strips	25.83	21.98	0.00	0.00

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
Thermostats	Smart Programmable Thermostat - South (Dual)	321.03	199.40	0.00	0.00
Thermostats	Smart Programmable Thermostat - South (Electric)	740.25	742.14	0.00	0.00
Weatherization	Weatherstripping	5.75	4.66	0.00	0.00
Other	Pipe Insulation	0.00	334.19	0.00	0.00
Water-Saving Devices	Bathroom Aerator	0.00	0.00	0.00	0.00
Thermostats	Wi-Fi Thermostat - South (Dual)	0.00	0.00	0.00	0.00
Thermostats	Wi-Fi Thermostat - South (Electric)	0.00	0.00	0.00	0.00

Table 11. 2022 Residential Prescriptive Program Per-Unit Gross Savings – Instant Rebates Channel

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
Appliance and Plug Load Reduction	Air Purifier	681	0.00	0.00	0.00
Other	Heat Pump Water Heater	2,556.77	2,549.87	0.35	0.35
Thermostats	Smart Programmable Thermostat - South (Dual)	229.64	290.10	0.00	0.00
Appliance and Plug Load Reduction	Dehumidifier	0.00	91.73	0.00	0.00
Thermostats	Smart Programmable Thermostat - South (Electric)	0.00	1,007.51	0.00	0.00
Appliance and Plug Load Reduction	Smart Power Strips	0.00	0.00	0.00	0.00
Lighting	LED Specialty	0.00	0.00	0.00	0.00
Lighting	LED Reflector	0.00	0.00	0.01	0.00
Water-Saving Devices	Kitchen Aerator	0.00	0.00	0.00	0.00
Water-Saving Devices	Bathroom Aerator	0.00	0.00	0.00	0.00

The following describes measures with substantial differences between *ex post* and *ex ante* savings by program channel.

Residential Prescriptive – Standard

The following are the notable assumption differences between *ex ante* and *ex post* savings:

- **Air purifier.** Cadmus relied on the Illinois TRM V9.0 rather than the ENERGY STAR calculator because the former is based on the most recent ENERGY STAR specification that came into effect in 2020. The ENERGY STAR calculator, which CenterPoint Energy used to determine *ex ante* savings, assumes a baseline clean air delivery rate (CADR) of 1.0, whereas the Illinois TRM V9.0 assumes a more efficient baseline with a CADR of 1.9. This updated baseline assumption came from the Air Cleaner Data Package released by ENERGY STAR to supplement the new specification update.
- **Heat pump tune-up.** *Ex ante* heat pump efficiency metrics were from averages of efficient heat pumps installed in 2019. In the 2021 evaluation, Cadmus used efficiency metrics from the Illinois

TRM V9.0, which more accurately captures the market average heat pump to which a tune-up would be applied.

- **Insulation.** Differences in reported-to-evaluated savings for insulation measures are primarily due to shifts in HVAC equipment saturations based on participant surveys.
- **Variable speed pool pump.** Differences in variable speed pool pump *ex ante* and *ex post* savings are explained by the 2022 program database field for operating days per year. On average, this value was higher than the *ex ante* assumption, which used the 2015 IN TRM V2.2, resulting in higher per-unit evaluated savings.

Residential Prescriptive – Midstream

The majority of the Midstream channel's *ex ante* savings were based on evaluated savings for similar measures in the 2021 evaluation. Notable assumption differences between *ex ante* and *ex post* savings are these:

- **Ductless heat pump.** The savings differences in ductless heat pumps were due to differences in efficiency metrics and especially in capacity values from evaluated savings in 2019 and 2021 compared to installed measures in 2022.

Residential Prescriptive – Online Marketplace

The majority of the Online Marketplace channel's *ex ante* savings were based on evaluated savings for similar measures in the 2021 evaluation. Notable assumption differences between *ex ante* and *ex post* savings are these:

- **Energy efficiency kits.** This measure was new to the program in 2022. Energy efficiency kits contain two types of faucet aerators (kitchen and bathroom), a showerhead, a specialty bulb, night lights, and a hot water temperature gauge. For most of the contents, Cadmus based its savings methodology on the 2015 IN TRM V2.2. For the hot water temperature gauge, Cadmus used the IL TRM V10 and averaged the savings across electric and natural gas heated homes. Most of the installations occurred in homes with natural gas heating, so the evaluated electric savings were relatively low. These installations are counted in the electric scorecard because of the electric lighting included in the energy efficiency kits. CenterPoint Energy's *ex ante* estimated savings assumed that water heater fuel was electric for all installations. The difference in reported and evaluated savings is due to differences in how the type of fuel is split between homes.
- **Pipe insulation.** The 2022 electric scorecard did not include this measure, but the electric program data contained pipe insulation data. Cadmus used the 2015 IN TRM V2.2.
- **Weatherstripping.** The *ex ante* kWh savings were much lower than the evaluated kWh savings, resulting in a very high realization rate.

Residential Prescriptive – Instant Rebates

This was the first year for the Instant Rebates channel, so *ex ante* savings were sourced primarily from past evaluated savings of similar measures in other CenterPoint Energy programs. Different programs have different program-specific considerations and measure granularity. Some program measure savings may be specific to fuel type, housing segment, or installation location. Differences in these assumptions drive some of the differences in *ex ante to ex post* savings for Instant Rebates measures. The program data included fields for service territory and equipment fuel type, which Cadmus used to inform which installations received savings and for which fuel type. All of these considerations resulted in differences between reported and evaluated measure quantities and savings.

- **Dehumidifier.** The 2022 scorecard did not include this measure, but the program data contained dehumidifier records. Cadmus used the federal 2015 Notice of Proposed Rulemaking Technical Support Document (NOPR TSD).[6]
- **Thermostats**. CenterPoint Energy appears to have used the ASHP average capacity from Cadmus' 2021 evaluation to determine savings. Cadmus used 2022 program data to calculate the average capacity, so the differences between *ex ante* and *ex post* are largely due to differences in participant survey results and program tracking data.

Residential New Construction Program

Through the ***Residential New Construction Program,*** CenterPoint Energy has provided incentives to builders who construct homes that receive a Home Energy Rating System (HERS) score of 62 or lower.[7] HERS raters measure and verify participating home performance. All builders constructing high-efficiency homes in CenterPoint Energy's service territory could have participated in the program.

The program was discontinued at the end of 2021, except where carryover rebates were paid prior to the discontinuation of the program for projects completed in 2021.

Prior to the discontinuation of the program, CenterPoint Energy provided three incentive tiers: one for Gold Star homes (rating 61 to 62), one for Platinum Star homes (rating 60 or less), and one for Platinum Star Plus homes (rating 60 or less, including installation of a natural gas tankless water heater). Since the discontinuation of the Residential New Construction Program, builders have been encouraged to continue using energy-efficient building practices with incentives offered through the Residential Prescriptive Program.

Impact Evaluation Overview

For the 2022 evaluation, Cadmus evaluated projects carried over from the 2021 program year. Cadmus used the evaluated per-unit savings from 2021 multiplied by the number of measures in 2022, which increased realization rates. The realization rates for the Residential New Construction Program increased to 95% for energy and increased to 51% for demand in 2022 (39% for energy and 32% for demand in 2021). The realization rates increased due to changes in reported values in 2022.

Table 12 lists the evaluated savings summary for the Residential New Construction Program.

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6 Regulations.gov. 2015 Notice of Proposed Rulemaking (NOPR). "2015-05 NOPR Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Dehumidifiers." https://www.regulations.gov/document?D=EERE-2012-BT-STD-0027-0030

7 Under HERS, the lower the score the higher the efficiency.

Table 12. 2022 Residential New Construction Program Electric Savings

Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rates	NTG Ratio	Evaluated Net Savings
	Reported	Audited	Verified				
Total kWh	21,997	21,997	21,997	20,933	95%	57%	11,932
Total kW	16.20	5.76	5.76	8.26	51%	57%	4.71

Table 13 provides per-unit annual gross savings for each program measure (incentive tier).

Table 13. 2022 Residential New Construction Program Per-Unit Gross Savings

Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
	Reported	Evaluated	Reported[a]	Evaluated
Gold Star (Dual Fuel)	435	158	0.386	0.094
Platinum Star (Dual Fuel)	481	195	0.386	0.250
Platinum Star (Electric)	508	206	0.386	0.267
Platinum Star Plus (Dual Fuel)	608	236	0.386	0.071

[a] CenterPoint Energy's 2021 Electric DSM Scorecard reported an averaged, per-unit kW savings value.

Income Qualified Weatherization Program

Through the ***Income Qualified Weatherization (IQW) Program***, CenterPoint Energy offers its low-income customers (up to 200% of the federal poverty level) a walk-through home energy audit that includes full diagnostic testing for the home.

CenterPoint Energy sponsors the program. CLEAResult, as the program implementer, is responsible for scheduling appointments and completing initial assessments with their trained auditors. Auditors recommend weatherization measures or upgrades that facilitate the installation of energy-saving measures at no cost to the customer. Auditors will help participants schedule follow-up installation appointments with trade allies if professional contractor work is needed.

Gross Savings

Installation of attic insulation measures in electric only (electric heating and cooling) likely boosted per-home savings in 2022 compared to 2021. Savings per home increased to 384 kWh in 2022 from 346 kWh in 2021. This increase was largely driven by three homes with electric resistance heat that received attic insulation measures, which accounted for 9% of all electric energy savings in 2022. No homes with electric resistance heat received attic insulation measures in 2021. Without these three, savings per home would be 349 kWh in 2022, very similar to the 346 kWh in 2021.

Recommendation: Where possible, prioritize homes with electric resistance heat for weatherization measures such as attic insulation. Additional research could be conducted to identify high electric energy using customers that could be targeted by the program.

The IQW Program did not meet its goals this year because it did not reach expected participation. The program planned to serve 760 homes in 2022 but was able to serve only 415 (55% of goal), despite adjustments to the recruitment approach. CenterPoint Energy and the program implementer changed the language used in recruitment and offered incentives for referring friends and family. Program staff plans to continue revising the recruitment approach to bolster participation in 2023.

Recommendation: Add questions to the 2023 participant evaluation survey to better understand customer motivation for participation and use the findings to inform recruitment approaches in subsequent program years.

Recommendation: Explore partnership opportunities with community action agencies, even just to help promote or raise awareness for the program

Evaluated whole home electric savings were much lower than reported because the IQW Program cannot claim savings for air purifiers and dehumidifiers that do not replace an existing inefficient or inoperable model. In 2022, air purifiers and dehumidifiers installed through the Healthier Homes Initiative were reported and attributed to the Whole Home IQW (electric only) measure savings category. However, typically, these installations for the Healthier Homes Initiative are new and do not replace an existing inefficient or inoperable model. They do not reduce the home's energy load but instead add to it. Nevertheless, as intended by the Healthier Homes Initiative, these measures add value by providing real health benefits to participants from improved air quality in the home.

Cadmus removed these measures from the savings verification process, as it is inappropriate to claim savings for measures that add load. This resulted in significantly lower evaluated savings for Whole Home IQW than reported.

Recommendation: Continue to offer but do not claim savings for measures like air purifiers and dehumidifiers when they are offered due to environmental concerns as they are new and adding load (instead of replacing an existing inefficient or inoperable model). Savings can and should be claimed when new equipment is replacing old inefficient equipment. Tracking when old equipment is replaced will be required to fully claim the savings. Work with the evaluator to determine information that should be tracked.

Impact Evaluation Overview

Table 14 lists the evaluated savings summary for the IQW Program.

Table 14. 2022 Income Qualified Weatherization Electric Savings

Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rate	NTG Ratio	Evaluated Net Savings
	Reported	Audited	Verified				
Total kWh	245,248	245,222	244,136	182,201	74%	100%	182,201
Total kW	52.42	85.98	85.95	43.67	83%	100%	43.67

Table 15 provides per-unit annual gross savings for each program measure.

Table 15. 2022 Income Qualified Weatherization Per-Unit Gross Savings

Measure	Annual Gross Savings (kWh)[a]		Annual Gross Savings (Coincident Peak kW)[b]	
	Reported	Evaluated	Audited	Evaluated
AC Tune-Up	154	78	0.195	0.127
Air Sealing 20% Infil. Reduction - (Dual Fuel)	213	393	0.312	0.576
Attic Insulation (Dual Fuel)	423	401	0.399	0.378
Attic Insulation (Electric)	4,662	5,529	0.901	0.538
Audit Fee MF (Dual Fuel)	17	48	0.005	0.001
Audit Fee SF (Dual Fuel)	80	68	0.019	0.001
Audit Fee SF (Electric Measures)	76	64	0.008	0.001
Audit Fee SF (Electric Only)	114	106	0.021	0.001
Bathroom Aerator MF (Electric)	27	27	0.003	0.003
Bathroom Aerator SF (Electric)	27	30	0.003	0.003
Central Air Conditioner 16 SEER	228	242	0.326	0.344
Exterior LED Lamps	92	92	0.000	0.000
Furnace Tune-Up	6	4	0.006	0.000
HP Tune-Up	155	266	0.197	0.118
IQW Whole Home (Dual Fuel)	571	19	0.372	0.029
IQW Whole Home (Electric Only)	681	0	0.000	0.000
Kitchen Flip Aerator - Electric MF	132	132	0.007	0.007
Kitchen Flip Aerator - Electric SF	117	116	0.007	0.007
LED 5W Bulb IQW MFDI	19	11	0.002	0.002
LED 5W Bulb Manufactured home	18	19	0.002	0.002
LED 5W Bulb SFH	19	18	0.002	0.002
LED 5W Candelabra	23	23	0.003	0.003
LED Night Light	13	13	0.000	0.000
LED R30 Bulb SFH	54	53	0.022	0.007
Low Flow Showerhead - Electric SF	291	267	0.015	0.015
Pipe Wrap - Electric DHW (per home)	89	90	0.010	0.010
Refrigerator Replacement	735	345	0.108	0.051
Smart Power Strips	25	24	0.002	0.002
Smart Thermostat MF (Dual Fuel)	337	191	0.000	0.000
Smart Thermostat MF (Electric)	747	517	0.000	0.000
Smart Thermostat SF (Dual Fuel)	337	321	0.000	0.000
Smart Thermostat SF (Electric)	1,364	1,323	0.000	0.000
Wall Insulation - (Dual Fuel)	39	26	0.042	0.026
Wall Insulation - (Gas)	72	66	0.078	0.070

[a] CenterPoint Energy's 2022 DSM Scorecard did not have kWh savings at the measure level. These per-unit savings reflect audited savings from the 2022 program tracking data.
[b] CenterPoint Energy's 2022 Electric DSM Scorecard reported an averaged, per-unit kW savings value.

Appliance and plug load reduction. Refrigerator replacement per-unit savings are updated yearly with an analysis based on appliance recycling program findings, the existing refrigerator's age and model, and installed efficient refrigerator model numbers reported in the tracking data. In the 2020 evaluation, a single 37-year-old refrigerator was replaced which resulted in an average existing refrigerator UEC of 1,965 kWh, compared with an average age of 18 years and existing refrigerator UEC of 1,128 kWh in 2022. These inputs contribute to the assumed baseline energy consumption and are the biggest drivers in determining refrigerator replacement per-unit savings. Evaluated savings for refrigerator replacement resulted in an average per-unit savings of 388 kWh in 2022, compared with the average of 747 kWh calculated in 2020.

Audit education. The audit education measures vary from year to year depending on how many survey respondents say they have taken energy-saving actions. No IQW Program survey was conducted in 2022, so Cadmus used the results from the 2021 survey. In 2021, 43% of respondents reported taking shorter showers compared with 46% in 2020, and 68% reported turning off the lights while not in use compared with 61% in 2020. However, no respondents in 2021 reported installing additional weatherization measures, compared with 12% in 2020.

Evaluated savings are also dependent on whether a household installed a smart strip, smart thermostat, or both; if so, that household is ineligible for savings associated with unplugging appliances or programming the thermostat correctly. In 2022, a significantly larger portion of audit participants installed additional smart strips than in 2020. Therefore, in 2022, evaluated energy savings for these measures were less than reported energy savings.

HVAC measures. Differences in savings varied by measure:

- **Air conditioner tune-ups** had substantially lower evaluated savings than reported savings, and **heat pump tune-ups** had substantially higher evaluated savings than reported savings. The heat pump tune-up measure was not offered prior to 2019, so reported savings were not based on previous evaluation findings. To determine energy and demand savings, Cadmus used the average capacity of 2022 program-installed central air conditioners and 2021 air source heat pumps as an input to the 2015 Indiana TRM v2.2 algorithm. Reported savings were from an unknown source and used the same deemed savings for both air conditioners and heat pumps in 2020, 2021, and 2022, so the planning methodology may have differed from the TRM for air conditioner and heat pump tune-ups.[8]
- **Furnace tune-up for electric furnaces** had lower evaluated savings than reported savings. Evaluated savings included electric furnace tune-up savings associated with reduced activation and fan use as a result of cleaning electric furnace heating elements; however, the savings associated with reduced fan use were much less than reported. Reported savings were from an unknown source and used the same deemed savings for both air conditioners and heat pumps in 2020, 2021, and 2022.
- **Central air conditioner** had higher evaluated savings than reported savings due to higher cooling capacities in 2022, with an average capacity of 29,300 BTUH compared with an average capacity of 26,147 BTUH in 2020.

8 CenterPoint Energy did not provide *ex ante* assumptions for air conditioner and heat pump tune-ups.

Lighting. Realization rates were around 100% for all bulb types with one exception. For the LED 5-watt bulb in multifamily homes, a greater portion of the homes used electric heating and cooling in 2022 than in 2020. Due to the interactive effects associated with electric heating and cooling, average evaluated savings for the LED 5-watt bulb were less in 2022 than in 2020.

Thermostats. Evaluated smart thermostat savings are based off the combination of a 2013-2014 CNP South territory thermostat study and baseline saturations informed by IQW participant surveys. No IQW Program survey was conducted in 2022, so Cadmus used results from the 2021 survey to inform existing manual and programmable thermostat saturations . Smart thermostats had lower evaluated savings than reported savings because the programmable thermostat baseline saturation increased in 2021. Forty-three percent of the respondents to the 2021 IQW Program survey reported owning a programmable thermostat prior to installing a smart thermostat, compared with 53% in the 2020 IQW Program survey.

Water-saving devices. Differences in savings for water-saving devices were due to differences in the survey inputs for a single-family home, such as people per home, showers per home, and bathroom faucets per home, from year to year. No IQW Program survey was conducted in 2022, so Cadmus used the results from the 2021 survey. For example, faucets per home is a survey input that has an inverse relationship with aerator savings. Bathroom faucets per single-family home was 1.41 in 2021 compared with 1.60 in 2020, resulting in evaluated savings greater than reported. For kitchen aerators, a difference in verified in-service rates resulted in the slightly lower evaluated savings, where the in-service rate in the 2021 IQW Program survey was 91.7% compared with 95.2% in 2020. There were no multifamily responses in the 2021 survey data, so Cadmus determined inputs using survey data from the 2020 Multifamily Direct Install Program, which resulted in the same evaluated savings as reported for multifamily faucet aerator.[9]

Weatherization. Reported and evaluated savings for weatherization measures differed widely because each installation had site-specific data that affected the amount of savings given to each home:

- **Air sealing** had higher evaluated savings primarily due to higher average infiltration reduction in 2022 compared with 2020. The average difference in pre- and post-installation air flow was 2,135 cfm in 2022 compared with 1,155 cfm in 2020.
- **Attic and wall insulation** per-unit savings differences were the result of different average installed square footage and R-values in 2020 and 2022.
- **Whole Home IQW** measures received lower evaluated savings than reported savings for a variety of factors. For the reported Whole Home IQW measures not associated with the Healthier Homes Initiative dehumidifier and air purifier install measures, evaluated savings used notes provided in the neighborhood weatherization whole home recap and health and safety recap to assign applicable program average deemed savings for measures that could not already be accounted for elsewhere in the program. These measures included water heater replacement, air sealing, duct sealing, air conditioner tune-up, furnace tune-up, furnace

[9] Cadmus. June 4, 2021. *2020 CenterPoint Energy Demand-Side Management Portfolio Natural Gas Impacts Evaluation.*

replacement, and air conditioner replacement. Average per-household electric energy savings were less in 2022 compared with 2020 because an electric water heater replacement measure in 2020 resulted in significantly higher savings than is typical for this measure.

In 2022, air purifiers and dehumidifiers installed through the Healthier Homes Initiative were reported and attributed to the Whole Home (electric only) measure savings category. However, these installations for the Healthier Homes Initiative are new and not to replace an existing inefficient or inoperable model; that is, they are not reducing the home's energy load but instead are adding to it. Although these measures add value by providing real health benefits to participants from improved air quality in the home, Cadmus determined that these measures have no basis for savings and assigned zero evaluated Whole Home IQW (electric only) savings.

Residential Behavioral Savings Program

Since 2012, the ***Residential Behavioral Savings (RBS) Program*** has been sending customers home energy reports (HERs), which provide energy consumption information and encourage the adoption of energy-saving behaviors and home improvements. These reports contain the household's energy use data, a similar neighbor comparison on energy use, and energy-saving tips. The program also provides energy usage information to all residential CenterPoint Energy customers on the customer's online utility account webpage. Oracle is the program implementer.

The RBS Program uses an experimental design called a randomized control trial wherein customers are randomly assigned to either a treatment group (recipients of HERs) or a control group (nonrecipients). Treatment group customers are mailed print HERs, and those with valid email addresses also receive the reports via email. Control group customers do not receive the HERs; the control group's consumption provides a baseline for measuring the program's energy savings.

Treatment and control group customers are further segmented into "waves" according to their CenterPoint Energy fuel service (electric only or dual fuel) and the year in which they started or would have started receiving the HERs. For several years, CenterPoint Energy operated the program with two waves—one electric only and one dual fuel—as Wave 1.

In 2020, CenterPoint Energy launched a second dual fuel wave—as Wave 2—to address customer attrition. Attrition occurs when customers close their CenterPoint Energy accounts. Long-running programs like CenterPoint Energy's can lose a large portion of the originally randomized customers as the program ages, and this loss can compromise the experimental design and reduce the likelihood of detecting a significant treatment effect (energy savings).

Savings & Uplift

Savings for both dual fuel waves dropped from 2021 to 2022. Wave 1 (electric only) increased in savings from 2021 to 2022. Cadmus observed that, from 2021 to 2022, Wave 1 electric only savings increased from 1.20% to 1.32%. Wave 1 dual fuel savings fell from 1.53% to 1.06%, and Wave 2 dual fuel savings fell from 0.88% to 0.71%.

Wave 1 electric savings were still lower than prior program years, and the drop in savings can be attributed to more temperate weather and normalizing to typical savings.

Wave 1 dual fuel savings, however, fell to the lowest levels in the last four years. In particular, from May 2022 to October 2022, Wave 1 dual fuel had 1.04% in savings, compared with an average of 1.33% over the same months in all other years since program launch.

Wave 2 had savings of 0.71% savings. The slight decrease in savings from 2021 may be due to the decrease in savings from May to October 2022. Savings during these months averaged 0.49%, similar to the 0.41% average savings in 2020, but lower than the 0.92% in 2021.

Recommendation: Work with implementer to determine if savings for the dual fuel waves could be increased with different messaging or targeted recommendations in 2023.

The RBS Program is encouraging cross-program participation. In 2021, across all three electric waves—Wave 1 electric only, Wave 1 dual fuel, and Wave 2— and across all programs, uplift savings were positive. In 2022, Wave 1 electric only had negative uplift savings across all programs while Wave 1 dual fuel and Wave 2 remained positive across all programs.

In 2022, the HERs specifically promoted appliance recycling and low-income efficiency kits. RBS Program uplift savings were positive for two waves, both Wave 1 electric only and Wave 1 dual fuel. Wave 1 electric only achieved 2,305 kWh in energy savings between the two promoted programs, while other programs had negative uplift savings. Wave 1 dual fuel achieved a combined 20,922 kWh in energy savings from the Appliance Recycling and Income Qualified Weatherization programs. While combined uplift for the appliance recycling program increased from 2021, total uplift savings across all programs and waves decreased from 70,900 kWh in 2021 to 18,231 in 2022.

Impact Evaluation Overview

Table 16 lists the evaluated savings summary for the Residential Behavioral Savings Program. The 2022 evaluation resulted in a 137% energy savings realization rate and a 83% demand realization rate. Cadmus deducted 26,276 kWh and 8.61 kW uplift savings to avoid double-counting savings claimed in other CenterPoint Energy programs. The deductions are only from waves with positive savings. For energy savings, the deduction was for both dual fuel waves. For demand, uplift savings occurred only in Wave 1 dual fuel. For waves where uplift savings were negative, no adjustments were made because savings are not being double-counted in other programs.

Table 16. 2022 Residential Behavioral Electric Savings

Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rates	NTG Ratio	Evaluated Net Savings
	Reported	Audited	Verified				
Total kWh	3,948,025	3,948,025	3,948,025	5,396,100	137%	N/A	5,396,100
Total kW	2,025	2,025	2,025	1,684	83%	N/A	1,684

Note: Evaluated savings have been adjusted for uplift.

Table 17 and Table 18 show the 2022 reported and evaluated program net energy and demand savings and the realization rates for the RBS Program.[10] The reported energy and demand savings are within

[10] Because the experimental design uses a control group as the savings baseline, the regression analysis produces only net savings estimates (no gross estimates).

Cadmus' 90% confidence interval for evaluated *ex post* savings. The confidence interval defines the range of values that are likely (specifically, 90% likely defined by the confidence level) to contain the true *ex post* savings. If the *ex ante* savings are also within this range then there is no statistical difference. Savings in these tables do not include the uplift findings.

Table 17. 2022 RBS Program Electric Savings

Customer Segment	Annual Net Electricity Savings (MWh/yr)		90% Confidence Interval		Relative Precision	Realization Rate
	Reported	Evaluated[1]	Lower Bound	Upper Bound		
Wave 1 Electric Only (2012)	N/A	1,912	84	3,741	±96%	N/A
Wave 1 Dual Fuel (2013)	N/A	2,640	-354	5,634	±113%	N/A
Wave 2 Dual Fuel (2020)	N/A	870	120	1,620	±86%	N/A
Total	**3,948**	**5,422**	**1,835**	**9,010**	**±66%**	**137%**

Note: Evaluated savings have not been adjusted for uplift.

Table 18. 2022 RBS Program Demand Savings

Customer Segment	Annual Net Electricity Savings (MW/yr)[1]		90% Confidence Interval		Relative Precision	Realization Rate
	Reported	Evaluated	Lower Bound	Upper Bound		
Wave 1 Electric Only (2012)	N/A	0.60	-0.08	1.28	±114%	N/A
Wave 1 Dual Fuel (2013)	N/A	0.82	-0.29	1.94	±135%	N/A
Wave 2 Dual Fuel (2020)	N/A	0.27	-0.01	0.55	±103%	N/A
Total	**2.03**	**1.69**	**0.80**	**2.58**	**±51%**	**84%**

Note: Evaluated savings have not been adjusted for uplift.

Table 19 shows the 2022 reported the historical daily savings for the three waves of the program.

Table 19. 2022 RBS Program Historical Daily Electric Savings per Customer

Program Year	Wave 1 Electric Only		Wave 1 Dual Fuel		Wave 2 Dual Fuel	
	kWh/day [a]	Percentage [b]	kWh/day [a]	Percentage [b]	kWh/day [a]	Percentage [b]
2012	0.431 (0.094) ***	1.10%	0.208 (0.085) **	0.63%	N/A	N/A
2013	0.641 (0.142) ***	1.52%	0.297 (0.1) ***	0.95%	N/A	N/A
2014	0.727 (0.176) ***	1.66%	0.427 (0.118) ***	1.39%	N/A	N/A
2015	0.699 (0.175) ***	1.69%	0.46 (0.127) ***	1.50%	N/A	N/A
2016	0.66 (0.189) ***	1.62%	0.436 (0.143) ***	1.39%	N/A	N/A
2017	0.734 (0.198) ***	1.85%	0.395 (0.149) ***	1.33%	N/A	N/A
2018	0.815 (0.244) ***	1.85%	0.297 (0.169) *	0.94%	N/A	N/A
2019	0.674 (0.25) ***	1.61%	0.47 (0.179) ***	1.56%	N/A	N/A
2020	0.795 (0.264.) ***	1.99%	0.583 (0.186) ***	2.01%	0.178 (0.099) *	0.50%
2021	0.485 (0.285) *	1.20%	0.446 (0.196) **	1.53%	0.29 (0.098) ***	0.88%
2022	0.527 (0.306) *	1.32%	0.302 (2.08)	1.06%	0.235 (0.123) *	0.71%

[a] Standard errors clustered on customers are presented after the estimated treatment effect in parentheses (*** Significant at 1%; ** Significant at 5%; * Significant at 10%). The treatment effects represent the average daily savings per treatment group customer.
[b] Percentage savings are relative to control group consumption in the same time period.

In 2022, savings decreased for both dual fuel segments compared to 2021, from 1.53% to 1.06% for Wave 1 and from 0.88% to 0.71% for Wave 2. Wave 1 electric only savings increased from 1.2% to 1.32%. Part of the decreases for both dual fuel segments is likely attributable to more temperate weather; however, weather may not be the sole driver. When examining the monthly savings for Wave 1 dual fuel, Cadmus found that savings fell from May to October of 2022, an average savings of 1.04%. During the same months in all other program years, average savings were 1.33%.

Wave 2 had savings of 0.235 kWh per day, equivalent to 0.71% of baseline consumption. This slight decrease from 2021 may be partly due to the decrease in savings from May to October 2022. Savings during these months averaged 0.49%, similar to the 0.41% average savings from May to October 2020.

Table 20 and Table 21 shows annual uplift savings per treated home and total uplift savings by program and wave. Both dual fuel waves exhibited positive uplift savings in 2022, indicating that the HERs drove increased savings in other CenterPoint Energy programs. Appliance Recycling and Income Qualified Weatherization were both promoted by CenterPoint in the 2022 HER reports.

Wave 1 dual fuel had the largest savings uplift for both energy and demand. Wave 1 electric only had negative savings for both energy and demand. At a program level, Income Qualified Weatherization accounted for 56% of the energy savings uplift and 70% of the demand uplift for the Wave 1 dual fuel savings. Because waves achieved both positive and negative uplift savings, Cadmus adjusted only the positive wave-level savings to avoid double-counting.

As discussed in previous evaluations, negative uplift savings may be caused by a greater number of control participants who were not encouraged early on to participate in other CenterPoint programs. Wave 1 electric only had fewer treatment group participants than control group participants per 1,000 households, which aligns with negative energy and demand uplift savings. Wave 1 dual fuel had more treatment group participants than control group participants per 1,000 households.

Table 20. 2022 RBS Program Electricity Savings from Uplift

Program	Wave 1 Electric Only		Wave 1 Dual Fuel		Wave 2 Dual Fuel		Total Uplift Savings (kWh/yr)
	Annual Uplift Savings per Home (kWh/yr)	Total Uplift Savings (kWh/yr)	Annual Uplift Savings per Home (kWh/yr)	Total Uplift Savings (kWh/yr)	Annual Uplift Savings per Home (kWh/yr)	Total Uplift Savings (kWh/yr)	
Appliance Recycling	0.12	1,238	0.27	6,740	-0.08	-823	7,156
Income Qualified Weatherization	0.10	1,067	0.58	14,182	-0.23	-2,514	12,735
Residential Prescriptive - Marketplace	-0.05	-549	0.21	5,121	0.35	3,730	8,302
Residential Prescriptive - Midstream	-0.71	-7,247	-0.17	-4,247	0.48	5,131	-6,363
Residential Prescriptive - Standard	-0.23	-2,332	0.01	224	-0.46	-4,945	-7,053
Smart Cycle	-0.02	-222	0.00	0	0.04	461	239
Total	-0.79	-8,045	1.02	25,236	0.10	1,040	18,231

Table 21. 2022 RBS Program Demand Savings from Uplift

Program	Wave 1 Electric Only		Wave 1 Dual Fuel		Wave 2 Dual Fuel		Total Uplift Savings (kW)
	Uplift Savings per Home (kW)	Total Uplift Savings (kW)	Uplift Savings per Home (kW)	Total Uplift Savings (kW)	Uplift Savings per Home (kW)	Total Uplift Savings (kW)	
Appliance Recycling	0.0001	1.05	0.0000	0.74	0.0000	-0.30	1.48
Income Qualified Weatherization	0.0000	0.25	0.0002	6.00	-0.0004	-4.22	2.03
Residential Prescriptive - Marketplace	0.0000	0.18	0.0000	0.80	0.0000	0.33	1.32
Residential Prescriptive - Midstream	-0.0005	-4.90	0.0000	-0.65	0.0002	1.77	-3.79
Residential Prescriptive - Standard	-0.0006	-6.28	0.0001	1.72	-0.0005	-5.00	-9.56
Smart Cycle	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.00
Total	-0.0010	-9.71	0.0003	8.61	-0.0007	-7.41	-8.51

Appliance Recycling Program

Through the ***Appliance Recycling Program***, CenterPoint Energy provides removal and recycling services for operable refrigerators, freezers, and room air conditioners to prevent older appliances from remaining in service at a participant's premise or elsewhere in CenterPoint Energy's service territory. The program implementer, ARCA Recycling Inc., works with CenterPoint Energy to deliver the program. ARCA operates a recycling facility that follows U.S. Environmental Protection Agency best practices and recycles close to 100% of each unit picked up.

In 2022, customers could recycle up to two working refrigerators or freezers, sized 10 to 30 cubic feet, by scheduling a pick-up of the units through the program implementer. CenterPoint Energy provides a $50 incentive to customers for each qualifying refrigerator or freezer unit picked up, and during the month of April an additional $25 was offered with every pick-up. Free pick-up of room air conditioners with any qualifying refrigerator or freezer is allowed.

Program Implementation and Delivery

Limited transportation resources led to scheduling conflicts and high cancellation rates. The implementer reported a 41% cancellation rate for CenterPoint Energy's 2022 program, which is higher than the implementer's standard 20% cancellation rate. The implementer has been working on establishing its own transportation system with further plans to execute and grow its in-house network. However, due to limited drivers and high costs, the implementer has had to rely on a third-party transportation network, which has negatively impacted the scheduling and pick-up process.

Program Participation

Due to external market factors, program participation decreased. The implementer said participation in 2022 decreased due to high inflation rates and because customers bought fewer products. In 2022, 1,083 participants recycled a qualifying appliance, achieving 74% of the program participation goal. In 2021, there were 1,497 participants, which exceeded the 2021 goal. CenterPoint Energy and the implementer plan to investigate best marketing practices and explore retail partnerships to find solutions to increase participation in the Appliance Recycling Program.

Gross Savings Review

Per-unit savings are likely to decrease as the program recycles newer refrigerators and freezers over time. In 2022, evaluated per-unit gross kWh savings were 1% higher for refrigerators and 8% lower for freezers compared with CenterPoint Energy's reported savings, which were based on the results of the 2020 evaluation. Compared with 2020, the modest increase in refrigerator savings in 2022 was primarily due to recycling more refrigerators with a side-by-side configuration (6 percentage points) and fewer with a single-door configuration (1 percentage point). For freezers, evaluated savings were 8% lower than reported primarily due to a decrease of 7 percentage points in the portion of the year in which freezers were being used (part-use) and a 2% decrease in the average size of freezers.

Impact Evaluation Overview

Table 22 lists the evaluated savings summary for the Appliance Recycling Program.

Table 22. 2022 Appliance Recycling Program Electric Savings

Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rates	NTG Ratio	Evaluated Net Savings
	Reported	Audited	Verified				
Total kWh	1,017,988	1,013,628	1,013,628	1,009,663	99%	52%	521,359
Total kW	158	157	157	155	98%	54%	83

Table 23 provides per-unit annual gross savings for each program measure.

Table 23. 2022 Appliance Recycling Program Per-Unit Gross Savings

Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
	Reported	Evaluated	Reported	Evaluated
Freezer	722.0	663.0	0.107	0.097
Refrigerator	1,014.0	1,021.0	0.150	0.150
Room Air Conditioner	304.0	304.0	0.205	0.205

For 2022, Cadmus found a 1% increase in per-unit evaluated gross energy savings for refrigerators compared with reported savings (which are based on 2020 evaluated savings), primarily due to the following:

- 6 percentage point increase in the number of refrigerators with a side-by-side configuration
- 1 percentage point decrease in the number of refrigerators with a single-door configuration

The configuration is a key driver in how much energy a refrigerator consumes, and the mix of recycled refrigerators will drive the per-unit savings up or down.

For freezers, Cadmus found an 8% decrease in per-unit gross energy savings compared with the reported savings, primarily due to the following:

- 7 percentage point decrease in the portion of the year that freezers were being used (part-use factor)[11]

[11] A survey was not conducted in 2022. The 2022 evaluation used part-use factors from the 2021 survey.

- 2% decrease in average size of freezers
- 4 percentage point decrease in freezers manufactured before 1990[12]
- 16% decrease in the average age of freezers

Smart Cycle Program

Through the ***Smart Cycle Program***, CenterPoint Energy direct installs smart thermostats in residential homes to call load control events during the summer peak season. Although the program targets demand reductions during peak summer hours, it also achieves energy savings from the smart thermostats throughout the year.

Each year, CenterPoint Energy recruits participants from the long-running Summer Cycler Program to transition to the Smart Cycle Program.[13] Summer Cycler participants receive complimentary removal of their load control switches, an ecobee thermostat installed by a technician at no additional cost, and automatic enrollment into the Smart Cycle Program.

For the 2022 program year, CenterPoint Energy contracted with Threshold to schedule and perform the removal of the Summer Cycler load control switches and replace them with ecobee thermostats.

The 2022 Smart Cycle Program evaluation focused only on savings derived from normal use of the ecobee thermostats that were direct installed during the 2022 program year. [14]

Program Administration and Delivery

CenterPoint Energy could not deliver the Smart Cycle Program as planned due to challenges with the new installation contractor. The 2022 program completed 84 installations, well below the target of 500, due to unsuccessful marketing campaigns and marketing tactics. Halfway through the year, CenterPoint Energy discontinued work with the installation contractor. CenterPoint Energy will select a new installation contractor for 2023 and focus on improving marketing tactics to increase enrollment.

Peak Demand Savings for Smart Thermostats

There are not enough data to support the application of peak demand savings for smart thermostats aside from savings achieved through load control events. The 2015 Indiana TRM v2.2 assumes no coincident peak demand reduction for smart thermostats, and Cadmus could derive no consensus from researching other TRMs or studies. Peak definitions are highly dependent on climate and region, so it is best to rely on peak demand factors from local TRMs. There are conflicting approaches in the industry, so this topic warrants further discussion during the development of the updated Indiana TRM. The 2022

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[12] The U.S. Department of Energy's energy conservation standards for consumer refrigerators and freezers started in 1990.

[13] The Summer Cycler Program is another CenterPoint Energy program designed to reduce residential and small commercial air-conditioning and water-heating electricity loads during summer peak hours. Through this program, customers receive bill credits for allowing CenterPoint Energy to use radio communication equipment and load control switches to cycle off selected appliances during the summer.

[14] Cadmus evaluates the demand response impacts of the Smart Cycle Program under a separate evaluation.

Smart Cycle evaluation focused only on savings from normal use of the smart thermostats; therefore, this conclusion does not speak to the demand response impacts from Smart Cycle load control events during 2022.

Recommendation: For planning purposes, assume no coincident peak demand savings for normal use of smart thermostats until the new Indiana TRM is released and provides updated guidance.

Impact Evaluation Overview

Table 24 lists the evaluated savings summary for the Smart Cycle Program.

Table 24. 2022 Smart Cycle Program Electric Savings

Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rates	NTG Ratio	Evaluated Net Savings
	Reported	Audited	Verified				
Total kWh	43,593	43,593	40,513	39,550	91%	94%	37,277
Total kW	92	92	-	-	-	94%	-

Table 25 provides per-unit annual gross savings for the Smart Cycle Program.

Table 25. 2022 Smart Cycle Program Per-Unit Gross Savings

Program Component	Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
			Reported	Evaluated	Reported	Evaluated
Standard	Thermostats	Smart Cycle Thermostat - Dual Fuel	518.97	289.15	1.10	0
Standard	Thermostats	Smart Cycle Thermostat - Electric	518.97	924.16	1.10	0

The difference between reported and evaluated kWh savings is probably due to differences in *ex ante* and *ex post* assumptions of home heating fuel. Cadmus was unable to verify the exact assumptions, but comparison to the 2021 *ex ante* savings indicated a higher share of electric heating was assumed for 2022 *ex ante* savings. In the 2019 evaluation, 17.9% of surveyed participants had heat pumps and 12.5% had electric furnaces. No survey was conducted from 2020 through 2022 because the participant population was small, so Cadmus applied these 2019 survey results for home heating fuel to the 2021 and 2022 evaluations.

The 2015 Indiana TRM v2.2 does not assign coincident peak demand savings for smart thermostats. Additional details for measure-level savings can be found in *Appendix A. Impact Evaluation Methodology*.

Community Based LED Specialty Bulb Distribution Program

Through the ***Community Based LED Specialty Bulb Distribution Program,*** CenterPoint Energy partners with food banks and trustee offices in its electric service territory to give away LED bulbs and LED night lights at no cost to recipients. Starting in 2021 and continuing through 2022, due to modifications to the effective useful life (EUL) baseline for general service LEDs (GSLs), CenterPoint Energy distributed specialty LED bulbs (4-watt candelabras) instead of 9-watt GSLs through the program. In 2021, CenterPoint Energy also began distributing LED night lights and continued to do so in 2022.

Participant Trends

Low-income customers may be beginning to adopt LED bulbs on their own. Though evaluation surveys have not produced a statistically large number of responses, the evaluation team has tracked survey responses about pre-program LED bulb purchase habits since the first evaluation survey in 2018. Every year between 2018 and 2021, more than half of the respondents had not installed LEDs prior to their participation in the program.[15] In 2022, this trend changed, with 20 of 29 respondents (69%) having installed LEDs in their home prior to their participation. In 2023, the program will stop offering LEDs and instead offer other measures (such as smart strips and weatherstripping). This change is well-timed, given the trend toward LED adoption and federal standards going into effect. Cadmus can continue to track this metric to see if the trend continues.

Reported Savings

CenterPoint Energy used its 2020 *ex post* per-unit value for a 9-watt GSL as a proxy for its 4-watt candelabra measure, which affected program realization rates. Similar to 2021, per-unit savings of the 2022 program candelabras were 6% greater than the program GSLs in 2020. It would have been more appropriate to estimate savings based on a 4-watt candelabra.

In-Service Rates

The in-service rates for specialty LED bulbs in 2022 were consistent with in-service rates for specialty LED bulbs in 2021. Participant surveys from 2021 and 2022 indicated consistent results from in-service rates. Candelabra in-service rates were 77% in 2022 and 72% in 2021. In 2022, respondents installed 96% of the night lights they received.

Impact Evaluation Overview

Table 26 lists the evaluated savings summary for the Community Based LED Specialty Bulb Distribution Program. CenterPoint Energy realized 67% of reported annual energy savings and 51% of reported demand savings. Evaluated savings were lower than reported savings due to differences in lighting in-service rates, LED efficient wattage, and baseline wattage.

Table 26. 2022 Community Based LED Specialty Bulb Distribution Program Electric Savings

Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rate	NTG Ratio	Evaluated Net Savings
	Reported	Audited	Verified				
Total kWh	2,011,495	2,011,495	1,507,113	1,353,085	67%	100%	1,353,085
Total kW	313	312	241	160	51%	100%	160

Table 27 provides per-unit annual gross savings for each program measure.

15 Percentage of respondents who had **not** installed LED bulbs prior to their participation in the program for previous years: 2021 (n=9): 56%; 2020 (n=11): 55%; 2019 (n=67): 52%; 2018 (n=68): 57%

Table 27. 2022 Community Based LED Specialty Bulb Distribution Program Per-Unit Gross Savings

Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
	Reported	Evaluated	Reported	Evaluated
4W Candelabra	29.0	18.6	0.0040	0.0026
LED Night Light	13.1	12.2	0.0040	0

Evaluated savings deviated from reported savings primarily due to differences in baseline and efficient wattages. For 4-watt candelabras, CenterPoint Energy reported savings based on *ex post* savings of a 9-watt general purpose LED from 2020. Cadmus evaluated savings for this measure using the calculation methodology outlined in the Indiana TRM v2.2, efficient wattage based on the incentivized LED manufacturer model, and baseline wattage in the wattage equivalency table from the Illinois TRM v10.0.

For LED night lights, evaluated savings were lower than reported savings due to the application of in-service rates from participant surveys and a difference in the LED night light efficient wattage between reported and evaluated savings. Reported savings used an assumed LED night light wattage of 0.33, and evaluated savings used an actual wattage of 0.5 based on manufacturer model.

Commercial and Industrial Programs

Commercial and Industrial Prescriptive Program

Through the ***Commercial and Industrial (C&I) Prescriptive Program***, CenterPoint Energy provides prescriptive rebates to facilities, based on the installation of energy-efficient equipment and system improvements. Rebates address lighting, variable frequency drives, HVAC, refrigeration, compressed air, and, through a midstream delivery channel, commercial kitchen appliances. The program implementer, Resource Innovations, processes program paperwork and, with the help of trade allies, promotes the program to CenterPoint Energy customers.

Program Goals

The 2022 program performed far below its participation goal compared to 2021 but still met its savings goal. CenterPoint Energy staff cited supply chain issues and inflation as challenges during 2022. To increase participation during 2022, CenterPoint Energy made efforts including hiring a new outreach representative, expanding the trade ally network from 77 to 136 contractors, and updating CenterPoint Energy's program branding and marketing outreach. Despite these efforts, the program met 58% of its 2022 participation goal. Nonetheless, the program still achieved 103% of its savings goal. In 2021, the program met its participation goal (122%) but did not meet its savings goal (85%).

Customer Satisfaction

The program continues to achieve high customer satisfaction. Among 2022 program participants who completed the survey, 13 of 14 respondents (93%) said they were *very satisfied* with the C&I Prescriptive Program. In 2021, 28 of 32 respondents (88%) said they were *very satisfied*.

Chillers and Compressed Air Leak Repairs

A lack of sample desk reviews for chillers and compressed air leak reports made it challenging to confidently evaluate reported savings. In 2022, 38% of all electric savings were from chiller tune-ups and compressed air leak repairs. Because Cadmus did not sample the program, the evaluation was limited to the documentation in the database, which did not provide enough information to confidently evaluate reported savings. Cadmus confirmed the savings calculation methodologies from the associated measures in the Indiana TRM were followed and the savings inputs and assumptions were accurate according to the available information.

Recommendation: To increase confidence in the reported savings of chiller tune-ups and compressed air leak repairs, conduct sample desk reviews in next year's evaluation.

Impact Evaluation Overview

Table 28 lists the evaluated savings summary for the C&I Prescriptive Program.

Table 28. 2022 Commercial and Industrial Prescriptive Program Electric Savings

Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rates	NTG Ratio	Evaluated Net Savings
	Reported	Audited	Verified				
Total kWh	10,339,350	10,339,350	10,339,350	10,641,878	103%	63%	6,704,383
Total kW	1,493	1,493	1,493	1,532	103%	63%	965

The C&I Prescriptive Program realized 103% of reported energy savings and 103% of reported demand savings. Similar to prior years, more than 55% of reported electric energy savings are from lighting measures, 39% from chiller and compressed air measures, and 6% from six measure categories: HVAC, kitchen equipment, refrigeration, thermostats, VFD/motors, and other.

Table 29 provides per-unit annual gross savings for each program measure.

Table 29. 2022 Commercial and Industrial Prescriptive Program Per-Unit Gross Savings

Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
	Reported[a]	Evaluated	Reported[a]	Evaluated
Chillers	175,887	183,588	34.1	32.7
Compressed Air Systems	286,237	284,275	33.5	33.3
HVAC	979	833	0.2	0.2
Kitchen Equipment	1,935	1,948	0.4	0.4
Lighting	20,687	19,795	2.8	2.9
Refrigeration	3,298	2,340	0.2	0.1
Thermostat	10,757	10,757	0.0	0.0
Other	1,864	2,162	0.3	0.3
VFD/Motor	15,202	38,950	1.8	4.0

[a] CenterPoint Energy's 2022 DSM Scorecard did not include per-unit kWh or kW savings. Cadmus used available information to provide the averaged, per-unit reported savings.

Cadmus found minor discrepancies between evaluated and reported energy savings for the three measure types accounting for 94% of all reported energy savings: chillers, compressed air systems, and lighting.

- **Chiller tune-ups** account for 21% of total reported energy savings for the C&I Prescriptive Program and 95% of the reported energy savings within the Chillers measure category. For three of the 11 tune-ups, Cadmus found minor discrepancies between the reported calculation input and the corrected algorithm input, but these discrepancies impacted the overall realization rate by less than 5% for energy and demand savings. Energy savings for tune-ups are highly dependent on the state of disrepair of the chiller prior to the tune-up.
- **Compressed air measures** account for 17% of total reported electric energy savings for the program. Compressed air leak surveys and repairs account for almost all of these savings. Savings derive from reduced compressor energy use after identifying and eliminating leaks in a compressed air system. Cadmus found that evaluated energy savings closely matched reported energy savings for all compressed air measures; discrepancies accounted for less than 5% of the difference. For two of the six measures, the total estimated leakage was not provided, so Cadmus estimated leakage using historical measure performance and engineering judgment.
- **Lighting** accounted for 55% of reported energy savings for the program. Cadmus found discrepancies resulting in a per-measure realization rate greater than 105% or less than 95% for 13 of the 272 measures evaluated. In these cases, differences in waste heat factors accounted for the greatest impact on savings.

Commercial and Industrial Custom Program

Through the ***Commercial and Industrial (C&I) Custom Program***, CenterPoint Energy focuses on energy-saving projects unique to the commercial participant's facility. Customers and/or their trade allies submit engineering analyses showing first-year energy savings to qualify for program incentives. CenterPoint Energy calculates program incentive levels on a basis of $0.10 per kWh saved and $1.00 per therm saved. Incentives cannot exceed 50% of total project costs and must have a maximum of up to $100,000 for qualified projects. Projects achieving a simple payback of one year or less do not qualify for the program.

The C&I Custom Program includes multiple subcomponents, as described in Figure 1.

CenterPoint Energy administers the program and contracts with Resource Innovations to implement the program and with Willdan to engage design teams for the new construction component. Trade allies, including design firms and installation contractors, promote the program and execute custom energy efficiency measures.

Figure 1. 2022 C&I Custom Program Subcomponents

Program Goals

The 2022 program performed far below its goals. CenterPoint Energy staff cited supply chain issues and inflation. Despite making several efforts to increase participation during 2022, the program met 40% of its participation goal of 40 projects and 48% of its energy savings goal of 3,500,000 kWh. These efforts included hiring a new outreach representative, expanding the trade ally network from 77 to 136 contractors, and updating CenterPoint Energy's program branding and marketing outreach.

Gross Savings

CenterPoint Energy realized lower annual electric energy savings and electric demand savings in 2022 than in prior years. In 2022, the C&I Custom Program produced realization rates of 86.7% for annual electric energy and 86.3% for electric demand savings. Only seven of the 15 projects realized 100% of annual energy and electric demand savings. Evaluated energy savings were lower than reported savings primarily due to adjustments made to equipment energy use load profiles. Cadmus found that supporting documentation insufficiently justified the savings calculation inputs and assumptions for eight projects, so Cadmus revised the load profiles and found that lower savings were realized.

Recommendation: Provide supporting documentation such as trend data, photos, equipment specifications, or investigation reports to justify energy use characteristics or equipment control for all projects.

Net Savings

In 2022, the estimated NTG ratio of 58% was lower than the 93% NTG ratio estimated in 2021. In 2022, two of six survey respondents accounted for 78% of the program gross energy savings in the analysis sample, and their combined gross savings weighted average freeridership estimate was 43%. The 2022 C&I Custom Program freeridership estimate of 42% is heavily weighted toward these two respondents.

In 2021, one of the six survey respondents represented 87% of the program gross energy savings in the analysis sample and was estimated at 6% freeridership. The overall savings weighted freeridership estimate of 7% in 2021 was heavily weighted toward this one respondent.

NTG results rely completely on self-reported responses and therefore can change from one year to the next. With a small analysis sample size and the potential for large variation in gross savings for projects, as has been the case for the C&I Custom Program, freeridership and NTG results has varied from year to year.

Impact Evaluation Overview

Table 30 lists the evaluated savings summary for the C&I Custom Program.

Table 30. 2022 Commercial and Industrial (C&I) Custom Program Electric Savings

Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rate	NTG Ratio	Evaluated Net Savings
	Reported	Audited	Verified				
Total kWh	1,671,771	1,496,924	1,482,488	1,444,307	86.7%	58%	837,698
Total kW	426	370	398	367	86.3%	58%	213

Table 31 provides per-unit annual gross savings for each program measure.

Table 31. 2022 Commercial and Industrial (C&I) Custom Program Per-Unit Gross Savings

Measure (Application ID)	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)		Measure Description
	Reported	Evaluated	Reported	Evaluated	
220	53,170	53,169.75	17.80	17.80	AHU tune-ups
233	479,302	479,302.48	174.69	174.69	Process upgrade (egg-cooling production)
286	162,485	3,168.00	26.18	0.51	Process upgrade (pneumatic to digital conversion)
311	55,200	43,119.00	53.08	33.17	Process upgrade (pneumatic to digital conversion)
363	13,582	13,267.39	2.16	2.13	Energy recovery wheels and advanced rooftop controls
465	83,682	83,681.55	54.20	54.20	AHU controls optimization
523	81,754	77,283.6	26.10	26.10	Lighting, HVAC, and envelope upgrades
870	87,183	67,912	28.40	26.84	Lighting, HVAC, and envelope upgrades
1208	169,664	169,541.04	18.34	9.16	Lighting upgrades
1815	252,323	252,323.46	0.00	0.00	Lighting upgrades
1858	139,627	139,626.82	10.15	8.21	Chiller and compressed air optimization
2520	9,834	9,833.77	8.53	8.53	Process upgrade (flange machine)
2578	25,978	0	0.00	0.00	Lighting upgrades
2747	34,482	34,481.78	5.53	5.53	Compressed air leak repairs
2769	17,596	17,596.48	-0.17	(0.17)	Advanced rooftop controls

In 2022, 53 electric energy-saving measures were installed at 15 buildings under the 15 application IDs through the C&I Custom Program. Cadmus performed desk reviews on all 53 measures:

- 9 of 15 projects realized 100% of reported annual energy savings.
- 7 of 12 projects realized 100% of reported demand savings.
- 2 projects realized less than 10% of reported annual electric energy savings.

One of the projects that realized less than 10% of reported savings involved a process upgrade that included a conversion from a pneumatic vibration device to an electronic vibration device. The reported calculations were based on a compressed air leak approach that used total air consumption on the existing operating pressure and an open orifice. Based on Cadmus' research of identical pneumatic vibration devices, actual air consumption is 98% less than reported, resulting in lower realized energy savings than reported.

The other project that realized less than 10% of reported savings involved the demolition of exterior LED flood lights and LED parking lot lights. No photos, building design documents, or labor invoices were provided of the pre- and post-implementation conditions to describe existing conditions, reason for the demolition of the LED lights, or future use of the space.

For the six projects with realization rates below 100%, Cadmus adjusted the energy use load profiles of the impacted equipment. For these projects, no trend data, photos, equipment specifications, or investigation reports were provided or were insufficient in justifying energy use characteristics. Cadmus revised load profiles using manufacturer data, technical reference manuals, the Department of Energy's Uniform Methods Project, and research source documentation.

For the remaining projects, Cadmus ensured that the underlying methodology was consistent with the other projects in the program and found no clerical issues for nonqualifying products and no double-counting of savings. Evaluated savings aligned with CenterPoint Energy's reported savings, and Cadmus made no adjustments. Additional details for measure savings can be found in *Appendix A. Impact Evaluation Methodology*.

Small Business Energy Solutions Program

Through the ***Small Business Energy Solutions (SBES) Program***, CenterPoint Energy helps qualifying businesses identify savings opportunities by providing free on-site energy assessments, installation of energy-efficient measures, and low-cost pricing for energy-efficient measures recommended in the assessments. To participate, a customer's business must be in CenterPoint Energy's service territory and have a peak electric demand of 400 kW or less over the past 12 months. Resource Innovations is the program implementer. Participating trade allies are responsible for customer outreach, conducting on-site energy assessments, and installing no-cost and low-cost direct install measures.

Gross Savings

***Ex ante* thermostat savings are understated.** Cadmus found that some thermostats are claiming only those electric savings associated with cooling season fan operation and not claiming savings for the cooling itself or for heating season fan operation. In the tracking database, these systems are all recorded as air conditioning with gas heat.

Recommendation: Ensure that, where appropriate, *ex ante* thermostat savings account for cooling savings as well as fan energy savings for both the heating and cooling seasons.

Impact Evaluation Overview

Table 32 lists the evaluated savings summary for the SBES Program.

Table 32. 2022 Small Business Energy Solutions Electric Savings

Energy Savings Unit	*Ex Ante* Savings			Evaluated *Ex Post* Savings	Realization Rate	NTG Ratio	Evaluated Net Savings
	Reported	Audited	Verified				
Total kWh	5,521,287	5,521,287	5,521,287	5,557,142	101%	88%	4,890,285
Total kW	1,126	1,126	1,126	1,106	98%	88%	973

Table 33 provides per-unit annual gross savings for each program measure.

Table 33. 2022 Small Business Energy Solutions Per-Unit Gross Savings

Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
	Reported[a]	Evaluated	Reported[a]	Evaluated
Lighting - Controls	143.2	143.2	0.029	0.029
Lighting - Exit Signs	82.2	83.9	0.010	0.010
Lighting - Exterior	1,446.7	1,442.5	0.016	0.000
Lighting - Interior	278.9	279.6	0.086	0.086
Lighting - Refrigerated Cases	240.1	240.1	0.036	0.036
Wi-Fi and Programmable Thermostats	885.9	1,694.0	0.000	0.000
Vending Machine Occupancy Sensors	1,611.8	1,611.8	0.000	0.000

[a] CenterPoint Energy's 2022 DSM Scorecard did not have kWh or kW savings at the measure level. Per-unit kWh savings reflect audited savings from the 2022 program tracking data, and per-unit kW savings reflect an averaged value based on the 2022 program tracking data.

In 2022, most differences between reported and evaluated savings were small. The following measures had large deviations between reported and evaluated savings:

- **Lighting – exterior.** Exterior lighting did not receive evaluated demand savings because Cadmus determined these measures were installed in unconditioned locations. Cadmus used hours of use and baseline wattages, as reported in the tracking database, and a coincidence factor of 0%, as stated in the 2015 Indiana TRM v2.2. Lighting installed in unconditioned spaces does not have any interactive effects with HVAC equipment, so no waste heat factors were applied to the exterior lighting measures.
- **Wi-Fi and programmable thermostats.** Thermostats had an energy savings realization rate of 191%. The deviation from 100% is mainly because six projects (59% of installed thermostats) reported only cooling season fan savings. Heating season fan savings is a large contributor to overall savings, particularly where there is natural gas heating. This was the case for all program-sponsored thermostats installed in 2022.

Appendices

Appendix A. Impact Evaluation Methodology

As a part of the impact evaluation, Cadmus reviewed gross savings, verified measure installation, and determined freeridership and spillover to calculate a net-to-gross (NTG) ratio and estimated realized program savings. The impact evaluation reports the following metrics:

- **Reported *ex ante* savings.** Annual gross savings for the evaluation period, as reported by CenterPoint Energy in the 2022 Electric DSM Scorecard.
- **Audited savings.** Annual gross savings after CenterPoint Energy's per-unit calculations and measure counts were confirmed by Cadmus (using 2022 program tracking data).
- **Verified savings.** Annual gross savings adjusted for an in-service rate.
- **Evaluated *ex post* savings.** Annual gross savings adjusted for an in-service rate and savings adjustments resulting from the gross savings review.
- **Realization rate (percentage).** The percentage of savings the program actually realized, calculated as follows:

$$Realization\ Rate = \frac{Ex\ Post\ Savings}{Ex\ Ante\ Savings}$$

- **Evaluated net savings.** Evaluated *ex post* savings, adjusted for NTG (i.e., freeridership and spillover).

A.1 Gross Savings Review

Cadmus calculated electric energy savings and demand reduction for all programs. This appendix details the specific methodology Cadmus used to determine per-unit gross savings. Table A-1 lists the evaluation activities Cadmus performed for each program, including these:

- ***Engineering analysis.*** To assess CenterPoint Energy's claimed energy savings and coincident peak demand reduction, Cadmus conducted an engineering desk review for most of CenterPoint Energy's 2022 demand-side management (DSM) programs. Cadmus used assumptions from technical reference manuals (TRMs) from Indiana and other states and industry studies to determine inputs to the savings estimates, which were calibrated with survey results and program tracking data where possible. Cadmus also determined if any additional savings were generated from the early replacement of measures installed through the residential and commercial and industrial (C&I) prescriptive programs, based on program data and survey results.
- ***REM/Rate analysis.*** Cadmus conducted a REM/Rate analysis for the Residential New Construction Program, which entailed modeling a baseline home, which Cadmus compared with participant homes that received program incentives. Cadmus relied on the Home Energy Rating System (HERS) certificates for the key data inputs that modeled home savings.
- ***Regression/billing analysis.*** Through billing analyses, Cadmus modeled savings by comparing the consumption of program participants to nonparticipants while controlling for exogenous factors such as weather.

Table A-1. Gross Savings Review Task by Program

Program	Engineering Analysis	REM/Rate Analysis	Regression/ Billing Analysis
Residential Programs			
Residential Specialty Lighting	✓		
Residential Prescriptive	✓		
Residential New Construction	✓	✓	
Income Qualified Weatherization	✓		
Residential Behavioral Savings			✓
Appliance Recycling	✓		✓
Smart Cycle	✓		
Community Based LED Specialty Bulb Distribution	✓		
Commercial and Industrial Programs			
C&I Prescriptive	✓		
C&I Custom	✓		
Small Business Energy Solutions	✓		

A.1.1 Measure Verification

Cadmus reviewed tracking data to audit measure installations for all programs. As shown in Table A-2, for most programs, Cadmus relied on surveys with program participants, along with program application documentation, to confirm customer participation status, the number and type of measures that received program incentives, and the persistence of installations. Cadmus used this equation to calculate the in-service rate for each program:

$$In-Service\ \text{Rate} = \frac{\text{Verified Installations}}{\text{Reported Installations}}$$

Table A-2. Measure Verification Method by Program

Program	Program Data Review	Participant Surveys	Deemed Value 2019/2020[a]	Secondary Resource[b]
Residential Programs				
Residential Specialty Lighting	✓			✓
Residential Prescriptive – Standard and Marketplace	✓	✓		
Residential Prescriptive - Midstream	✓			
Residential New Construction	✓		✓	
Income Qualified Weatherization	✓		✓	
Energy Efficient Schools	✓		✓	
Residential Behavioral Savings	✓			
Appliance Recycling	✓			
Smart Cycle	✓			
Community Based LED Specialty Bulb Distribution	✓	✓	✓	

Program	Program Data Review	Participant Surveys	Deemed Value 2019/2020[a]	Secondary Resource[b]
Commercial and Industrial Programs				
Commercial and Industrial Prescriptive	✓	✓		
Commercial and Industrial Custom	✓	✓		
Small Business Energy Solutions	✓		✓	

[a] Cadmus applied in-service rates and fuel shares from surveys conducted as part of the program's 2019 and 2020 evaluation.
[b] Cadmus used the discounted future savings approach from the Uniform Methods Project to account for lifetime in-service rates and savings for installations in future years.

A.2 Residential Specialty Lighting Program

Cadmus' impact evaluation of the Residential Specialty Lighting Program included two categories of measures with attributable electric savings:

- Reflector LED
- Specialty LED (candelabra or globe)

A.2.1 LED Lighting

To determine the program's *ex post* gross savings, Cadmus applied the deemed values in the 2015 Indiana TRM v2.2 for hours of use (HOU), waste heat factor (WHF), and coincidence factor (CF) to determine the *ex post* savings for each lamp's stock keeping unit (SKU) in the program's tracking database.[16] Cadmus then totaled the savings by each specific lamp type.

The 2015 Indiana TRM v2.2 uses the following equations for determining energy savings and demand reductions for residential lighting:

$$\Delta kWh = (\frac{watts_{BASE} - watts_{EFF}}{1000}) * ISR * HOURS * (1 + WHF_E)$$

$$\Delta kW = (\frac{watts_{BASE} - watts_{EFF}}{1000}) * ISR * CF * (1 + WHF_D)$$

To determine baseline watts for all program bulbs, ($watts_{base}$), Cadmus used the ENERGY STAR lumens equivalence method specified in the most recent version of the Uniform Methods Project.[17] After carefully reviewing the delta watts multiplier approach recommended by the 2015 Indiana TRM v2.2, Cadmus determined that the specific values in the delta watts multiplier approach were out of date.

16 Stock keeping unit (SKU) is the standard retail categorization that identifies each individual product a particular retailer sells. Cadmus used SKU as a unique identifier for each lamp for which the Residential Lighting Program provided incentives through each participating retailer.

17 Dimetrosky, S., K. Parkinson, and N. Lieb. October 2017. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* "Chapter 6: Residential Lighting Evaluation Protocol." https://www.nrel.gov/docs/fy17osti/68562.pdf

When the delta watts multiplier for LEDs was generated for the 2015 Indiana TRM v2.2, LEDs produced, on average, around 50 lumens per watt. For 2022 data, the average LED produced closer to 83 lumens per watt. This means that, as the technology improves, the continued use of the current TRM multiplier will probably significantly understate the savings potential of LED bulbs.

Cadmus used specified values for hours of use, waste heat factor for energy and demand, and coincidence factor for demand from the 2015 Indiana TRM v2.2. These values are listed in Table A-3.

Table A-3. Residential Lighting Program Deemed Inputs Used to Determine *Ex Post* Gross Savings

Input	Deemed Input
Hours of Use[a]	902
Coincidence Factor[b]	0.11
Waste Heat Factor Energy[c]	-0.034
Waste Heat Factor Demand[c]	0.092
In-Service Rate	86%

[a] TecMarket Works, et al. *Indiana Core Lighting Logger Hours of Use (HOU) Study*. July 29, 2013. Annual hours of use for specialty bulbs and multifamily common areas are from 2015 Illinois TRM, Version 4.0.
[b] Nexus Market Research, RLW Analytics, and GDS Associates. January 20, 2009. *New England Residential Lighting Markdown Impact Evaluation.*
[c] Based on weighted average waste heat factor for Evansville Indiana. 2015 Indiana TRM v2.2.

A.2.2 Lighting Measure Verification

For the Residential Specialty Lighting Program, Cadmus calculated verified savings by applying an in-service rate to program-sponsored bulbs. In Indiana, 86% of LED lamps are expected to be installed in the first year after purchase.[18] Historically, in-service rates have accounted for the delayed installation of lamps allowing for savings to carry over to future program years.

Cadmus is no longer attributing carryover savings to account for the assumption that LEDs will not get savings credit following the application of updated EISA baselines in 2023 and instead applied an in-service rate of 86% to all specialty and reflector LEDs in 2022.

Table A-4 shows reported, audited, and verified installations and the in-service rates for reflector and specialty LEDs.

18 Cadmus applied first-year in-service rates, derived through the *2014 Market Effects Study* from Opinion Dynamics (2015), the most current research available from Indiana. More recent studies in Maryland (86%, 2016) and New Hampshire (87%, 2016) have similar first year LED ISRs. ISRs for LEDs typically range between 74% (Wyoming, 2016) and 97% (New Hampshire, 2016).

Table A-4. 2021 Residential Lighting Program Measure Verification Results – In-Service Rates

Measure Category	Installations			In-Service Rate[a]
	Reported	Audited	Verified	
LED Reflector	78,855	78,855	67,815	86%
LED Specialty	68,295	68,295	58,734	86%
Total	**147,150**	**147,150**	**126,549**	**86%**

[a] ISRs are not adjusted to include savings for lamps installed after the end of 2022.

A.3 Residential Prescriptive Program

Cadmus' impact evaluation of the Residential Prescriptive Program included measures with attributable electric savings, including these:

HVAC measures:

- Air conditioner and heat pump tune-up
- Air source heat pumps
- Central air conditioners
- Ductless heat pumps

Thermostats:

- Smart programmable thermostats
- Wi-Fi thermostats

Weatherization measures:

- Attic and wall insulation
- Duct sealing
- Weatherstripping

Other:

- Air purifiers
- Clothes dryers
- Clothes washers
- Dehumidifiers
- Faucet aerators
- Heat pump water heaters
- Lighting
- Pool heaters
- Smart power strips
- Variable speed pool pumps
- Showerhead
- Pipe insulation
- Energy efficiency kits

Table A-5 through Table A-8 provide per-unit annual gross savings for each program measure by channel.

Table A-5. 2022 Residential Prescriptive Program Per-Unit Gross Savings – Standard Channel

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
HVAC	AC Tune-Up	89.44	109.68	0.15	0.18
Appliance and Plug Load Reduction	Air Purifier	680.73	236.86	0.08	0.03
Weatherization	Attic Insulation (Electric)	4041.01	4,409.15	0.43	0.44
HVAC	Central Air Conditioner 16 SEER	376.84	398.92	0.47	0.48
HVAC	Central Air Conditioner 18 SEER	695.39	848.54	0.59	0.70
Appliance and Plug Load Reduction	Clothes Dryer	160.00	162.00	0.02	0.02

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
Appliance and Plug Load Reduction	Clothes Washer	202.00	164.86	0.03	0.02
Appliance and Plug Load Reduction	Dehumidifier	273.00	97.78	0.06	0.01
Weatherization	Attic Insulation (Dual Fuel)	450.84	428.74	0.38	0.36
HVAC	HP Tune-up	288.86	412.23	0.14	0.19
Other	Pool Heater COP >= 6	1233.74	1,254.50	-	-
Other	Pool Heater COP 5.5-5.9	899.94	1,087.70	-	-
Thermostats	Smart Programmable Thermostat - South (Dual)	282.31	253.93	-	-
Thermostats	Smart Programmable Thermostat - South (Electric)	887.94	935.52	-	-
Other	Variable Speed Pool Pump	1172.57	1,755.31	-	1.72
Weatherization	Wall Insulation - All EL	868.76	843.05	0.07	0.06
Weatherization	Wall Insulation - Dual Fuel	94.40	109.68	0.09	0.09
Thermostats	Wi-Fi Thermostat - South (Dual)	281.90	265.09	-	-
Other	HP Water Heater	2505.10	2,574.99	-	0.35
Weatherization	Duct Sealing South	0.00	-	-	-
Thermostats	Wi-Fi Thermostat - South (Electric)	443.85	471.95	-	-

Table A-6. 2022 Residential Prescriptive Program Per-Unit Gross Savings – Midstream Channel

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
HVAC	Air Source HP 16 SEER	828.06	594.37	0.45	0.25
HVAC	Air Source HP 18 SEER	1,474.78	1,334.63	0.25	0.24
HVAC	Ductless HP 19 SEER 9.5 HSPF	2,910.73	2,997.69	0.34	0.35
HVAC	Ductless HP 21 SEER 10 HSPF	3,300.64	3,019.95	0.39	0.36
HVAC	Ductless HP 23 SEER 10 HSPF	2,614.09	2,377.64	0.36	0.35
Other	HP Water Heater	0.00	0.00	0.34	0.00

Table A-7, 2022 Residential Prescriptive Program Per-Unit Gross Savings – Online Marketplace Channel

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
Water-Saving Devices	Aerator (Dual)	88.39	25.93	0.01	0.36
Appliance and Plug Load Reduction	Air Purifier	210.34	60.67	0.09	0.01
Appliance and Plug Load Reduction	Dehumidifier	273.00	98.48	0.06	0.01
Other	EE Kits	670.03	199.58	0.00	0.03
Lighting	LED Night Light	13.14	0.00	0.00	0.00

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
Lighting	LED Reflector	49.09	42.45	0.01	0.01
Lighting	LED Specialty	28.73	39.21	0.00	0.00
Water-Saving Devices	Showerhead	321.14	0.00	0.01	0.00
Appliance and Plug Load Reduction	Smart Power Strips	25.83	21.98	0.00	0.00
Thermostats	Smart Programmable Thermostat - South (Dual)	321.03	199.40	0.00	0.00
Thermostats	Smart Programmable Thermostat - South (Electric)	740.25	742.14	0.00	0.00
Weatherization	Weatherstripping	5.75	4.66	0.00	0.00
Other	Pipe Insulation	0.00	334.19	0.00	0.00
Water-Saving Devices	Bathroom Aerator	0.00	0.00	0.00	0.00
Thermostats	Wi-Fi Thermostat - South (Dual)	0.00	0.00	0.00	0.00
Thermostats	Wi-Fi Thermostat - South (Electric)	0.00	0.00	0.00	0.00

Table A-8. 2022 Residential Prescriptive Program Per-Unit Gross Savings – Instant Rebates Channel

Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
		Reported	Evaluated	Reported	Evaluated
Appliance and Plug Load Reduction	Air Purifier	0.00	0.00	0.00	0.00
Other	Heat Pump Water Heater	2,556.77	2,549.87	0.35	0.35
Thermostats	Smart Programmable Thermostat - South (Dual)	229.64	290.10	0.00	0.00
Appliance and Plug Load Reduction	Dehumidifier	0.00	91.73	0.00	0.00
Thermostats	Smart Programmable Thermostat - South (Electric)	0.00	1,007.51	0.00	0.00
Appliance and Plug Load Reduction	Smart Power Strips	0.00	0.00	0.00	0.00
Lighting	LED Specialty	0.00	0.00	0.00	0.00
Lighting	LED Reflector	0.00	0.00	0.01	0.00
Water-Saving Devices	Kitchen Aerator	0.00	0.00	0.00	0.00
Water-Saving Devices	Bathroom Aerator	0.00	0.00	0.00	0.00

A.3.1 HVAC Measures

Air Conditioner and Heat Pump Tune-Up

Cadmus started with the 2015 Indiana TRM v2.2 methodology, which used this formula to calculate savings per air conditioner and heat pump tune-up:

$$\Delta kWh_{CAC} = EFLH_{Cool} * Btuh_{Cool} * \frac{1}{SEER_{CAC} * 1{,}000} * MF_E$$

$$\Delta kWh_{ASHP} = \left(EFLH_{Cool} * Btuh_{Cool} * \left(\frac{1}{SEER_{ASHP}}\right) + EFLH_{Heat} * Btuh_{Heat} * \left(\frac{1}{HSPF_{ASHP}}\right)\right) * \frac{MF_E}{1{,}000}$$

$$\Delta kW = Btuh_{Cool} * \frac{1}{EER * 1{,}000} * MF_D * CF$$

Where:

$EFLH_{Cool}$	=	Equivalent full load cooling hours
$BTUH_{Cool}$	=	Cooling capacity of equipment in BTUH
$SEER_{CAc}$	=	SEER efficiency of existing central air conditioning unit receiving maintenance
MF_E	=	Maintenance energy savings factor
$SEER_{ASHP}$	=	SEER efficiency of existing air-source heat pump unit receiving maintenance
$EFLH_{Heat}$	=	Equivalent full load heating hours
$BTUH_{Heat}$	=	Heating capacity of equipment in BTUH
HSPFBase	=	Heating season performance factor of existing air-source heat pump unit receiving maintenance
EER	=	EER

efficiency of existing unit receiving maintenance

MFD	=	Maintenance demand reduction factor
CF	=	Summer peak coincidence factor

To determine effective full-load hours (EFLH), each installation was matched to its nearest 2015 Indiana TRM v2.2 reference city using the installation location's zip code. The FLH associated with that reference city was then used in the savings calculation for the installation. Table A-9 shows the other variables used in this evaluation.

Table A-9. 2022 Residential Prescriptive Program Air Conditioner and Heat Pump Tune-Up Calculation Variables

Variable	Value	Units	Source
$BTUH_{Cool}$	AC 36,597 HP 40,333	BTUH	2022 Residential Prescriptive Program tracking data
$SEER_{CAC}$	10	BTUH/Watt-hr	Illinois TRM V9
MF_E	5%	%	2015 Indiana TRM v2.2
$SEER_{ASHP}$	10	BTUH/Watt-hr	Illinois TRM V9
$BTUH_{Heat}$	40,333	BTUH	2022 program tracking data
$HSPF_{Base}$	6.8	BTUH/Watt-hr	Illinois TRM V9
EER	AC 9.2 HP 9.2	BTUH/Watt-hr	Illinois TRM V9
MF_D	5%	%	2015 Indiana TRM v2.2

Variable	Value	Units	Source
CF	88%	%	2015 Indiana TRM v2.2
Conversion	1,000	BTUH/ therm	Constant

Air Source Heat Pump, Dual Fuel Heat Pump, and Central Air Conditioner

Cadmus used these equations to calculate savings per heat pump installed (excluding ISR):[19]

$$Annual\ kWh\ Savings = [((FLHcool \times BTUH \times (1/SEERbase - 1/SEERnew)))/1000 + ((FLHheat \times BTUH \times (1/HSPFbase - 1/HSPFnew)))/1000]$$

$$Demand\ kW\ Savings = [BTUH \times (1/EERbase - 1/EERnew))/1000 \times CF]$$

Cadmus calculated central air conditioner savings using the following equation:

$$Annual\ kWh\ Savings = [(FLHcool \times BTUH \times (1/SEERbase - 1/SEERnew))/1000]$$

$$Demand\ kW\ Savings = [BTUH \times (1/EERbase - 1/EERnew))/1000 \times CF]$$

To determine FLH, each installation was matched to its nearest 2015 Indiana TRM v2.2 reference city using the installation location's zip code. The FLH associated with that reference city was then used in the savings calculation for the installation. Table A-10 shows the other inputs Cadmus used to evaluate impacts for these measures.

Table A-10. 2022 Residential Prescriptive Program Heat Pump and Central Air Conditioner Inputs Variables

Variable	Value	Units	Source
$SEERbase$	14 ASHP 13 CAC	Btu/Watt-hr	Federal standard for ASHPs and CACs
$EERbase$	11 Replacement	Btu/Watt-hr	Federal standard for ASHPs and CACs.
$HSPFbase$	8.2 Replacement	Btu/Watt-hr	Federal standard for ASHPs.
CF	0.88	decimal	2015 Indiana TRM v2.2
$FLHheat$	633	hours	This was a corrected *FLHheat* value for heat pumps installed at a property with gas heating. The assumption was that gas heat will be used as a supplemental heat source; therefore, the heat pump can qualify only for a portion of heating savings.

Cadmus used output capacity (BTUH), SEER (SEERnew), EER (EERnew), and HSPF (HSPFnew) values of installed equipment from the non-Midstream channel data to calculate savings for each installation. For the remaining systems with missing data, Cadmus used average values by measure. The Midstream channel data did not provide capacity (BTUH), SEER (SEERnew), EER (EERnew), or HSPF (HSPFnew) in the

19 These equations are referenced in the 2015 Indiana TRM v2.2. https://www.ilsag.info/technical-reference-manual/il-trm-version-9/

installation data. Cadmus used averages of these variables from the non-Midstream Residential Prescriptive program data from 2019, 2020, and 2021 to calculate savings for each installation.

Cadmus assumed that dual fuel air source heat pumps have gas furnaces that supply supplemental heat when outside temperatures fall below 38°F; therefore, all electric only heat pumps received heating and cooling savings while dual fuel heat pumps received all cooling savings and partial electric heating savings. To calculate heating savings for dual fuel air source heat pumps, Cadmus ran a bin analysis to adjust the FLH in the 2015 Indiana TRM v2.2 from 982 to 633 to correct the heat pump run time hours where supplemental gas heat was available.

Early Replacement Savings

The non-Midstream channel tracking data did distinguish early replacement units, but the field was not consistently populated. Therefore, Cadmus determined an early replacement proportion using installation data across all air source heat pump and central air conditioner measures. Cadmus further vetted these data by including only installations with data entries for "existing unit age" and "condition of existing unit." Cadmus considered any installation in this final group with an equipment age less than 18 years for central air conditioners and 15 years for ASHPs and an operable condition to be an early replacement installation. Using this approach, in 2022, 23.2% of air source heat pump and central air conditioner installations qualified as early replacement.

The Midstream channel tracking data did not distinguish early replacement units. Therefore, Cadmus determined an early replacement proportion of 27% using historical Residential Prescriptive installation data from 2019, 2020, 2021, and 2022 across all air source heat pump measures.

Efficiency metrics of baseline equipment in early replacement cases were based on appropriate federal standard values for HSPF and SEER. These values are shown in Table A-11.

Table A-11. 2022 Mechanical System Efficiency by Age

Mechanical Systems	Units	1993-2006	2006-2015	2015-present
Air Source Heat Pump	HSPF	6.8	7.7	8.2
Air Source Heat Pump	SEER	10	13	14
Central Air Conditioner	SEER			

Using the table above in conjunction with equipment age information from installation data, Cadmus determined the baseline SEER and HSPF values. For installations missing input in this data field, Cadmus applied the average equipment age of the other installations for which the equipment age was less than the EUL of the measure. To determine baseline EER values for early replacement cases, the following equation was used according to the 2015 Indiana TRM v2.2:

$$EERbase = 0.9 * SEERbase$$

Ductless Heat Pump

The 2015 Indiana TRM v2.2 does not include ductless heat pumps. For the 2021 evaluation, Cadmus used the Illinois TRM V9 method. Cadmus calculated ductless heat pump savings using these equations (excluding in-service rate):

$$Annual\ \mathrm{kWh\ Savings} = \Delta\mathrm{kWh}_{\mathrm{HEATING}} + \Delta\mathrm{kWh}_{\mathrm{COOLING}}$$

$$\Delta kW\mathrm{h}_{\mathrm{HEATING}} = \mathrm{Elec}_{\mathrm{Heat}} * \mathrm{Capacity}_{\mathrm{Heat}} * \mathrm{FLH}_{\mathrm{Heat}} * \mathrm{DHP}_{\mathrm{HeatFLH}_{\mathrm{Adjustment}}} * (1/(\mathrm{HSPF\_base}\ ) - 1/(\mathrm{HSPF\_ee}\ ))$$

$$\Delta kW\mathrm{h}_{\mathrm{Cooling}} = \mathrm{Capacity}_{\mathrm{cool}} * \mathrm{FLH}_{\mathrm{Cool}} * \mathrm{DHP}_{\mathrm{CoolFLH}_{\mathrm{Adjustment}}} * \left(\frac{1}{\mathrm{SEER}_{\mathrm{base}}} - \frac{1}{\mathrm{SEER}_{\mathrm{ee}}}\right)$$

$$Demand\ kW\ Savings = \mathrm{Capacity}_{\mathrm{Cool}} \times \frac{\left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right)}{1000} \times CF$$

To determine FLH, each installation was matched to its nearest 2015 Indiana TRM v2.2 reference city using the installation location's zip code. The FLH associated with that reference city was then used in the savings calculation for the installation. Table A-12 shows other inputs Cadmus used to evaluate impacts for this measure. Cadmus used output capacity ($\mathrm{Capacity}_{\mathrm{cool}}$ and $\mathrm{Capacity}_{\mathrm{heat}}$), SEER (SEERee), EER (EERee), and HSPF (HSPFee) values of installed equipment from the program data on a per-installation basis. The Midstream channel data did not provide output capacity ($\mathrm{Capacity}_{\mathrm{cool}}$ and $\mathrm{Capacity}_{\mathrm{heat}}$), SEER (SEERee), EER (EERee), or HSPF (HSPFee) in the installation data. Similar to the HVAC measures, Cadmus used averages of these variables from the Standard channel Residential Prescriptive program data from 2019, 2020, and 2021 to calculate savings for each installation

Table A-12. 2022 Residential Prescriptive Program Ductless Heat Pump Input Variables

Variable	Value	Units	Source
$\mathrm{Elec}_{\mathrm{Heat}}$	1	-	Illinois TRM V9
$\mathrm{DHP}_{\mathrm{HeatFLH}_{\mathrm{Adjustment}}}$	0.77	-	This adjustment is necessary to accurately calculate the savings for DHP measures using Indiana 2015 Indiana TRM v2.2 FLHs. The Illinois TRM V9 has FLHs specific to DHP, which are lower than the FLHs for ASHPs. This adjustment factor is the DHP FLHs divided by the ASHP FLHs from the Illinois TRM V9. Cadmus applied this factor to the Indiana FLHs to get Indiana DHP FLHs.
$\mathrm{DHP}_{\mathrm{CoolFLH}_{\mathrm{Adjustment}}}$	0.61	-	This adjustment is necessary to accurately calculate the savings for DHP measures using 2015 Indiana TRM v2.2 FLHs. The Illinois TRM V9 has FLHs specific to DHP, which are lower than the FLHs for ASHPs. This adjustment factor is the DHP FLHs divided by the ASHP FLHs from the Illinois TRM V9. Cadmus applied this factor to the Indiana FLHs to get Indiana DHP FLHs.
Factor of 3.412	3.412	kBtu/kWh	Illinois TRM V9
HSPFbase	3.412	Btu/Watt-hr	Assume electric baseboard heat as baseline
SEERbase	11.3	Btu/Watt-hr	2016 Pennsylvania TRM
EERbase	9.8	Btu/Watt-hr	2016 Pennsylvania TRM
CF	0.88	-	2015 Indiana TRM v2.2

A.3.2 Thermostat Measures

Smart Programmable (Learning) and Wi-Fi Thermostats (Non-Learning)

CenterPoint Energy's Residential Prescriptive Program has two types of thermostat measures:

- Smart thermostats (mostly learning) [20]
- Wi-Fi thermostats (mostly non-learning)

Cadmus calculated smart and Wi-Fi thermostat savings using the following equations (excluding ISR).

$$Annual\ kWh\ Savings = \Delta kWh_{HEATING} + \Delta kWh_{COOLING}$$

$$\Delta kWh_{HEATING} = FLH_{HEAT} * BTUH_{HEAT} * ESF_{AdjustedBaseline_{HEAT}} * \left(\frac{\%_{HEAT\ PUMP}}{\eta_{HEAT\ PUMP} * 3412} + \frac{\%_{ER}}{\eta_{ER} * 3412}\right) * TStat\_Type_{Adjustment}$$

$$\Delta kWh_{Cooling} = \Delta Cooling_{AdjustedBaseline} * TStat_{Type_{COOLING\,DiscountRate}} * \%AC$$

Each thermostat category has two measures, one for dual fuel and one for electric. Cadmus used the same savings methodology for both categories of thermostats, though savings differ significantly because of differences in the proportion of learning and non-learning thermostats in each category.[21] Table A-13 shows the inputs Cadmus used to evaluate impacts for this measure.

Cadmus applied savings to installations with defined heating or cooling equipment for that equipment type. For installations with no defined equipment type, Cadmus applied partial electric and gas savings based on the equipment saturations of existing heating equipment reported in Table A-13. Cadmus used the average heat pump capacity from the tracking database for the BTUH capacity in the electric heating savings calculation. Cadmus used a heat pump efficiency of 2.40 based on the federal standard and an electric resistance efficiency of 1.0 from the 2015 Indiana TRM v2.2. To determine EFLH, each installation was matched to its nearest 2015 Indiana TRM v2.2 reference city using the installation location's zip code. The FLH associated with that reference city was then used in the savings calculation for the installation.

The program data for Online Marketplace measures included fields describing service territory, water heater fuel type, and heating system fuel type. Cadmus used these fields to determine which installations should receive savings and for which fuel type.

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20 Examples of learning thermostats are all Nest thermostats and ecobee3, which all have advanced features that can attribute to higher savings. These features include occupancy detection, heat pump lockout temperature control, upstaging and downstaging, optimal humidity/humidity control/air conditioner overcool, fan dissipation, behavioral features, and free cooling/economizer capability.

21 Cadmus reviewed thermostat capabilities using model numbers to determine if the thermostat was learning or non-learning.

Table A-13. 2022 Residential Prescriptive Program Thermostat Input Variables

Variable	Value	Units	Source
$\eta_{HEAT\ PUMP}$	2.40	-	Federal standard
η_{ER}	1.0	-	2015 Indiana TRM v2.2
$BTUH_{HEAT}$	32,713	BTUH	Average of 2022 CenterPoint Energy Residential Prescriptive heat pump tracking data capacities
$\%_{HEAT\ PUMP}$	2%	%	2022 Residential Prescriptive Program participant survey
$\%_{GAS}$	92%	%	2022 Residential Prescriptive Program participant survey
$\%_{ER}$	6%	%	2022 Residential Prescriptive Program participant survey
Manual thermostat saturation	18%	%	2022 Residential Prescriptive Program participant survey
Programmable thermostat saturation	82%	%	2022 Residential Prescriptive Program participant survey
$TStat\_\mathrm{Type}_{\mathrm{DiscountRate}}$	31% non-learning 100% learning	%	The 2013-2014 Thermostat Evaluation indicates that heating savings are highly dependent on thermostat technology and that cooling savings are not.
$TStat\_Type_{COOLING\ DiscountRate}$	100%	%	No cooling savings adjustment can be directly derived from the comparative study of smart Wi-Fi thermostats. Cadmus is not comfortable discounting products without direct supporting evidence. The 2013-2014 Thermostat Evaluation indicates that heating savings are highly dependent on thermostat technology and that cooling savings are not.
$ESF_{AdjustedBaseline_{HEAT}}$	9.7%	%	Calculated, example below
$\%AC$	95%	%	2021 Residential Prescriptive Program participant survey
$\Delta Cooling_{AdjustedBaseline}$	241	kWh	Calculated, example below

2013-2014 Thermostat Evaluation and Adjusted Baseline

Cadmus' analysis of smart thermostat savings used the results of a separate Cadmus evaluation of programmable and Nest Wi-Fi thermostats in CenterPoint Energy South territory.[22] This evaluation reports household cooling energy savings of 332 kWh and a household heating energy saving factor (ESF) of 5% for programmable thermostats. It reports household cooling energy savings of 429 kWh and a household heating ESF of 12.5% for Nest Wi-Fi thermostats.

This study used a 100% manual thermostat baseline for both programmable and Nest Wi-Fi thermostats. However, the 2021 Residential Prescriptive Program participant survey indicated that the saturation was 17% for manual thermostats and 83% for programmable thermostats.

Cadmus used the reported household cooling and heating savings for programmable thermostats from the 2013-2014 Cadmus thermostat study and a weighted average to adjust the savings for Nest thermostats from a manual thermostat baseline to a mixed manual and programmable thermostat baseline.

[22] Cadmus. January 29, 2015. *Evaluation of the 2013-2014 Programmable and Smart Thermostat Program.*

Cadmus used the following equations:[23]

$$\Delta Cooling_{AdjustedBaseline} = [18\% * 429 + 82\% * (429 - 213.1)] * 95\% = 241\ kWh$$

$$\mathrm{ESF}_{\mathrm{AdjustedBaseline}_{\mathrm{HEAT}}} = 18\% * 12.5\% + 82\% * (12.5\% - 3.6\%) = 9.7\%$$

In the $\Delta Cooling_{AdjustedBaseline}$ calculation, the 213.1 represents the cooling savings (332 kWh multiplied by 64% correct use factor) for programmable thermostats.[24] Cadmus did equivalent calculations to obtain adjusted baseline values for ESF-heat. The 2013-2014 thermostat evaluation investigated only homes with gas heating, so Cadmus assumed that the percentage of gas savings from that evaluation apply to electric heat as well.

Learning and Non-Learning Wi-Fi Thermostats

The 2014 thermostat evaluation concerned Nest Wi-Fi thermostats only. In 2022, the Residential Prescriptive Program's tracking data recorded many more models of smart and Wi-Fi-enabled thermostats. According to a later study Cadmus study conducted in 2015 for a Midwest utility thermostat program,[25] there is a significant difference in savings between Nest Wi-Fi thermostats and other Wi-Fi thermostats; this study yielded a heating savings discount rate of 31% for non-Nest Wi-Fi thermostats. This means non-learning thermostats save 31% as much heating energy as learning thermostats.[26] The results of Cadmus' evaluation of the 2016 Vectren Smart Thermostat Pilot supported this conclusion.[27] However, no cooling savings adjustment can be directly derived from the comparative study conducted in 2015 for a Midwest utility because the result was not statistically different from 0%.

The Vectren 2013-2014 Programmable and Smart Thermostat Program Evaluation indicates that heating savings are highly dependent on thermostat technology and that cooling savings are not. Heating savings are 5% for programmable thermostats and 12.5% for smart Wi-Fi thermostats, and cooling savings are 13.1% for programmable thermostats and 13.9% for smart Wi-Fi thermostats. Cadmus did not discount specific name brands without direct supporting evidence and instead took a features-based approach. Cadmus determined if each thermostat in the tracking data exhibited learning features. For the 2021 evaluation, Cadmus applied the 31% discount rate to the heating savings of all non-learning thermostat installations.

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23 Cadmus. January 29, 2015. *Evaluation of the 2013-2014 Programmable and Smart Thermostat Program..*

24 The correct use rate is the percent of homeowners that use their basic programmable or non-learning Wi-Fi thermostat in an energy-saving manner (i.e. by turning the setpoint down in the winter or up in the summer).

25 Cadmus conducted an evaluation of thermostats for a Midwest utility, but the report is not publicly available.

26 Examples of learning Wi-Fi enabled thermostats are all Nest thermostats and Ecobee3, which have advanced features that Cadmus believes are attributable to higher savings. These features include occupancy detection, heat pump lockout temperature control, upstaging and downstaging, optimal humidity/humidity control/air conditioner overcool, fan dissipation, behavioral features, and free cooling/economizer capability.

27 Cadmus. August 8, 2017. *Vectren Residential Smart Thermostat Program 2016 Energy Savings Analysis.*

CenterPoint Energy's thermostat offerings for 2022 align with this evaluation approach by segmenting Wi-Fi-enabled thermostats into two separate thermostat measures: smart and Wi-Fi thermostats. Cadmus found that thermostats rebated through the smart thermostats measure were overwhelmingly learning thermostats, which meant applying the 31% discount to only a handful of thermostats determined to be non-learning for this measure. Cadmus found that thermostats rebated through the Wi-Fi thermostats measure were overwhelmingly non-learning, which meant applying the 31% to all but a handful of thermostats for this measure. All differences in savings between these thermostat variants are due to the proportion of learning thermostats in each thermostat measure.

A.3.3 Weatherization Measures

Attic and Wall Insulation

This algorithm from the 2015 Indiana TRM v2.2 served as the basis to calculate and verify energy saving (excluding in-service rate):

$$Annual\ (Energy\ or\ Demand)\ Savings = kSF\ x\ \frac{(Energy\ or\ Demand)\ Savings}{kSF}$$

Where:

kSF	=	Area of installed insulation (1,000 square feet)
	=	Actual installed
$\frac{(Energy\ or\ Demand)\ Savings}{kSF}$	=	Unit energy or demand savings per 1,000 square feet of insulation. Dependent on recorded pre- and post R-value conditions, kWh/kSF or kW/kSF.

Energy and demand savings (kWh/kSF, kW/kSF) differed based on heating, cooling, and measure type using a series of look-up tables in the 2015 Indiana TRM v2.2. Table A-14 shows savings scenarios by measure and equipment type.

Table A-14. 2022 Residential Prescriptive Program Equipment Scenarios by Measure

Measure	Equipment Scenarios
Attic Insulation (All Electric)	Heat pump
	Electric heat with air conditioning
	Electric heat without air conditioning
Attic Insulation (Dual Fuel)	Gas furnace with air conditioning
Wall Insulation (All Electric)	Heat pump
	Electric heat with air conditioning
	Electric heat without air conditioning
Wall Insulation (Dual Fuel)	Gas furnace with air conditioning

Energy savings per installation depended on pre- and post-retrofit insulation R-values, which Cadmus calculated using a three-step process. For the few cases where these R-values were not recorded in the tracking database, Cadmus used the average pre- and post-retrofit value for calculating savings, following these steps:

1. Determine variables to use for insulation compression, R_{ratio}, and void factors
2. Calculate adjusted pre- and post-retrofit R-values using the inputs from step one
3. Interpolate the 2015 Indiana TRM v2.2 tables to calculate savings using the adjusted R-values from step two

Variables to Use for Insulation Compression, Rratio, and Void Factors.

Cadmus adjusted R-values to account for compression, void factors, and surrounding building material. To calculate these adjusted pre- and post-retrofit R-values, Cadmus used this formula:

$$R\ value\ Adjusted = R_{nominal}\ x\ F_{compression}\ x\ F_{void}$$

Where:

$R_{nominal}$ = Actual pre- and post-retrofit R-values per manufacturing specifications.

$F_{compression}$ = Compression factor dependent on the percentage of insulation compression. Cadmus assumed a value of 1 at 0% compression for the evaluation.

F_{void} = Void factor, which accounted for insulation coverage and was dependent on installation grade level, pre- and post-retrofit R-values and compression effects.

This equation determined F_{void}:

$$R_{ratio} = \ (R_{nominal}\ x\ F_{compression})x\ ((R_{nominal}\ x\ R_{framing\ and\ air\ space}))$$

Where:

$R_{nominal}$ = As stated above.

$F_{compression}$ = As stated above.

$R_{framing/airspace}$ = R-value for material, framing, and air space of the installed insulation's surrounding area. Cadmus used R-5 for this evaluation, as recommended in the 2015 Indiana TRM v2.2.

Table A-15 lists the void factor based on the calculated R_{ratio}. Cadmus used 2% as a conservative assumption since this information was unknown.

Table A-15. 2015 Indiana TRM v2.2: Insulation Void Factors

Rratio	Void Factor	
	2% Void (Grade II)	5% Void (Grade III)
0.5	0.96	0.9
0.55	0.96	0.9
0.6	0.95	0.88
0.65	0.94	0.87
0.7	0.94	0.85
0.75	0.92	0.83
0.8	0.91	0.79
0.85	0.88	0.74
0.9	0.83	0.66
0.95	0.71	0.49
0.99	0.33	0.16

Adjusted R-values

Applying the formula above (R_{value} Adjusted), Cadmus used the inputs defined in step one to calculate R-adjusted values for pre- and post-installation and calculated adjusted R-values for every insulation installation in the database.

Interpolate 2015 Indiana TRM v2.2 Tables

Cadmus used the pre- and post-installation adjusted R-values from step two to interpolate energy and demand for every 2022 insulation installation. Appendix C of the 2015 Indiana TRM v2.2 defines energy and demand savings for insulation measures by heating and cooling equipment.

Cadmus based its assumptions on data collected in the 2022 Residential Prescriptive Program participant survey, which found that the saturation of central cooling equipment was 95%, of heat pumps was 31%, of electric furnaces was 67%, and of electric baseboard was 2%.[28] Cadmus adjusted the ducted savings by a duct efficiency of 76% for electric resistance furnaces because the TRM savings are representative of electric baseboard heating, which has no duct losses. Cadmus also calculated demand savings using a 0.88 coincidence factor from the 2015 Indiana TRM v2.2 for central air conditioners and cooling heat pumps.

Duct Sealing

In 2022, CenterPoint Energy's Residential Prescriptive Program had duct sealing measures for heat pumps. Cadmus calculated savings for the duct sealing measures using the following equations (excluding ISR):

[28] Cadmus normalized electric heating saturations to sum to 100% (excluding gas heating) for the all-electric insulation measures.

$$Annual\ Cooling\ kWh\ Savings = \frac{DE_{AFTER} - DE_{BEFORE}}{DE_{AFTER}} * EFLH_{COOL} * \frac{Btuh_{COOL}}{SEER * 1{,}000}$$

$$Annual\ Heating\ kWh\ Savings = \frac{DE_{AFTER} - DE_{BEFORE}}{DE_{AFTER}} * EFLH_{HEAT} * \frac{Btuh_{HEAT}}{3{,}412\ *\ \eta_{HEAT}}$$

$$Demand\ kW\ Savings = \frac{DEPK_{AFTER} - DEPK_{BEFORE}}{DEPK_{AFTER}} * \frac{Btuh_{COOL}}{EER * 1{,}000} * CF$$

Because program-specific information was not available regarding pre-existing conditions, to determine DE_{before} Cadmus used the average distribution efficiency for cases between no observable leaks and catastrophic leaks as a conservative assumption. Cadmus used the 2015 Indiana TRM v2.2 to determine the $\mathrm{DEPK_{BEFORE}}$ and $\mathrm{DEPK_{AFTER}}$values for the appropriate DE_{before} and DE_{after} values.

Cadmus used program data to determine average heating and cooling system capacities. To determine EFLH, each installation was matched to its nearest 2015 Indiana TRM v2.2 reference city using the installation location's zip code. The full load hours associated with that reference city were then used in the savings calculation for the installation. Table A-16 shows the other inputs Cadmus used to evaluate impacts for this measure.

Table A-16. 2022 Residential Prescriptive Program Duct Sealing Input Variables

Variable	Value	Units	Source
$\mathrm{DE_{AFTER}}$	87%	%	Used the following reference (listed in the 2015 Indiana TRM v2.2) from the Building Performance Institute: http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf Percentage of ducts within conditioned space was unknown. Assumed the average of all potential values under "Connections Sealed with Mastic." Distribution efficiency of ductwork after dealing sealing
$\mathrm{DE_{BEFORE}}$	76%	%	Used the following reference (listed in the 2015 Indiana TRM v2.2) from the Building Performance Institute: http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf Percentage of ducts within conditioned space was unknown. Assumed the average of all potential values under "No Observational Leaks," "Some Observed Leaks," "Significant Leaks," and "Catastrophic Leaks." Distribution efficiency of ductwork before dealing sealing
$\mathrm{DEPK_{AFTER}}$	85%	%	2015 Indiana TRM v2.2, DE for use in peak demand savings
$\mathrm{DEPK_{BEFORE}}$	73%	%	2015 Indiana TRM v2.2, DE for use in peak demand savings
$\mathrm{Btuh_{COOL}}$	35,702	BTUH	2022 program tracking data
SEER	12	BTUH/Watt-hr	2022 program tracking data
EER	11	BTUH/Watt-hr	2022 program tracking data

Weatherstripping

Cadmus referred to the Connecticut TRM methodology (as there was no applicable savings methodology in the 2015 Indiana TRM v2.2), which used this formula to calculate savings for weatherstripping: [29]

$$\Delta Therms = Feet * Therms\ Savings\ per\ Foot * \frac{HLH_{IN}}{HLH_{CT}}$$

Table A-17 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-17. Residential Prescriptive Program Weatherstripping Calculation Variables

Variable	Value	Units	Source
Feet	Varies by install	Feet	2022 program tracking data and feedback from program staff
Therms Savings per Foot	0.44	Therms	CT TRM Section 4.4.13
HLH_{CT}	2,878	Hours	CT TRM Section 4.4.13
HLH_{IN}	Indianapolis 2,250 Evansville 2,067	Hours	TMY3 Data

Cadmus determined feet on a per-installation basis. Cadmus assigned feet to each installation according to model number. If the model number was missing from the data, Cadmus used the description to determine the length.

The climate in Connecticut is not the same as in Indiana, so Cadmus adjusted the heating load hours (HLH) found in the Connecticut TRM. Using TMY3 weather data, Cadmus generated ratios between HDDs in Indiana to HDDs in Connecticut. This ratio was used to discount the HLH hours according to installation location.

The program data for Online Marketplace measures included fields describing service territory, water heater fuel type, and heating system fuel type. Cadmus used these fields to determine which installations should receive savings and for which fuel type.

A.3.4 Other Measures

Air Purifier

Cadmus calculated air purifier savings based using the following equations (excluding ISR): [30]

$$Annual\ kWh\ Savings = kWh_{Deemed}$$

$$Demand\ kW\ Savings = \frac{Annual\ kWh\ Savings}{Hours} * CF$$

[29] Energize Connecticut. October 31, 2016. *Connecticut Program Savings Document.* Section 4.4.13. https://www.puc.nh.gov/EESE%20Board/EERS_WG/ct_trm.pdf

[30] These equations are referenced in the Illinois TRM V9.

Table A-18 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-18. 2022 Residential Prescriptive Program Air Purifier Input Variables

Variable	Value	Units	Source
CF	66.7%	%	Illinois TRM V9
Hours	5,844	Hours	Illinois TRM V9

The Indiana 2015 TRM v2.2 does not have an air purifier measure, so Cadmus used the Illinois TRM V9.[31] This method assigns deemed kWh savings to an air purifier according to it's smoke clean air delivery rate (CADR). The tracking data did not include equipment CADR, so Cadmus researched CADR values for each installation based on the installations reported equipment model number.

The program data for Online Marketplace measures included fields describing service territory. Cadmus used this field to determine which installations should receive savings. All installations where the fuel type did not align with a CenterPoint Energy fuel account were assigned no savings.

Clothes Dryer

Cadmus calculated clothes dryer savings using the following equations (excluding ISR): [32]

$$Annual\ kWh\ Savings = \left(\frac{Load}{CEF_{base}} - \frac{Load}{CEF_{eff}}\right) * N_{cycles} * \%Electric$$

$$Demand\ kW\ Savings = \frac{Annual\ kWh\ Savings}{Hours} * CF$$

Table A-19 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-19. 2022 Residential Prescriptive Program Clothes Dryer Input Variables

Variable	Value	Units	Source
Load	Varies by dryer size	lbs	IL TRM V9
CEF_{base}	Varies by dryer class	lbs/kWh	IL TRM V9
CEF_{eff}	Varies by install	lbs/kWh	ENERGY STAR QPL
N_{cycles}	283	Cycles/year	IL TRM V9
%Electric	100%	%	Program design only targets electric dryers
Hours	283	Hours/year	IL TRM V9
CF	3.8%	-	IL TRM V9

The Indiana 2015 TRM v2.2 does not have a clothes dryer measure, so Cadmus used the Illinois TRM V9. The tracking data did not include information about dryer size, dryer class, or combined energy factor (CEF), so Cadmus matched each install's manufacturer and model number to the ENERGY STAR qualified

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31 These equations are referenced in the Illinois TRM V9.

32 Ibid.

product list (QPL) to pull these values. For the few dryers without matches on the ENERGY STAR QPL, Cadmus found these values from online retailers using the installations' reported equipment manufacturer and model number.

Clothes Washer

Cadmus calculated clothes washer savings using the following equations (excluding ISR): [33]

$$Annual\ kWh\ Savings = Capacity * N_{cycles} * \left(\left(\frac{1}{IMEF_{base}} * Consumption\ \%_{base}\right) - \left(\frac{1}{IMEF_{eff}} ** Consumption\ \%_{eff}\right) \right)$$

$$Consumption\ \%_{base} = \left(\%CW_{base} + (\%Electric_{DHW} * \%DHW_{base}) + \left(\%Dryer_{base} * \%Electric_{dryer}\right)\right)$$

$$Consumption\ \%_{eff} = \left(\%CW_{eff} + \left(\%Electric_{DHW} * \%DHW_{eff}\right) + \left(\%Dryer_{eff} * \%Electric_{dryer}\right)\right)$$

$$Demand\ kW\ Savings = \frac{Annual\ kWh\ Savings}{Hours} * CF$$

$$Water\ Savings = Capacity * N_{cycles} * (IWF_{base} - IWF_{eff})$$

Table A-20 shows the inputs Cadmus used to evaluate impacts for this measure.

The Indiana 2015 TRM v2.2 does not have a clothes dryer measure, so Cadmus used the Illinois TRM V9. The tracking data did not include information about the integrated modified energy factor (IMEF), integrated water factor (IWF), or capacity, so Cadmus matched each install's manufacturer and model number to the ENERGY STAR QPL to determine these values. For the few washers without matches on the ENERGY STAR QPL, Cadmus found these values from online retailers using the installations' reported equipment manufacturer and model number.

Therms savings were also calculated for clothes washer installation locations with gas accounts for cost-effectiveness inputs. These therms savings reflect the savings associated with a clothes washer upgrade's impact on a gas hot water system and gas dryer. Additional water savings benefits were also calculated for all clothes washer installs for cost-effectiveness inputs.

[33] These equations are referenced in the Illinois TRM V9.

Table A-20. 2022 Residential Prescriptive Program Clothes Washer Input Variables

Variable	Value	Units	Source
Capacity	Varies by install	Cubic feet	ENERGY STAR QPL
$IMEF_{base}$	1.75	lbs/kWh	IL TRM V9
$IMEF_{eff}$	Varies by install	lbs/kWh	ENERGY STAR QPL
N_{cycles}	320	Cycles/year	IL TRM V9
$\%Electric_{DHW}$	27%	Fuel share % of electric DHW systems	IL TRM V9
$\%Electric_{dryer}$	66%	Fuel share % of electric dryers	IL TRM V9
$\%Gas_{DHW}$	63%	Fuel share % of gas DHW systems	IL TRM V9
$\%Gas_{dryer}$	34%	Fuel share % of gas dryers	IL TRM V9
$\%CW_{base}$	8.1%	% of total baseline energy per wash used by washer	IL TRM V9
$\%DHW_{base}$	26.5%	% of total baseline energy per wash used by hot water system	IL TRM V9
$\%Dryer_{base}$	65.4%	% of total baseline energy per wash used by dryer	IL TRM V9
$\%CW_{eff}$	5.8%	% of total efficient case energy per wash used by washer	IL TRM V9
$\%DHW_{eff}$	31.2%	% of total efficient case energy per wash used by hot water system	IL TRM V9
$\%Dryer_{eff}$	63.0%	% of total efficient case energy per wash used by dryer	IL TRM V9
Hours	320	Hours/year	IL TRM V9
CF	4.5%	-	IL TRM V9
IWF_{base}	5.29	Gallons	IL TRM V9
IWF_{eff}	Varies by install	Gallons	ENERGY STAR QPL

Dehumidifier

Cadmus calculated dehumidifier savings based on the 2015 Indiana TRM v2.2 methodology:

$$Annual\ kWh\ Savings = X_{Dehum} * Capacity * \frac{0.473}{24} * Hours * \left(\frac{1}{\frac{L}{kWh_{base}}} - \frac{1}{\frac{L}{kWh_{eff}}}\right)$$

$$Demand\ kW\ Savings = \frac{Annual\ kWh\ Savings}{Hours} * CF$$

Table A-21 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-21. 2022 Residential Prescriptive Program Dehumidifier Input Variables

Variable	Value	Units	Source
Capacity	Varies by install	Pints/day	ENERGY STAR QPL
Pints to Liters	0.473	Liters/pint	Constant
Hours	3,799	Hours/year	2015 NOPR TSD; Table 7.4.2
Hours per Day	24	Hours/day	Constant
$\frac{L}{kWh_{base}}$	Varies by install	L/kWh	2019 Federal Standard
$\frac{L}{kWh_{eff}}$	Varies by install	L/kWh	ENERGY STAR QPL
X_{Dehum}	35.3%	% of operating hours dehumidifier is running (as opposed to fan and standby operations)	2015 NOPR TSD; Table 7.4.2
CF	0.37%	-	2015 Indiana TRM v2.2

The tracking data did not include information about capacity or liters per kilowatt hours (L/kWh), so Cadmus matched each installation's manufacturer and model number to the ENERGY STAR QPL to determine these values. For the few dehumidifiers that did not align with a model on the ENERGY STAR QPL, Cadmus found these values from online retailers using the reported equipment manufacturer and model number or used the averaged values of the other dehumidifier installations.

In the scorecard, there were dehumidifier measures in the Standard and Online Marketplace channels, but the program data Cadmus received also included a dehumidifier in the Instant Rebates channel. Therefore, Cadmus included this Instant Rebates dehumidifier in the calculations.

Faucet Aerator

Cadmus calculated faucet aerator savings using the following equations (excluding ISR): [34]

$$Annual\ kWh\ Savings = (GPM_{base} - GPM_{low}) * MPD * \frac{PH}{FH} * DR * 8.3 * (T_{mix} - T_{in}) * Days * \frac{1}{RE * 3{,}412}$$

$$Demand\ kW\ Savings = \frac{Annual\ kWh\ Savings}{\left(MPD * \frac{PH}{FH} * Days\right)} * CF * 60$$

$$Water\ Savings = (GPM_{base} - GPM_{low}) * MPD * \frac{PH}{FH} * DR * Days$$

Table A-22 shows the inputs Cadmus used to evaluate impacts for this measure.

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[34] These equations are referenced in the 2015 IN TRM V2.2 and adjusted using federal guideline for residential humidifiers. Regulations.gov. 2015 Notice of Proposed Rulemaking (NOPR). "2015-05 NOPR Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Dehumidifiers."https://www.regulations.gov/document?D=EERE-2012-BT-STD-0027-0030

Table A-22. 2022 Residential Prescriptive Program Faucet Aerator Input Variables

Variable	Value	Units	Source
MPD	2.6	Faucet minutes per person per day	2015 IN TRM V2.2, weighting kitchen and bathroom aerators together using data from RECS 2015
GPM_{base}	2.09	Gallons per minute	2015 IN TRM V2.2, weighting kitchen and bathroom aerators together using data from RECS 2015
GPM_{low}	Varies by install	Gallons per minute	Research of online retailers
PH	2.5	People per household	Res Rx Participant Survey
FH	2.89	Faucets per household	RECS 2015
DR	63%	%	2015 IN TRM V2.2, weighting kitchen and bathroom aerators together using data from RECS 2015
Specific Heat of Water	8.3	Btu/lbF	Constant
T_{mix}	88	F	2015 IN TRM V2.2, weighting kitchen and bathroom aerators together using data from RECS 2015
T_{in}	Varies by install	F	2015 IN TRM V2.2
Days	365	Days/year	Constant
RE	Gas 76% Electric 98%	%	2015 IN TRM V2.2
Factor of 3,412	3,412	Btu/kWh	Constant
CF	19.3%	%	2015 IN TRM V2.2, weighting kitchen and bathroom aerators together using data from RECS 2015

The tracking data did not include information about GPM, so Cadmus found these values from online retailers using the product manufacturer and model number in the tracking data. To determine water inlet temperature, each installation was matched to its nearest 2015 Indiana TRM v2.2 reference city using the installation location's zip code. The water inlet temperature associated with that reference city was then used in the savings calculation for the installation.

The program data for Online Marketplace measures included fields describing service territory, water heater fuel type, and heating system fuel type. Cadmus used these fields to determine which installations should receive savings and for which fuel type. The discrepancies between reported and evaluated savings can be explained by the difference in distribution of fuel types between this and last year and the surplus of installed aerators (dual). In the 2021 report, there were only electric savings for aerators, while in 2022, aerators were distributed between natural gas and electric fuel, leading to the difference in reported and evaluated kWh savings for aerators.

Heat Pump Water Heater

Cadmus calculated heat pump water heater (HPWH) savings using the following equations (excluding ISR):[35]

$$Annual\ kWh\ Savings = kWh_{BASE} * \frac{COP_{NEW} - COP_{Base}}{COP_{New}} + (kWh_{COOLING} - kWh_{HEATING}) * \%\_Units\_In\_Conditioned\_Space$$

$$kWh_{HEATING} = kWh_{ER} * Saturation_{ER} + kWh_{HP} * Saturation_{HP} + kWh_{GAS} * Saturation_{GAS}$$

$$Demand\ kW\ Savings = \frac{Annual\ kWh\ Savings}{Hours} * CF$$

Table A-23 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-23. 2022 Residential Prescriptive Program Heat Pump Water Heater Input Variables

Variable	Value	Units	Source
kWh_BASE	3,460	kWh	2015 Indiana TRM v2.2
COP_BASE	0.945	-	Federal standard
kWh_COOLING	180	kWh	2015 Indiana TRM v2.2
CF	34.6%	-	2015 Indiana TRM v2.2
Hours	2,533	Hours	2015 Indiana TRM v2.2
kWh_ER	1,577	kWh	2015 Indiana TRM v2.2
kWh_HP	779	kWh	2015 Indiana TRM v2.2
kWh_GAS	0	kWh	2015 Indiana TRM v2.2
Saturation_HP	2%	%	2022 Residential Prescriptive participant survey
Saturation_GAS	92%	%	2022 Residential Prescriptive participant survey
Saturation_ER	6%	%	2022 Residential Prescriptive participant survey
%_Units_In_Conditioned_Space	28%	%	2022 Residential Prescriptive participant survey
kWh_HEATING	108.75	kWh	Weighted average calculation

Cadmus obtained the unit energy savings for HPWHs by calculating the savings for each installation in the tracking database and averaging the results. Cadmus used assumptions from the 2015 Indiana TRM v2.2 for all values except $\mathrm{COP_{NEW}}$ and $\mathrm{kWh_{HEATING}}$. Cadmus used HPWH model specifications for $\mathrm{COP_{NEW}}$ provided in program data and a weighted average of heating equipment saturations and deemed kWh savings to determine $\mathrm{kWh_{HEATING}}$ using the 2015 Indiana TRM v2.2.

Cadmus used the federal standard coefficient of performance (COP) for <55 gallon electric storage water heaters because the storage capacity of HPWHs is larger for the same water heating load than for non-HPWHs. Cadmus assumed the baseline was a 50-gallon water heater to represent the typical electric storage water heater load, regardless of the HPWH tank size.

[35] These equations are referenced in the 2015 Indiana TRM v2.2

In addition, Cadmus did not consider early replacement for HPWHs. Due to the low number of installations for this measure, Cadmus was unable to gather sufficient data to support a breakout between replace-on-burnout and early replacement for this measure.

Lighting

Cadmus calculated reflector and specialty lighting savings using the following equations (excluding ISR):[36]

$$Annual\ kWh\ Savings = \frac{Watts_{base} - Watts_{eff}}{1{,}000} * Hours * (1 + WHF_e)$$

$$Annual\ therms\ Savings = Watts_{base} - Watts_{eff} * .00003412 * Hours * WHF_e$$

$$Demand\ kW\ Savings = \frac{Annual\ kWh\ Savings}{Hours} * CF$$

Table A-24 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-24. 2022 Residential Prescriptive Program Lighting Input Variables

Variable	Value	Units	Source
$Watts_{base}$	Varies by install	W	2015 IN TRM V2.2
$Watts_{eff}$	Varies by install	W	Research of online retailers
W/kW	1,000	W/kW	Constant
Therms/W	0.00003412	W/therm	Constant
WHF_e	Varies by install	%	2015 IN TRM V2.2
WHF_g	Varies by install	%	2015 IN TRM V2.2
WHF_d	Varies by install	%	2015 IN TRM V2.2
Hours	902	Hours/year	2015 IN TRM V2.2
CF	11%	%	2015 IN TRM V2.2

The tracking data did not include information about wattages, so Cadmus found these values from online retailers using the product manufacturer and model number in the program tracking data. To determine waste heat factors, each installation was matched to its nearest 2015 Indiana TRM v2.2 reference city using the installation location's zip code. The waste heat factors associated with that reference city and that install's heating system fuel type was then used in the savings calculation for the installation. Waste heat factors across HVAC configurations were weighted together into electric and natural gas specific waster heat factors using counts of homes by HVAC configurations found in Appendix B of the 2015 IN TRM V2.2.

The program data for Online Marketplace measures included fields describing service territory, water heater fuel type, and heating system fuel type. Cadmus used these fields to determine which

[36] These equations are referenced in the 2015 IN TRM V2.2

installations should receive savings and for which fuel type (for lighting, heating system fuel type informed which installations received savings associated with lighting HVAC interaction effects).

Pool Heater

Pool heater measures are broken into two efficiency bins in the Residential Prescriptive Program:

- Pool Heater COP >=6
- Pool Heater COP 5.5-5.9

Cadmus used the following equations to calculate savings per pool heater installed (excluding ISR):

$$Annual\ kWh\ Savings = \left(kWh\ Consumption * \frac{COP_{Assumed}}{COP_{base}} - kWh\ Consumption * \frac{COP_{Assumed}}{COP_{ee}}\right) * \left(\frac{Hrs_{Evansville}}{Hrs_{Chicago}}\right)$$

$$kWh\ Consumption = \frac{Cost_{OPERATION}}{Year} * Price_{ELECTRICITY}$$

$$Annual\ kW\ Savings = There\ are\ no\ peak\ demand\ savings\ for\ this\ measure$$

Table A-25 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-25. 2022 Residential Prescriptive Program Pool Heater Input Variables

Variable	Value	Units	Source
COP_Assumed	5.0	unitless	Energy.gov. "Heat Pump Swimming Pool Heaters." http://energy.gov/energysaver/heat-pump-swimming-pool-heaters
COP_base	5.2	unitless	Engineering assumption, based on available models in Air Conditioning, Heating, & Refrigeration Institute (AHRI) catalogue
COP_ee	Varies	unitless	Based on model number research for each install
kWh Consumption	12,176	kWh/yr	Calculated from equation, above
Hrs_Chicago: Hrs June-Sep temp below 80F	1,884	Hours	Typical Meteorological Year 3 (TMY3) bin data
Hrs_Evansville/: Hrs June-Sep temp below 80F	1,514	Hours	Typical Meteorological Year 3 (TMY3) bin data
(Cost_OPERATION)/Year: Cost to operate a pool in Chicago per year	1,035	$/yr	Energy.gov. "Heat Pump Swimming Pool Heaters." http://energy.gov/energysaver/heat-pump-swimming-pool-heaters
Price_ELECTRICITY	0.085	$/kWh	Energy.gov. "Heat Pump Swimming Pool Heaters." http://energy.gov/energysaver/heat-pump-swimming-pool-heaters

Cadmus used heat pump pool heater calculations from the U.S. Department of Energy to derive the average heating energy consumption for a residential pool in Chicago.[37] Cadmus adjusted this value for weather in Evansville, Indiana, using the ratio of the number of hours every June through September,

[37] The U.S. Department of Energy provides values only for large cities and Chicago is the closest city to CenterPoint's Indiana territory. ENERGY STAR. "Heat Pump Swimming Pool Heaters." http://energy.gov/energysaver/heat-pump-swimming-pool-heaters

assuming pools are operated for 100 days,[38] and assuming the outside air temperature is below 80°F in Evansville compared to Chicago.[39] This ratio is 80% (1,514 hours divided by 1,884 hours). Cadmus' calculations assumed a $COP_{Assumed}$ of 5.0, a pool area of 1,000 square feet, a temperature setpoint of 80°F, and a cost of 0.085 $/kWh.

Smart Power Strips

Cadmus calculated smart power strip savings using the following equations (excluding ISR): [40]

$$Annual\ kWh\ Savings = \frac{Hours}{1000} * (1 + WHF_e) * \sum(W_{standby} * F_{homes} * F_{control})$$

$$Annual\ therms\ Savings = Hours * 0.00003412 * WHF_g * \sum(W_{standby} * F_{homes} * F_{control})$$

$$Demand\ kW\ Savings = \frac{1}{1000} * (1 + WHF_d) * \sum(W_{standby} * F_{homes} * F_{control}) * CF$$

Table A-26 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-26. 2022 Residential Prescriptive Program Smart Power Strip Input Variables

Variable	Value	Units	Source
$W_{standby}$	Varies by peripheral	W	2015 IN TRM V2.2
F_{homes}	Varies by peripheral	%	2015 IN TRM V2.2
$F_{control}$	Varies by peripheral	%	2015 IN TRM V2.2
W/kW	1,000	W/kW	Constant
Therms/W	0.00003412	W/therm	Constant
WHF_e	Varies by install	%	2015 IN TRM V2.2
WHF_g	Varies by install	%	2015 IN TRM V2.2
WHF_d	Varies by install	%	2015 IN TRM V2.2
Hours	Computer 7,474 TV 6,784	Hours/year	2015 IN TRM V2.2
CF	50%	%	2015 IN TRM V2.2

To determine waste heat factors, each installation was matched to its nearest 2015 Indiana TRM v2.2 reference city using the installation location's zip code. The waste heat factors associated with that reference city and that install's heating system fuel type was then used in the savings calculation for the installation. Waste heat factors across HVAC configurations were weighted together into electric and natural gas specific waster heat factors using counts of homes by HVAC configurations found in Appendix B of the 2015 IN TRM V2.2.

38 The 2015 Indiana TRM v2.2 assumes pool operation from Memorial Day to Labor Day.

39 TMY3 bin data for Chicago, Illinois, and Evansville, Indiana.

40 These equations are referenced in the 2015 IN TRM V2.2.

The program data for Online Marketplace measures included fields describing service territory, water heater fuel type, and heating system fuel type. Cadmus used these fields to determine which installations should receive savings and for which fuel type (for smart power strips, heating system fuel type informed which installations received savings associated with waste heat factors). The differences between the reported and evaluated savings can be explained by the difference in program data from year to year. In 2021, significantly more homes used fossil fuel heat; in 2022, many more homes had all electric heat. This change in the data can explain discrepancies between reported and evaluated values.

Variable Speed Pool Pump

Cadmus used these equations to calculate savings per variable speed pool pump installed (excluding in-service rate):[41]

$$Annual\ kWh\ Savings = HP * LF * \frac{0.746}{\eta Pump} * \frac{Hrs}{day} * \frac{Days}{yr} * ESF$$

$$Annual\ kW\ Savings = HP * LF * \frac{0.746}{\eta Pump} * CF * DSF$$

Table A-27 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-27. 2022 Residential Prescriptive Program Variable Speed Pool Pump Input Variables

Variable	Value	Units	Source
HP – Horsepower	1.5	hp	Default baseline horsepower from the 2015 Indiana TRM v2.2
LF – Load factor	0.66	Decimal	2015 Indiana TRM v2.2; First Energy, Residential Swimming Pool Pumps memo
ηPump	0.325	Decimal	2015 Indiana TRM v2.2; First Energy; Residential Swimming Pool Pumps memo
Hrs/day	6	Hrs/day	2015 Indiana TRM v2.2; Consortium for Energy Efficiency; Pool Pump Exploration Memo, June 2009
Days/yr	Varies by install	Days/yr	2021 Residential Prescriptive Program Data
ESF (energy savings factor)	86%	%	2015 Indiana TRM v2.2; First Energy; Residential Swimming Pool Pumps memo
CF	83%	%	2015 Indiana TRM v2.2; Efficiency Vermont, TRM August 9, 2013. Coincidence factor based on market feedback about typical run pattern for pool pumps, which revealed that most people run pump during the day and set timer to turn pump off during the night.
DSF (demand savings factor)	91%	%	2015 Indiana TRM v2.2; First Energy, Residential Swimming Pool Pumps memo

The 2022 program tracking data's pool pump annual operating hours field was updated to help customers more realistically estimate their pool pump operating schedule. Rather than recording annual operating hours, this field now describes operating days per year. Cadmus used this data field to inform the days per year input to the savings algorithm above. If an installation did not have data in this field, it was given the 2015 IN TRM V2.2's default value of 100 days per year.

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[41] These equations are referenced in the 2015 Indiana TRM v2.2.

A federal standard requiring pool pumps to be variable speed came into effect July 18, 2021. Savings for variable speed pool pumps persisted throughout 2021 as vendors sold through their stock of models manufactured before the standard took effect. Savings for this measure will not be available beyond 2021. Savings credited this year for pool pumps are carried over from before the new federal standards came into effect. All savings from this measure are from pool pumps installed in 2021, but the rebates were not processed until 2022, making them still eligible for savings.

Showerhead

Cadmus calculated showerhead savings using the following equations (excluding ISR): [42]

$$Annual\ therms\ Savings = (GPM_{base} - GPM_{low}) * MS * \frac{PH}{SH} * SPD * 8.3 * (T_{mix} - T_{in}) * Days * \frac{1}{RE * 100{,}000}$$

$$Water\ Savings = (GPM_{base} - GPM_{low}) * MS * \frac{PH}{SH} * SPD * Days$$

Table A-28 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-28. Residential Prescriptive Program Showerhead Input Variables

Variable	Value	Units	Source
MS	7.8	Shower minutes per day	2015 IN TRM V2.2
GPM_{base}	2.63	Gallons per minute	2015 IN TRM V2.2
GPM_{low}	Varies by install	Gallons per minute	Research of online retailers
PH	2.5	People per household	Res Rx Participant Survey
SH	1.56	Showers per household	RECS 2015
SPD	0.6	Showers per person per day	2015 IN TRM V2.2
Specific Heat of Water	8.3	Btu/lbF	Constant
T_{mix}	101	F	2015 IN TRM V2.2
T_{in}	Varies by install	F	2015 IN TRM V2.2
Days	365	Days/year	Constant
RE	Electric 98%	%	2015 IN TRM V2.2
Factor of 100,000	100,000	Btu/therms	Constant

The tracking data did not include information about GPM, so Cadmus found these values from online retailers using the installations' reported equipment manufacturer and model number. To determine water inlet temperature, each installation was matched to its nearest 2015 Indiana TRM v2.2 reference city using the installation location's zip code. The water inlet temperature associated with that reference city was then used in the savings calculation for the installation.

The program data for Online Marketplace measures included fields describing service territory, water heater fuel type, and heating system fuel type. Cadmus used these fields to determine which installations should receive savings and for which fuel type.

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[42] These equations are referenced in the 2015 IN TRM V2.2.

Pipe Insulation

Cadmus calculated pipe insulation savings using the following equations (excluding ISR): [43]

$$Annual\ kWh\ Savings = (1/R_{exist} - 1/R_{new}) * (L * C * \ DeltaT * Hours)\ /\ Ndhw * 3{,}412$$

Table A-29 shows the inputs Cadmus used to evaluate impacts for this measure.

Table A-29. Residential Prescriptive Program Pipe Insulation Input Variables

Variable	Value	Units	Source
R	Varies by install	Feet	Research of online retailers
R_{exist}	1	Fhourft^2/Btu	2015 IN TRM V2.2
R_{new}	Varies by install	Fhourft^2/Btu	Research of online retailers
L	12	Feet	Correspondence with program staff
DeltaT	65	F	2015 IN TRM V2.2
Hours	8,760	Hours/year	2015 IN TRM V2.2
Ndhwelectric	98%	Recovery efficiency of electric water heater (%)	2015 IN TRM V2.2
RE	75%	%	2015 IN TRM V2.2
Btu to kWh	3,412	Btu/kWh	Constant

The tracking data did not include information about radius, R-value, or the reported equipment manufacturer and model number so Cadmus found these values from the description and looking up online retailers. Cadmus determined length on a per-installation basis.

On the scorecard, pipe insulation was a gas measure, but the program data Cadmus received was electric. Therefore Cadmus calculated pipe insulation in electric, rather than gas.

Energy Efficiency Kits

Cadmus calculated Energy Efficiency Kits (EE kits) savings using the following equations (excluding ISR):

- Aerator
  - Same equation as the "Faucet Aerator" section above
- Showerhead
  - Same equation as the "Showerhead" section above
- Lighting
  - Same equation as the "Lighting" section above
- Hot water temperature gauge
  - $Annual\ kWh\ Savings = \frac{U*A*(T_{pre}-T_{post})*Hours}{3412*RE_{electric}}$
  - $Annual\ kW\ Savings = \frac{U*A*(T_{pre}-T_{post})*CF}{(3412*Re_{electric})}$
  - $Annual\ Therms\ Savings = \frac{U*A*(T_{pre}-T_{post})*Hours}{100000*RE_{gas}}$

[43] These equations are referenced in the 2015 IN TRM V2.2.

Variable	Value	Units	Source
U	0.083	ft	IL TRM v10
A	24.99	ft^2	IL TRM v10
T_{pre}	135	F	IL TRM v10
T_{post}	120	F	IL TRM v10
$Hours$	8766	Hours/year	IL TRM v10
CF	1	None	IL TRM v10
$RE_{electric}$	98%	Recovery efficiency of electric water heater (%)	IL TRM v10
RE_{gas}	75%	Recovery efficiency of gas water heater (%)	IL TRM v10
Btu to kWh	3,412	Btu/kWh	Constant
Btu to Therms	100,000	Btu/Therm	Constant

Contents in the EE kits already had savings calculated for in this program with one exception, the hot water temperature gauge. Cadmus calculated savings for this measure using the water heater setback algorithm and applied an ISR of 100%. Cadmus did not research ISRs for water heater temperature gauge this year due to low impact. Next year we will do more research to find a comparable IRS for the hot water temperature gauge. Evaluations for similar measures delivered via kits found ISRs to be around 10%. Because the water heater setback is not implemented on the site by an energy auditor or through direct-install contractors, other evaluations have found that recipients are less likely to follow through on adjusting their water heater temperature. Cadmus can also add EE Kit customers to the survey next year to collect primary data.

A.4 Residential New Construction Program

Cadmus' impact evaluation of the Residential New Construction Program included measures with attributable electric savings for the following Home Energy Rating System (HERS) tiers:

Score of 61 to 62 Gold Star (dual fuel)	*Score of 60 or less* Platinum Star (electric) Platinum Star (dual fuel)	*Score of 60 or less* Platinum Star Plus (dual fuel)

A.4.1 New Construction Homes

The Residential New Construction Program was discontinued at the end of 2021, except where carryover rebates were paid prior to the discontinuation of the program for projects completed in 2021. Cadmus applied 2021 evaluated per-unit savings to the carryover population to evaluate gross savings for these homes.

In 2021 Cadmus evaluated gross savings for Residential New Construction Program homes by drawing a random sample of builder applications from 2021 participants and recording critical home data, such as square footage, insulation levels, and HVAC efficiencies from Home Energy Rating System (HERS) certificates. Cadmus developed energy models using REM/Rate V16.0.6 to evaluate the electric savings of the homes built under program requirements.[44]

Cadmus calculated program realization rates as the evaluated savings divided by the reported savings of the program year. Realization rates were weighted by program tier and applied to the program population. Realization rates for energy savings were between 82% and 119%, depending on the home tier, and demand reductions were between 24% and 65% (in 2021, realization rates for energy savings were between 36% and 40% and demand reductions were between 32% and 61%), as shown in Table A-30.

Table A-30. 2022 Residential New Construction Program Realization Rates

Annual Gross Savings Type	2022 *Ex Ante* Savings	2022 *Ex Post* Savings	2022 Realization Rate
Gold Star kWh (n=162)	6,087	4,989	82%
Platinum Star kWh (n=116)	4,359	5,202	119%
Platinum Star Plus kWh (n=35)	11,551	10,742	93%
Gold Star Coincident Peak kW (n=162)	5.4	1.3	24%
Platinum Star Coincident Peak kW (n=116)	3.5	2.2	64%
Platinum Star Plus Coincident Peak kW (n=35)	7.3	4.8	65%
Total kWh	**21,997**	**20,933**	**95%**
Total Coincident Peak kW	**16.2**	**8.4**	**51%**

44 REM/Rate V16.0.6 was released in January 2021.

A.5 Income Qualified Weatherization Program

Cadmus' impact evaluation of the Income Qualified Weatherization (IQW) Program included measures with attributable electric savings, including these:

Audit education

- Audit

Appliance and plug load reduction

- Refrigerator replacement
- Smart power strips

Lighting

- Exterior LED lamp
- LED 5W globe
- LED 5W candelabra
- LED R30 dimmable
- LED night light

Water-saving devices

- Bathroom aerator
- Kitchen aerator
- Efficient showerhead

HVAC

- Air conditioner tune-up
- Central air conditioner
- Heat pump tune-up
- Furnace tune-up

Thermostats

- Smart thermostat

Weatherization measures

- Air sealing
- Attic insulation
- Wall Insulation
- Whole Home IQW

A.5.1 Audit Education

Energy auditors gave IQW Program participants home audit reports that recommended additional energy-efficient actions they could take to further reduce energy consumption. *Ex post* savings were specific to participants, using survey response data from 47 IQW Program participants in 2021. Of these respondents, 73% said they had implemented one or more recommendations from the home audit report.

Home audit reports have two types of recommended measures:

- **Behavioral measures** that require homeowners to modify how they use energy in their homes. Cadmus evaluated behavioral savings for the following energy-savings actions:
  - Turning off lights when not in use
  - Unplugging unused appliances
  - Taking shorter showers
  - Programming your thermostat with efficient settings
- **Installation measures** that required purchases and installations of equipment

Table A-31 shows household percentages for each recommended action that IQW Program participants reported engaging in after receiving an on-site energy assessment.

Table A-31. 2022 IQW Household Percentages and Average Savings per Recommended Measure

Recommendation	Percentage of Households that Reportedly Took Action	Average Per-unit Evaluated Savings for Action (kWh)
Behavioral Measures		
Turn off lights when not in use	68%	9
Unplug appliances when not in use	55%	12
Take shorter showers	43%	11
Program thermostat with efficient settings (excludes recipients of smart thermostats through program)	55%	88
Installation Measures		
Air sealing/weather-stripping	0%	NA

Table A-32 shows the assumptions that went into the evaluated savings for each component. For all energy-saving actions, Cadmus adjusted savings to account for any efficient equipment that was installed. For turning off the lights and showerheads, this meant adjusting the baseline usage to account for the installed efficient equipment. For unplugging appliances and programming thermostats correctly, this meant not evaluating savings for participants who received smart strips or smart thermostats, respectively.

Table A-32. 2022 IQW Audit Education Savings Assumptions

Recommendation	Assumption	Source
Behavioral Measures		
Turn off lights when not in use	20% reduction in hours of use per day.	CPUC. *PY2006-2008 Indirect Impact Evaluation of the Statewide Marketing and Outreach Programs.* Vol II. 2009.
Unplug appliances when not in use	21.3 kWh	CPUC. *PY2006-2008 Indirect Impact Evaluation of the Statewide Marketing and Outreach Programs.* Vol II. 2009.
Take shorter showers	5% reduction in time spent in shower. Household showerhead usage was adjusted to account for efficient showerheads installed	Engineering judgment
Program thermostat with efficient settings (excludes recipients of smart thermostats through program)	Savings are equivalent to the savings from installing a new programmable thermostat (incorporating a proper usage factor)	Evaluation of the 2013-2014 Programmable and Smart Thermostat Program
Installation Measures		
Air sealing/weather-stripping	Additional air sealing and weather-stripping will achieve 50% of evaluated air sealing savings.	Engineering judgment

A.5.2 Lighting

LED Bulbs

Cadmus used the following equations from the 2015 Indiana TRM v2.2 to calculate gross savings per LED bulb installed (excluding ISR):

$$kWh\ Savings = \left(\frac{watts_{BASE} - watts_{EFF}}{1{,}000} * HOURS\right) * (1 + WHF_E)$$

$$kW\ Savings = \left(\frac{watts_{BASE} - watts_{EFF}}{1{,}000} * HOURS\right) * (1 + WHF_D) * CF$$

Cadmus used baseline wattage values based on methodology from the Uniform Methods Project, which specifies baseline wattages based on lumen output and style of the installed bulbs.

Cadmus used the 2015 Indiana TRM v2.2 assumption of 902 as the hours of use (HOU) per year for direct install measures. Cadmus also applied a waste heat factor (WHF), representing the portion of annual lighting energy producing an interactive effect (lost or gained) with heating and cooling equipment. The heating and cooling factor were taken from the Indiana TRM v2.2 for the city of Evansville, Indiana, and were dependent on the heating and cooling type of each different site.

The assumption of 902 hours of use applied only to lighting installed indoors, so Cadmus used 2,475 hours from the Illinois TRM V8.0, which specifically applies to exterior bulbs. Exterior bulbs also did not have a waste heat factor because there are no interactive effects on bulbs installed outdoors.

The savings inputs Cadmus used for its *ex post* calculations are shown in Table A-33.

Table A-33. Lighting Savings Inputs

Input	Assumption	Source
Baseline wattage for equivalent incandescent bulb (5W LED globe) (WattsBase)	25	DOE Uniform Methods Project, Chapter 21 Residential Lighting Evaluation Protocol for EISA-exempt 525 lumen LED globe
Baseline wattage for equivalent halogen bulb (9W LED) (WattsBase)[a]	43	DOE Uniform Methods Project, Chapter 21 Residential Lighting Evaluation Protocol for post-EISA 800 lumen A-line LED
Baseline wattage for equivalent halogen bulb (R30 Dimmable LED) (WattsBase)	65	2016 Pennsylvania TRM[b]
Baseline wattage for equivalent incandescent bulb (exterior bulb 13W PAR30 LED) (WattsBase)	50	2016 Pennsylvania TRM[b]
Hours of use per year (HOURS)	902 (interior) 2,475 (exterior)	2015 Indiana TRM v2.2 (interior) Illinois TRM V8.0 (exterior)
Summer peak coincidence factor (CF)	0.11	2015 Indiana TRM v2.2

Input	Assumption	Source
Waste heat factor for energy (WHFe)	Dependent on heating and cooling type	2015 Indiana TRM v2.2 appendix with 2022 heating and cooling for each lighting participant
Waste heat factor for demand (WHFd)	Dependent on heating and cooling type	2015 Indiana TRM v2.2 appendix with 2022 heating and cooling for each lighting participant

[a] Aligning with *ex ante*, no savings are assigned for 9-watt bulb installations in 2022.

[b] The Uniform Methods Project does not include lumen bins for reflector bulbs. Since these bulbs are exempt from current EISA regulations, Cadmus used lumen bins for reflector bulbs in the 2016 Pennsylvania TRM. This TRM closely follows the Uniform Methods Project approach but has additional lumen bins for non-exempt bulbs like reflectors.

LED Night Lights

Cadmus used the following 2015 Indiana TRM v2.2 equation to calculate gross savings per night light installed (excluding ISR):

$$kWh\ Savings = \left(\frac{watts_{BASE} - watts_{EFF}}{1{,}000} * HOURS\right)$$

The savings inputs Cadmus used for its *ex post* calculations are shown in Table A-34.

Table A-34. LED Night Light Savings Inputs

Input	Assumption	Source
Baseline wattage for equivalent incandescent night light (WattsBase)	5.00	2015 Indiana TRM v2.2
Wattage of LED night light (WattsEff)	0.5	Provided by CenterPoint
Hours of use per year (Hours)	2,920	2015 Indiana TRM v2.2

A.5.3 Water-Saving Devices

Faucet Aerators

Cadmus used the following 2015 Indiana TRM v2.2 equations to calculate savings per faucet aerator installed (excluding ISR):

$$kWh\ Savings = (GPM_{BASE} - GPM_{LOW}) * MPD * \frac{PH}{FH} * DR * 8.3 * (T_{MIX} - T_{IN}) * \frac{365}{RE * 3{,}412}$$

$$kW\ Savings = (GPM_{BASE} - GPM_{LOW}) * 60 * DR * 8.3 * \frac{(T_{MIX} - T_{IN})}{RE * 3{,}412} * CF$$

The savings inputs Cadmus used for its *ex post* calculations are shown in Table A-35.

Table A-35. Faucet Aerator Savings Inputs

Input	Assumption		Source
	Kitchen Faucet	Bathroom Faucet	
Faucet usage (minutes/day/person) (MPD)	4.5	1.6	2015 Indiana TRM v2.2
Number of faucets per home (FH) – Single-Family	1	1.41	2021 IQW participant survey data for bathroom. 2015 Indiana TRM v2.2 for kitchen
Number of faucets per home (FH) – Multifamily	1	1.80	2020 MFDI participant survey data,[a] 2015 Indiana TRM v2.2 for kitchen
Average household size (participants/household, PH) – Single-Family	2.00	2.00	2021 IQW participant survey
Average household size (participants/household, PH) – Multifamily	2.28	2.28	2020 MFDI participant survey[a]
Input water temperature to house (°F) (°F, Tin)	62.8	62.8	2015 Indiana TRM v2.2 for Evansville, Indiana, cold water temperature entering the DWH system
Temperature of water at faucet (°F) (°F, Tmix)	93	86	2015 Indiana TRM v2.2
Percent of water flowing down drain (DR)	0.5	0.7	2015 Indiana TRM v2.2
Gallons per minute of baseline faucet aerator (GPMbase)	2.44	1.9	2015 Indiana TRM v2.2
Gallons per minute of low-flow faucet aerator (GPMlow)	1.5	1.0	2021 program tracking data
Electric water heater recovery efficiency (RE)	0.98	0.98	2015 Indiana TRM v2.2
Summertime peak coincidence factor (CF)	0.0033	0.0012	2015 Indiana TRM v2.2

[a] Cadmus used Multifamily Direct Install Program survey data because there were no multifamily-specific responses in the IQW Program survey data.

Efficient Showerhead

Cadmus used the following 2015 Indiana TRM v2.2 equations to calculate savings per efficient showerhead installed (excluding ISR):

$$kWh\ Savings = (GPM_{BASE} - GPM_{LOW}) * MS * SPD * \frac{PH}{SH} * 8.3 * (T_{MIX} - T_{IN}) * \frac{365}{RE * 3{,}412}$$

$$kW\ Savings = (GPM_{BASE} - GPM_{LOW}) * 60 * 8.3 * \frac{(T_{MIX} - T_{IN})}{RE * 3{,}412} * CF$$

The savings inputs Cadmus used for its *ex post* calculations are shown in Table A-36.

Table A-36. Efficient Showerhead Savings Inputs

Input	Assumption	Source
Average shower length in minutes (MS)	7.8	2015 Indiana TRM v2.2
Average household size (participants/household, PH) – Single-Family	2.00	2021 IQW participant survey data
Average household size (participants/household, PH) – Multifamily	2.28	2020 MFDI participant survey data[a]
Number of showerheads per home (SH) – Single-Family	1.37	2021 IQW participant survey data
Number of showerheads per home (SH) – Multifamily	1.62	2020 MFDI participant survey data[a]
Number of showers per day per person (SPD)	0.6	2015 Indiana TRM v2.2
Input water temperature to house (°F, Tin)	62.8	2015 Indiana TRM v2.2 for Evansville cold water temperature entering the DWH system
Water temperature at showerhead (°F, Tmix)	101	2015 Indiana TRM v2.2, average mixed temperature of water used for shower
Gallons per minute of baseline showerhead (GPMbase)	2.63	2015 Indiana TRM v2.2
Gallons per minute of low-flow showerhead (GPMlow)	1.50	2022 program tracking data
Electric recovery efficiency of hot water heater (RE)	0.98	2015 Indiana TRM v2.2
Summer peak coincidence factor (CF)	0.0023	2015 Indiana TRM v2.2

[a] Cadmus used Multifamily Direct Install (MFDI) Program survey data because there were no multifamily-specific responses in the IQW Program survey data

A.5.4 HVAC

Air Conditioner & Heat Pump Tune-Up

Cadmus used these equations to calculate savings per air conditioner and heat pump tune-up (excluding ISR):

$$\Delta kWh_{CAC} = EFLH_{Cool} * Btuh_{Cool} * \frac{1}{SEER_{CAC} * 1{,}000} * MF_E$$

$$\Delta kWh_{ASHP} = \left(EFLH_{Cool} * Btuh_{Cool} * \frac{1}{SEER_{ASHP} * 1{,}000} + EFLH_{HEAT} * Btuh_{HEAT} * \frac{1}{HSPF_{ASHP} * 1{,}000}\right) * \frac{MF_E}{1{,}000}$$

$$\Delta kW = Btuh_{Cool} * \frac{1}{EER * 1{,}000} * MF_D * CF$$

Where:

$EFLH_{Cool}$ = Equivalent full load cooling hours

$EFLH_{HEAT}$ = Equivalent full load heating hours

$Btuh_{Cool}$ = Cooling capacity of equipment in BTUH

$Btuh_{HEAT}$ = Heating capacity of equipment in BTUH

$SEER_{CAC}$ = SEER efficiency of existing central air conditioning unit receiving maintenance

$SEER_{ASHP}$ = SEER efficiency of existing air source heat pump unit receiving maintenance

$HSPF_{BASE}$ = Heating season performance factor of existing air source heat pump unit receiving maintenance

MF_E = Maintenance energy savings factor

EER = EER efficiency of existing unit receiving maintenance

MF_D = Maintenance demand reduction factor

CF = Summer peak coincidence factor

Cadmus calculated savings for air conditioner tune-ups implemented through the IQW Program using the savings inputs used for its *ex post* calculations are shown in Table A-37.

Table A-37. IQW Program Air Conditioner Tune-Up Savings Inputs

Variable	Value	Units	Source
$Btuh_{CoolCAC}$	29,300	Btuh	2022 IQW Central Air Conditioner tracking data
$Btuh_{CoolHP}$	27,000	Btuh	2021 IQW Central ASHP tracking data[a]
$Btuh_{HEAT}$	26,733.3	Btuh	2021 IQW Central ASHP tracking data[a]
SEER	11.2	Btuh/Watt-hr	2015 Indiana TRM v2.2
MF_E	5%	%	2015 Indiana TRM v2.2
EER	10	Btuh/Watt-hr	Used 2015 Indiana TRM v2.2 calculation to determine EER from SEER (EER=SEER * 0.9) for AC.
MF_D	5%	%	2015 Indiana TRM v2.2
CF	88%	%	2015 Indiana TRM v2.2

[a] Cadmus used 2021 IQW Central ASHP install tracking data because there were no Central ASHP install measures in 2022

Furnace Tune-Up

Cadmus used the following analysis equation from the 2019 Illinois TRM v8 to evaluate savings for furnace tune-ups:

$$kWhSavings = (BTUh_{Gas} * FLH_{heat}) * \frac{\left(\frac{1}{AFUE * (1 - Derating_{pre)}} - \frac{1}{AFUE * (1 - Derating_{post})}\right)}{100{,}000} * F_e * 29.3$$

The savings inputs Cadmus used for its *ex post* calculations are shown in Table A-38**.**

Table A-38. 2022 Income Qualified Weatherization Furnace Tune-Up Savings Inputs

Input	Assumption	Source
AFUE	84.8%	2012 Baseline Study
Size of gas furnace (BTUHgas)	71,231	2022 program tracking data
Full load heating hours (FLHheat)	982	2015 Indiana TRM v2.2: Varies, but all households for this measure in 2022 were in Evansville
Derating_pre	0.064	2019 IL TRM v8
Derating_post	0.000	2019 IL TRM v8
Fe	3.14%	2019 IL TRM v8
kWh per therm	29.3	2019 IL TRM v8

Central Air Conditioner

Cadmus used these equations to calculate savings per air conditioner replacement (excluding ISR):

$$Annual\ kWh\ Savings = FLH_{COOL} * Btuh * \left(\frac{1}{SEER_{Base}} - \frac{1}{SEER_{Eff}}\right) * \frac{1}{1000}$$

$$Demand\ kW\ Savings = \ Btuh * \left(\frac{1}{EER_{Base}} - \frac{1}{EER_{Eff}}\right) * \frac{1}{1000} * CF$$

Savings inputs Cadmus used its *ex post* calculations are shown in Table A-39.

Table A-39. IQW Program Central Air Conditioner Savings Inputs

Description	Assumption	Source
Efficient SEER	Varies	2022 program tracking data
Efficient EER	Varies	2022 program tracking data
Baseline SEER	13	Federal Standard SEER Rating, 2015 Indiana TRM v2.2
Baseline EER	11	Federal Standard EER Rating, 2015 Indiana TRM v2.2
CAC Btuh	Varies	2022 program tracking data
FLHcool – Evansville	600	2015 Indiana TRM v2.2
CF	88%	2015 Indiana TRM v2.2

A.5.5 Thermostats

Smart Thermostats

Cadmus calculated smart thermostat savings using the following equation (excluding ISR).

$$Annual\ kWh\ Savings = (\Delta kWh_{HEATING} + \Delta kWh_{COOLING}) * \ SqFt_{Adjust}$$

$$\Delta kWh_{HEATING} = FLH_{HEAT} * BTUH_{HEAT} * ESF_{AdjustedBaseline_{HEAT}} * \left(\frac{1}{\eta_{HEAT} \ * 3412}\right)$$

$$\Delta kWh_{Cooling} = \Delta Cooling_{AdjustedBaseline}$$

The savings inputs Cadmus used for its *ex post* calculations are shown in Table A-40. These inputs were primarily derived from results of a 2013-2014 evaluation of programmable and smart thermostats in CenterPoint South territory.[45] Because smart thermostats have a learning function, it was assumed that 100% were auto-adjusting temperature appropriately.

[45] Cadmus. January 29, 2015. *Evaluation of the 2013-2014 Programmable and Smart Thermostat Program*.

Table A-40. Smart Thermostat Savings Inputs

Variable	Value	Units	Source
FLH_{HEAT}	982	Hours	2015 Indiana TRM v2.2; Evansville, Indiana
$BTUH_{HEAT}$	32,000	BTUH	2016 Pennsylvania TRM
η_{HEAT}	2.0/1.0	-	2015 Indiana TRM v2.2 – 2.0 used for heat pumps. 1.0 used for electric resistance heat
Manual thermostat saturation	57%	%	2021 IQW Program participant survey
Programmable thermostat saturation	43%	%	2021 IQW Program participant survey
$ESF_{AdjustedBaseline_{HEAT}}$	10.87%	%	Calculated, example below. Based on Evaluation of the 2013-2014 Programmable and Smart Thermostat Program
$\Delta Cooling_{AdjustedBaseline}$	377	kWh	Calculated, example below. Based on Evaluation of the 2013-2014 Programmable and Smart Thermostat Program
Square Footage Adjustment for MF	45%	%	2009 RECS square footage by building type

In 2022, smart thermostats were installed in homes with gas heating and central air conditioning as well as homes with electric furnaces and central air conditioning. Cadmus calculated electric heating savings for all thermostats installed in electrically heated homes.

2013-2014 Thermostat Evaluation and Adjusted Baseline

Cadmus' analysis of smart programmable thermostat savings used the results of Cadmus' 2013-2014 evaluation of programmable and Nest Wi-Fi thermostats in CenterPoint South territory.[46] This evaluation reports household cooling energy savings of 332 kWh and a household heating energy saving factor (ESF) of 5% for programmable thermostats. It reports a household cooling energy savings of 429 kWh and a household heating ESF of 12.5% for Nest Wi-Fi thermostats.

This study used a 100% manual thermostat baseline for both programmable and Nest Wi-Fi thermostats. However, in 2021, the IQW Program participant survey indicated that the saturation was 57% for manual thermostats and 43% for programmable thermostats (n=9).

Cadmus used the reported household cooling and heating savings for programmable thermostats from its 2013-2014 evaluation and a weighted average to adjust the savings for Nest thermostats from a manual thermostat baseline to a mixed manual and programmable thermostat baseline. Cadmus used these equations:[47]

$$\Delta Cooling_{AdjustedBaseline} = [57\% * 429 + 53\% * (429 - 252)] = 321\ kWh$$

$$\mathrm{ESF}_{\mathrm{AdjustedBaseline}_{\mathrm{HEAT}}} = 57\% * 12.5\% + 43\% * (12.5\% - 3.8\%) = 10.87\%$$

In the $\Delta Cooling_{AdjustedBaseline}$ calculation, the 252 represents the cooling savings (332 kWh multiplied by 76% correct use factor) for replaced programmable thermostats. Cadmus did equivalent calculations to obtain adjusted baseline values for ESF-heat. The 2013-2014 thermostat evaluation investigated only

46 Cadmus. January 29, 2015. *Evaluation of the 2013-2014 Programmable and Smart Thermostat Program*.

47 Ibid.

homes with gas heating, so Cadmus assumed that the percentage of gas savings from that evaluation applies to electric heat as well.

Home Type Adjustment

The 2013-2014 thermostat evaluation from which savings are derived was based on single-family homes. To account for savings differences by home type due to reduced heating and cooling load for multifamily homes compared with single-family homes, Cadmus applied a square footage adjustment.

A.5.6 Appliance and Plug Load Reduction

Refrigerator Replacement

Cadmus used the following equation from the 2015 Indiana TRM v2.2 to calculate savings for replaced refrigerators (excludes ISR). The regression coefficients used were coefficient findings from the 2013 Appliance Recycling Program evaluation.

$$kWh\ Savings = [(UEC_{RETIRED} * F_{RUNTIME}) - UEC_{NEW}] * \left(\frac{RUL_{RECYCLED}}{EUL_{NEW}}\right) + [(UEC_{STANDARD} - UEC_{NEW}) * (\frac{(EUL_{new} - RUL_{RECYCLED})}{EUL_{NEW}})]$$

$$UEC_{existing} = 365.25 * \left[0.81 + (0.02 * Age) + \left(1.04 * F_{before1990}\right) + (0.06 * Size) + \left(-1.75 * F_{singledoor}\right) + \left(1.12 * F_{side-by-side}\right) + \left(0.56 * F_{primary}\right) + (-0.04 * HDD * F_{outdoor}) + (0.03 * CDD * F_{outdoor})\right]$$

$$kW\ Savings = \frac{\Delta kWh}{8{,}760} * TAF * LSAF$$

Cadmus calculated savings for each refrigerator replaced using the following sources:

- 2015 Indiana TRM v2.2 methodology for refrigerator recycling to establish the unit energy consumption (UEC) of the retired refrigerators, using algorithm coefficients from the 2013 Appliance Recycling Program evaluation results
- ENERGY STAR database to determine the UEC of the new refrigerator units based on make and model numbers
- 2022 program tracking data for recycled and new refrigerator characteristics for each participant

Cadmus determined a weighted average energy savings for two baseline scenarios over the life of the new refrigerator unit, obtaining remaining useful life and effective useful life values from the 2015 Indiana TRM v2.2:

- Recycled old refrigerator with a remaining useful life of eight years
- New standard refrigerator baseline for the remaining duration of the life of the new refrigerator (9 years=$EUL_{new\ refrigerator} - RUL_{recycled\ unit}$)

Savings inputs are shown in Table A-41.

Table A-41. IQW Program Refrigerator Replacement Savings Inputs

Description	Assumption	Source
UEC_new (kWh)	404	2022 program tracking data, ENERGY STAR database
UEC_retired (kWh)	1,128	2022 program tracking data, appliance recycling program coefficients
UEC_standard baseline (kWh)	411	2015 Indiana TRM v2.2, averaged by program data configuration
F_run time	1.000	2015 Indiana TRM v2.2
TAF	1.21	2015 Indiana TRM v2.2
LSAF_old	1.063	2015 Indiana TRM v2.2, refrigerator recycling
LSAF_new	1.124	2015 Indiana TRM v2.2, time-of-sale refrigerator
Remaining useful life of old unit (years)	8	2015 Indiana TRM v2.2
EUL of new refrigerator (years)	17	2015 Indiana TRM v2.2

Smart Strips

Cadmus used deemed savings from the 2015 Indiana TRM v2.2 to evaluate savings for smart strips (excludes ISR):

$$Energy\ Savings = \sum^{Peripherals} W_{standby} * F_{homes} * F_{control} * H * \frac{1 + WHF_E}{1000}$$

$$Demand\ Savings = \sum^{Peripherals} W_{standby} * F_{homes} * F_{control} * CF * \frac{1 + WHF_D}{1000}$$

The end usage of the smart strip is unknown, so Cadmus used the default weighting from the 2015 Indiana TRM v2.2 where 50% are installed with TV systems and 50% are installed with computer systems. The heating and cooling factor were taken from the Indiana TRM v2.2 for the city of Evansville and were dependent on the heating and cooling type of each participant home. The savings inputs Cadmus used for its *ex post* calculations are shown in Table A-42.

Table A-42. IQW Smart Strip Savings Inputs

Input	Assumption	Source
Power use in standby mode (Wstandby)	Varies from 0.3 watts to 18 watts depending on home computer or TV system peripheral device, per tables in the 2015 Indiana TRM v2.2 Smart Power Strip section	2015 Indiana TRM v2.2
Percentage of homes with peripherals (Fhomes)	Varies from 0.3% to 69% depending on home computer or TV system peripheral device, per tables in the 2015 Indiana TRM v2.2 Smart Power Strip section	2015 Indiana TRM v2.2
Percentage of peripherals controlled (Fcontrol)	Varies from 57% to 100% depending on home computer or TV system peripheral device, per tables in the 2015 Indiana TRM v2.2 Smart Power Strip section	2015 Indiana TRM v2.2
Number of hours per year peripherals are controlled (computers) (H)	7,474	2015 Indiana TRM v2.2
Number of hours per year peripherals are controlled (televisions) (H)	6,784	2015 Indiana TRM v2.2
Coincident factor (CF)	0.50	2015 Indiana TRM v2.2
Waste heat factor for energy (WHFe)	Dependent on heating and cooling type	2015 Indiana TRM v2.2 appendix with 2021 heating and cooling for each lighting participant
Waste heat factor for demand (WHFd)	Dependent on heating and cooling type	2015 Indiana TRM v2.2 appendix with 2021 heating and cooling for each lighting participant

A.5.7 Weatherization Measures

Air Sealing/Infiltration Reduction

Cadmus used these equations from the 2015 Indiana TRM v2.2 to calculate savings for each infiltration reduction retrofit (excludes ISR):

$$kWh\ Savings = \frac{CFM50_{EXIST} - CFM50_{NEW}}{N - factor} * \frac{kWh}{CFM}$$

$$kW\ Savings = \frac{CFM50_{EXIST} - CFM50_{NEW}}{N - factor} * \frac{\Delta kW}{CFM} * CF$$

Each site was calculated on an individual basis with different blower door measurements and heating and cooling types. The savings inputs Cadmus used for its *ex post* calculations are shown in Table A-43.

Table A-43. IQW Program Air Sealing Savings Inputs

Description	Assumption	Source
Leakage rate before installation (CFM50_exist)	Actual	2022 program tracking data
Leakage rate after installation (CFM50_new)	Actual	2022 program tracking data
N-Factor	16.3	2015 Indiana TRM v2.2
Summer peak coincidence factor (CF)	0.88	2015 Indiana TRM v2.2
kWh/CFM – Electric, CAC (kWh/CFM)	40.30	2015 Indiana TRM v2.2
kW/CFM – Electric, CAC (kW/CFM)	0.01	2015 Indiana TRM v2.2
kWh/CFM – Heat Pump (kWh/CFM)	20.50	2015 Indiana TRM v2.2
kW/CFM – Heat Pump (kW/CFM)	0.01	2015 Indiana TRM v2.2
kWh/CFM – Electric, NO AC (kWh/CFM)	36.90	2015 Indiana TRM v2.2
kW/CFM – Electric, NO AC (kW/CFM)	0.00	2015 Indiana TRM v2.2
kWh/CFM – Gas Furnace, CAC (kWh/CFM)	3.00	2015 Indiana TRM v2.2
kW/CFM – Gas Furnace, CAC (kW/CFM)	0.01	2015 Indiana TRM v2.2

Insulation (Attic and Wall)

Cadmus applied this algorithm from the 2015 Indiana TRM v2.2 to calculate and verify energy saving (excludes ISR):

$$Annual\ (Energy\ or\ Demand)\ Savings = kSF\ x\ \frac{(Energy\ or\ Demand)\ Savings}{kSF}$$

The inputs used for these formulas are shown in Table A-44.

Table A-44. IQW Program Attic and Wall Insultation Savings Inputs

Description	Assumption	Source
Area of installed insulation (kSF)	Actual	2022 program tracking data
Energy Savings	Dependent on recorded pre and post R-values	2022 program tracking data

Energy savings (kWh/kSF) differed by heating type and measure and are in a series of look-up tables in the 2015 Indiana TRM v2.2. Energy savings by installation depended on pre- and post-retrofit insulation R-values, which Cadmus calculated using a three-step process:

1. Determine variables to use for insulation compression, R_{ratio}, and void factors
2. Calculate adjusted pre- and post-retrofit R-values using the inputs from step one
3. Interpolate the 2015 Indiana TRM v2.2 tables to calculate savings using the adjusted R-values from step two

Variables to Use for Insulation Compression, Rratio, and Void Factors

Cadmus adjusted R-values to account for compression, void factors, and surrounding building material, using this formula:

$$R\ value\ Adjusted = R_{nominal}\ x\ F_{compression}\ x\ F_{void}$$

The following equation determined F_{void}:

$$R_{ratio} = (R_{nominal}\ x\ F_{compression})x\ ((R_{nominal}\ x\ R_{framing\ and\ air\ space}))$$

The inputs used for these formulas are shown in Table A-45.

Table A-45. Attic Insulation Compression, Rratio, and Void Factors

Description	Assumption	Source
Actual pre- and post-R-values per manufacturing specifications (Rnominal)	Actual	2022 IQW Program data
Compression factor dependent on the percentage of insulation compression (Fcompression)	1	Cadmus assumed a value of 1 at 0% compression for the evaluation
Void Factor (Fvoid)	Varied	Void factors accounted for insulation coverage and were dependent on installation grade level, pre- and post-R-values and compression effects
R-value for material (Rfarming and air space)	5	2015 Indiana TRM v2.2
Area of installed insulation in thousand square feet (kSF)	Varies by participant	2022 program tracking data for heating/cooling combination for each participant

Table A-46 lists the void factor based on the calculated R_{ratio}. Cadmus used a 2% void for the evaluation because this information was unknown, and 2% is common in most households.

Table A-46. Indiana TRM v2.2: Insulation Void Factors

R_{ratio}	Void Factor	
	2% Void (Grade II)	5% Void (Grade III)
0.5	0.96	0.9
0.55	0.96	0.9
0.6	0.95	0.88
0.65	0.94	0.87
0.7	0.94	0.85
0.75	0.92	0.83
0.8	0.91	0.79
0.85	0.88	0.74
0.9	0.83	0.66
0.95	0.71	0.49
0.99	0.33	0.16

Adjusted R-Values

Applying the formula above (R_{value} Adjusted), Cadmus used the inputs defined in step one to calculate adjusted R-values for pre- and post-installation and calculated adjusted R-values for every installation in the database.

Interpolate Indiana TRM v2.2 Tables

Cadmus used the pre- and post-adjusted R-values from step two to interpolate energy and demand for every 2022 installation based on the reported heating and cooling types. Appendix C of the 2015 Indiana

TRM v2.2 defines energy and demand savings for insulation measures by heating and cooling equipment.

Whole Home IQW

CenterPoint provided notes provided in the whole home recap and health and safety recap under which each IQW Whole Home claimed savings could fall. Evaluated savings used these notes to assign applicable program average deemed savings for measures that could not already be accounted for elsewhere in the program. These measures included water heater replacement, air sealing, duct sealing, air conditioner tune-up, furnace tune-up, furnace replacement, and air conditioner replacement.

In 2022, air purifier and dehumidifier installations installed through the Healthier Homes Initiative were reported and attributed to the IQW Whole Home (electric only) measure and reported claimed savings that align with other residential programs. However, these measures are intended as a new installation and are not replacing an existing inefficient or inoperable model; that is, they are not reducing the home's energy load but instead are adding to it. These measures have no basis for savings, so Cadmus assigned zero evaluated IQW Whole Home (electric only) savings.

A.6 Residential Behavioral Savings Program

Cadmus' impact evaluation of the Residential Behavioral Savings (RBS) Program included a billing analysis to evaluate the effect of home energy reports (HERs) on the behavior of treated customers. The evaluation of the RBS Program savings and efficiency program uplift consisted of these six tasks:

- Billing data collection, review, and preparation
- Equivalency checks on treatment and control groups
- Billing analysis
- Energy-savings estimations
- Energy efficiency program channeling analysis (uplift)
- Demand savings analysis

A.6.1 Data Collection, Review, and Preparation

CenterPoint Energy provided data from monthly utility bills for electric only and dual fuel homes for treatment and control group customers between January 2011 and January 2023 (approximately 13 months of bills prior to the beginning of the RBS Program in 2012 and 132 months of bills after the program began). Billing data included energy use during the monthly billing cycle, the last day of the billing cycle, and these fields:

- Customer segment (electric only or dual fuel and launch date/wave)
- Assignment to treatment or control groups
- First report date
- Opt-out date for customers choosing not to participate in the program
- Move-out date for customers who have moved
- Electric and gas account numbers for linking to billing data

Cadmus collected National Oceanic and Atmospheric Administration (NOAA) daily temperature data from the municipal airport weather stations near Henderson, Kentucky, Lawrenceville, Illinois, and Evansville, Indiana, the three stations nearest to all RBS Program treatment and control homes.

CenterPoint Energy provided participation and measure savings data for its 2022 DSM programs. For each program and measure, these data included the account number, the number and description of measures installed, measure installation dates, and verified savings. Cadmus used these data to estimate the RBS Program's participation and savings effects on other efficiency programs (uplift).

Data Preparation

Cadmus worked with CenterPoint Energy and the program implementer to acquire the data necessary for the RBS Program evaluation in 2022. Major data preparation steps included cleaning and compiling the program tracking data, billing consumption and weather data, and testing for significant differences in annual pretreatment consumption between treatment and control customers, by customer segment. This section describes the steps Cadmus took to process the data and verify customers in the tracking and billing data.

Program Tracking Data

Cadmus received RBS Program tracking data from the program implementer at the close of 2022. These data included treatment group customers who received HERs in the current or a previous year and control group customers tracked since the program's inception. Because the RBS Program was implemented as a randomized control trial, Cadmus included all possible customers in its evaluation, adopting a "once in, always in" policy for customers originally randomized into either the treatment or control group prior to the launch of the HERs.

Table A-47 shows customer attrition through 2022, by treatment and control groups, by customer segment, and as originally randomized and active at the beginning of treatment in 2022. The attrition process captures customers whose accounts closed (became inactive) since the launch of the program.

Table A-47. 2022 RBS Program Customer Attrition

Customer Segment	Originally Randomized		Active at the Beginning of Treatment in 2022	
	Treatment	Control	Treatment	Control
Wave 1 Electric Only (2012)	25,746	6,098	10,199	2,442
Wave 1 Dual Fuel (2013)	51,496	5,590	24,564	2,744
Wave 2 Dual Fuel (2020)	13,693	10,000	10,720	7,796
Program Total	**90,935**	**21,688**	**45,483**	**12,982**

Billing Data

Cadmus collected customer billing data for each customer segment from the program implementer. To clean the billing data, Cadmus followed these steps:

1. Drop customers whose accounts went inactive before the delivery of the first energy reports
2. Clean and calendarize bills, which included dropping bills that covered more than 100 days (about three months), dropping bills with negative consumption, dropping bills earlier than one year prior to the delivery of the first energy reports, and truing up bills with estimated reads
3. Drop customers with less than six months of pretreatment bills (six months of pretreatment bills was used as a cutoff to preserve sample sizes and be consistent across waves)

Table A-48 provides the attrition in the 2022 analysis sample from data cleaning steps. The final modeling sample included customers in Cadmus' final tracking data who were not dropped during the billing data cleaning process and were included in the billing analysis. These customers were not necessarily active at the beginning of treatment in 2022.

Table A-48. 2022 RBS Program Analysis Sample

Step in Attrition	Wave 1 Electric Only[a]		Wave 1 Dual Fuel[a]		Wave 2 Dual Fuel[a]	
	Treatment	Control	Treatment	Control	Treatment	Control
Originally Randomized Customers	25,746 (100%)	6,098 (100%)	51,496 (100%)	5,590 (100%)	13,693 (100%)	10,000 (100%)
Included in Billing Data	25,674 (100%)	6,082 (100%)	51,380 (100%)	5,576 (100%)	13,690 (100%)	9,991 (100%)
Active at Program Launch	25,168 (98%)	5,963 (98%)	50,809 (99%)	5,526 (99%)	13,642 (100%)	9,959 (100%)
Less than 6 Months of Pretreatment Data	24,133 (94%)	5,707 (94%)	50,018 (97%)	5,438 (97%)	13,375 (98%)	9,748 (97%)
Final Modeling Sample	**24,133 (94%)**	**5,707 (94%)**	**50,018 (97%)**	**5,438 (97%)**	**13,375 (98%)**	**9,748 (97%)**

[a] The billing data analysis sample includes customers who were randomized into the program and active when treatment began in 2012. These customers were not necessarily active in 2022.

Weather Data

Cadmus collected weather data from the weather station closest to each home and estimated the heating degree days (HDDs) and cooling degree days (CDDs) for each customer billing cycle. After merging the weather and billing data, Cadmus allocated the billing cycle electricity consumption, HDDs, and CDDs to calendar months.

Verification of Balanced Treatment and Control Groups

Cadmus has historically verified that subjects in the randomized treatment and control groups were equivalent in their annual pretreatment energy consumption in past waves. Cadmus verified the equivalence of waves using the cleaned billing data, comparing preprogram average annual consumption from before the launch of the program.

Waves introduced in late 2022 were not analyzed this year due to insufficient post-treatment data. Balance of treatment and control groups for these waves will be analyzed in 2023.

A.6.2 Regression Analysis

Cadmus used regression analyses of monthly billing data from customers in the treatment and control groups to estimate the RBS Program's energy savings. The billing analysis conformed to IPMVP Option C, whole facility,[48] and the approach described in the Uniform Methods Project.[49,50]

More specifically, Cadmus used a multivariate regression to analyze the energy use of customers who had been randomly assigned to treatment and control groups. Cadmus tested and compared two general model specifications to check the robustness of savings results:

- The ***post-only*** model regresses customer average daily consumption on a treatment indicator variable and includes as regressors customers' pretreatment energy use, month-by-year fixed effects and weather.[51] The model is estimated only with posttreatment customer bills.
- The ***difference-in-differences (D-in-D) fixed effects*** model regresses average daily consumption on a treatment indicator variable, month-by-year fixed effects, customer fixed effects, and weather. The model is estimated with pre- and post-treatment customer bills.

Both models yielded savings estimates that were within each other's confidence intervals, meaning that their results were not statistically different. In 2022, Cadmus reported the results of the post-treatment only model, consistent with previous program years.

The error terms of the post-only model and D-in-D fixed effects model should be uncorrelated with program participation ($PART_i$) and other observable variables because of the random assignment of homes to treatment and control groups, and therefore ordinary least squares (OLS) regression should result in an unbiased estimate of the average daily savings per customer. Cadmus clustered the standard

48 Efficiency Valuation Organization. January 2012. *International Performance Measurement and Verification Protocol, Concepts and Options for Determining Energy and Water Savings, Volume 1.* Page 25. (EVO 10000 – 1:2012) http://www.evo-world.org/

49 Agnew, K., and M. Goldberg. April 2013. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol.* U.S. Department of Energy, National Renewable Energy Laboratory. (NREL/SR-7A30-53827) http://www1.eere.energy.gov/office_eere/de_ump_protocols.html

50 Stewart, J., and A. Todd. August 2014. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 17: Residential Behavior Protocol.* U.S. Department of Energy, National Renewable Energy Laboratory. (NREL/SR-7A40-62497) http://www1.eere.energy.gov/office_eere/de_ump_protocols.html

51 Allcott, H., and T. Rogers. 2014. "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation." *American Economic Review* 104 (10), 3003-3037.

errors on customers to account for arbitrary correlation in customer consumption over the analysis period.

Post-treatment Only Model

Cadmus specified the post-treatment only model assuming the average daily consumption (ADC_{it}) of electricity of home 'i' in month 't' as given by the following equation:

$$ADC_{it} = \sum_{t=1}^{T} \beta_{1t} PART_i * PY_t + \sum_{m=1}^{M} \beta_2 Pre\text{–} ADC_{im} \times M_m + W'\gamma + \tau_t + \varepsilon_{it}$$

Where:

β_1	=	Coefficient representing the conditional average treatment effect of the program on electricity consumption (kWh per customer per day).
$PART_i$	=	Indicator variable for program participation (which equals 1 if customer 'i' was in the treatment group and 0 otherwise).
PY_t	=	Indicator variable for each program year (which equals 1 if the month 't' was in the program year and 0 otherwise).
β_2	=	Coefficient representing the conditional average effect of pretreatment electricity consumption on posttreatment average daily consumption (kWh per customer per day).
$Pre\text{–} ADC_{im}$	=	Mean household energy consumption of customer 'i' in month 'm' in the pretreatment period.
M_m	=	Variable indicating the month of the calendar year for months $m = 1,2, \ldots ,12$.
W	=	Vector using both HDD and CDD variables to control for weather impacts on energy use.
γ	=	Vector of coefficients representing the average impact of weather variables on energy use.
τ_t	=	Average energy use in month 't reflecting unobservable factors specific to the month. The analysis controls for these effects with month-by-year fixed effects.
ε_{it}	=	Error term for customer 'i' in month 't.'

D-in-D Fixed Effects Model

The D-in-D fixed effects model was specified, assuming average daily consumption (ADC_{it}) of electricity of customer 'i' in month 't', as given by the following equation:

$$ADC_{it} = \alpha_i + \tau_t + W'\gamma + \beta_1 PART_i \times POST_t + \epsilon_{it}$$

Where:

β_1	=	Coefficient representing the program's conditional average treatment effect on electricity use (kWh per customer per day).
$PART_i$	=	Indicator variable for program participation (which equals 1 if customer 'i' was in the treatment group and 0 otherwise).

$POST_t$	=	Indicator variable for whether month 't' is pre- or posttreatment (which equals 1 if month 't' was in the treatment period and 0 otherwise).
W	=	Vector using HDD and CDD variables to control for weather impacts on energy use.
γ	=	Vector of coefficients representing the average impact of weather variables on energy use.
α_i	=	Average energy use in customer 'i' reflecting unobservable, non-weather-sensitive, and time-invariant factors specific to the customer. The analysis controlled for these effects with customer fixed effects.
τ_t	=	Average energy use in month 't' reflecting unobservable factors specific to the month. The analysis controlled for these effects with month-by-year fixed effects.
ϵ_{it}	=	Error term for customer 'i' in month 't'

Regression Analysis Estimates

Cadmus estimated separate treatment effects for each customer segment and program year. Table A-49 shows both the post-treatment only and D-in-D fixed effects model estimates of average daily savings per customer, by segment and program year. All of the models were estimated by OLS, and Huber-White robust clustered standard errors were adjusted for correlation over time in a customer's consumption. The post-treatment only and D-in-D fixed effects models produce statistically indistinguishable results each year, showing that estimated treatment effects are robust.

Table A-49. RBS Program Historical Model Comparison of Savings

Treatment Year	Wave 1 Electric Only[a]		Wave 1 Dual Fuel[a]		Wave 2 Dual Fuel[a]	
	Post-Only (Standard Error)	D-in-D Fixed Effects (Standard Error)	Post-Only (Standard Error)	D-in-D Fixed Effects (Standard Error)	Post-Only (Standard Error)	D-in-D Fixed Effects (Standard Error)
2012	0.431 (0.093) ***	0.368 (0.092) ***	0.208 (0.085) **	0.166 (0.073) **	N/A	N/A
2013	0.641 (0.142) ***	0.602 (0.126) ***	0.297 (0.1) ***	0.273 (0.095) ***	N/A	N/A
2014	0.727 (0.176) ***	0.665 (0.161) ***	0.427 (0.118) ***	0.425 (0.116) ***	N/A	N/A
2015	0.699 (0.175) ***	0.622 (0.171) ***	0.46 (0.127) ***	0.439 (0.127) ***	N/A	N/A
2016	0.66 (0.189) ***	0.647 (0.19) ***	0.436 (0.143) ***	0.424 (0.144) ***	N/A	N/A
2017	0.734 (0.198) ***	0.689 (0.204) ***	0.395 (0.149) ***	0.406 (0.154) ***	N/A	N/A
2018	0.815 (0.244) ***	0.742 (0.235) ***	0.297 (0.169) *	0.339 (0.169) **	N/A	N/A
2019	0.674 (0.25) ***	0.602 (0.248) **	0.47 (0.179) ***	0.496 (0.184) ***	N/A	N/A
2020	0.795 (0.264) ***	0.71 (0.267) ***	0.583 (0.186) ***	0.609 (0.192) ***	0.178 (0.099) *	0.165 (0.084) **
2021	0.485 (0.285) *	0.384 (0.284)	0.446 (0.196) **	0.463 (0.202) **	0.29 (0.098) ***	0.319 (0.097) ***
2022	0.527 (0.306) *	0.492 (0.305)	0.302 (0.208)	0.311 (0.214)	0.235 (0.123) *	0.311 (0.123) *

[a] Standard errors clustered on customers are presented below the estimated treatment effect in parentheses (*** Significant at 1%; ** Significant at 5%; * Significant at 10%). The treatment effects represent the average daily savings per treatment group customer.

A.6.3 Program Total Savings Estimation

Cadmus estimated program savings in 2022 for each wave's population of treated customers as the product of average daily savings per participant and the number of days these customers were treated in 2022, as shown below. Cadmus assumed that the program implementer intended to treat all eligible customers at least once in 2022 and included treatment days for customers who should have received treatment in 2022 (i.e., those who were still active and randomized as a treatment customer), even when customers were not explicitly flagged as receiving 2022 treatment.

$$Savings_h = -\hat{\beta}_{1,h} * \sum_{i=1}^{N} Treatment\ Days_{i,h}$$

Where:

$\hat{\beta}_{1,h}$	=	Average daily savings (kWh) per treatment group customer in wave 'h', estimated from the post-only regression model.
$Treatment\ Days_{i,h}$	=	The number of days customer 'i' in wave 'h'was treated in 2022.

Cadmus estimated realization rates for each wave as the ratio of verified program savings to reported program savings (estimated by the program implementor).

A.6.4 Energy Efficiency Program Channel (Uplift) Analysis

Analysis of efficiency program uplift proved important for two reasons:

- CenterPoint Energy sought to learn whether and to what extent the RBS Program caused participation in CenterPoint Energy's other programs.
- To the extent the RBS Program caused participation in other efficiency programs, energy savings resulting from this participation would be counted twice—once in the regression estimate of RBS Program savings and once in the other programs' savings. (Thus, CenterPoint Energy should subtract the double-counted savings from the DSM portfolio savings.)

The uplift analysis yielded estimates of the percentage of the RBS Program's effect on other efficiency program participation and on the double-counted savings. Cadmus limited the analysis, however, to program measures that CenterPoint Energy tracked at the customer level. Cadmus performed participation and savings uplift analyses for these residential efficiency programs:

- Appliance Recycling Program
- Income Qualified Weatherization (IQW) Program
- Residential Prescriptive Program (all delivery channels)
- Smart Cycle Program

Cadmus did not perform channeling analyses for these residential efficiency programs:

- The Energy Efficient Schools Program targeted school children and their families. Participation was not voluntary.

- For the Residential Specialty Lighting Program, although the RBS Program may have influenced purchases of LEDs and other high-efficiency lighting, such purchases were tracked at the store level rather than the customer level.
- The Residential New Construction Program targeted builders of new homes, which the RBS Program did not target.

As with the energy-savings analysis, the uplift analysis followed the logic of the program's experimental design. Cadmus collected efficiency program participation and savings data in 2022, matching the data to RBS Program treatment and control homes, and applied a simple differences analysis to each customer segment and wave. Because customers in the treatment and control groups are expected to be identical, except for having participated in the RBS Program, the difference between these groups in other efficiency program participation would equal the RBS Program uplift.

In homes matching the 2022 efficiency program data, Cadmus excluded measures installed after an account became inactive or measures installed before the start of the evaluation year. When calculating energy uplift, Cadmus prorated a measure's savings based on the installation date, so that a measure installed halfway through the year was only credited half a year of savings. In addition, Cadmus prorated a measure's savings based on weather sensitivity. For demand uplift, Cadmus included full demand savings for any measure installed prior to the end of September 2022.

Let ρ_m be the participation rate (defined as the number of participants to the number of potential participants) in a program in 2022 for group m (as before, m=1, for treated homes, and m=0 for control homes) in period t (t in {0,1}), as illustrated in this equation:

$$\textit{Participation uplift} = \rho_1 - \rho_0$$

Cadmus used this method to express participation uplift relative to the participation rate of control homes in 2022, which yielded an estimate of the percentage uplift, as in this equation:

$$\%\textit{Participation Uplift} = \textit{Program Uplift} / \rho_0$$

Cadmus estimated RBS Program savings from participation in other efficiency programs the same way, by replacing the program participation rate with the program net savings per home, as illustrated in this equation:

$$\textit{Net savings per home from participation uplift} = \sigma_1 - \sigma_0$$ [52]

Multiplying net savings per home by the number of program homes yielded an estimate for a customer segment of total RBS net savings counted in CenterPoint Energy's other efficiency programs.

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[52] Cadmus obtained net savings by multiplying measure-verified gross savings by the estimated measure NTG ratio.

A.6.5 Demand Savings Analysis

Cadmus estimated the peak-coincident demand savings with Integral Analytics' DSMore software using a load shape for a typical CenterPoint Energy home and the evaluated net program energy savings as inputs. This is the same software that CenterPoint Energy uses to assess program cost-effectiveness, which helps maintain alignment. This methodology is a reasonable approach for programs that evaluate savings using billing analysis, in the absence of an hourly analysis of treatment and control AMI data. These approaches and validities are further outlined in the Uniform Methods Project.[53] Reported demand savings were based on per-household estimates that do not take into account year-to-year differences in energy savings.

The Calibrated DSMore Load-Shape Differences (CLSD) approach uses CenterPoint Energy-specific residential load shapes built into DSMore and calibrates the load shapes to match the verified annual consumption of the treatment group to equal the annual kWh savings. It then identifies and reports the demand reductions during the coincident peak for the utility. Cadmus performed separate demand savings analyses for dual fuel and electric only customers using load shapes specific to each customer segment.

The CLSD approach follows six specific steps:

1. Conduct a pre-post D-in-D (experimental design with randomized control group) billing analysis to identify average participant and program-wide energy (kWh) savings achieved. (This is described in more detail above in the *A.6.2 Regression Analysis* section in this appendix.)
2. Calibrate CenterPoint Energy-specific residential DSMore load shapes to match the kWh consumption levels of the treatment group.
3. Adjust the load shape so that the annual savings identified in the billing analysis are reflected on that load shape. Maintain the same shape, while reducing the amplification of that shape.[54]
4. Record the coincident load reduction on the calibrated DSMore load shape for the peak period defined by CenterPoint Energy.
5. Report the number determined in step four as the coincident kW reduction.
6. Multiply the peak reduction determined in step five by the number of active treatment customers to report program kW impacts.

The CLSD approach provides a reasonable estimate of the per household and program-wide peak kW reduction given the available data.

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[53] Stern, Frank, and Justin Spencer. October 2017. "Chapter 10: Peak Demand and Time-Differentiated Energy Savings Cross-Cutting Protocol." *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* https://www.nrel.gov/docs/fy17osti/68566.pdf

[54] This load-shape adjustment accounted for the fact that delivery of the first home energy reports occurred in late January and early February of 2012.

A.7 Appliance Recycling Program

Cadmus' impact evaluation of the Appliance Recycling Program included measures with attributable electric savings—recycled refrigerators, freezers, and room air conditioners.

A.7.1 Refrigerator and Freezer Models

To evaluate CenterPoint Energy's 2022 Appliance Recycling Program, Cadmus used a regression model specified in the U.S. Department of Energy's Uniform Methods Project (UMP) to estimate consumption for refrigerators.[55] Because the UMP does not have specifications for freezers, Cadmus created an analogous freezer model from an aggregated dataset of freezers metered by Cadmus in Wisconsin and Michigan. The coefficient for each independent variable indicates the influence of that variable on daily consumption. Holding all other variables constant, a positive coefficient indicates an upward influence on consumption, and a negative coefficient indicates a downward effect on consumption.

Table A-50 shows the model specification Cadmus used to estimate a refrigerator's annual unit energy consumption (UEC) and its estimated parameters. The coefficient indicates the marginal impact on the UEC of a one-point increase in the independent variable. For example, an increase of one cubic foot in the size of a refrigerator will result in a 0.06 kWh increase in daily consumption. For dummy variables, the coefficient value represents the difference in consumption if the given condition proves true. For example, Cadmus' refrigerator model uses a coefficient of 0.56 for the variable indicating whether a refrigerator is a primary unit; thus, with all else equal, a primary refrigerator consumes 0.56 kWh per day more than a secondary unit.

Table A-50. Refrigerator UEC Regression Model Estimates

(Dependent Variable=Average Daily kWh, R2=0.30)

Independent Variables	Coefficient	p-Value
Intercept	0.81	0.13
Age (years)	0.021	0.04
Dummy: Unit manufactured pre 1990s	1.04	<.0001
Size (cu. Ft.)	0.06	0.02
Dummy: Single Door	-1.75	<.0001
Dummy: Side-by-Side	1.12	<.0001
Dummy: Primary	0.56	0.003
Interaction: Unconditioned Space x HDDs[a]	-0.04	<.0001
Interaction: Unconditioned Space x CDDs[b]	0.03	0.19

[a] Heating degree day
[b] Cooling degree day

Table A-51 shows the final model specifications Cadmus used to estimate annual energy consumption of participating freezers and their estimated parameters.

[55] U.S. Department of Energy. October 2017. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* https://www.energy.gov/eere/about-us/ump-protocols

Table A-51. Freezer UEC Regression Model Estimates
(Dependent Variable=Average Daily kWh, R2=0.45)

Independent Variables	Coefficient	p-Value
Intercept	-0.96	0.54
Age (years)	0.045	0.12
Dummy: Unit Manufactured Pre-1990	0.54	0.24
Size (cu. Ft.)	0.12	0.09
Dummy: Chest Freezer	0.30	0.07
Interaction: Unconditioned Space x HDDs[a]	-0.03	0.54
Interaction: Unconditioned Space x CDDs[a]	0.08	0.07

[a] CDDs and HDDs derive from the weighted average CDDs and HDDs from TMY3 data for weather stations mapped to participating appliance zip codes. TMY3 is a typical meteorological year, using median daily values for a variety of weather data collected from 1991–2005.

Cadmus analyzed the corresponding characteristics (i.e., the independent variables) for the participating appliances (captured by ARCA, the program implementer, in the 2022 program tracking database). Table A-52 lists program averages or proportions for each independent variable. Cooling degree days (CDDs) equal the weighted average CDDs from typical meteorological year 3 (TMY3) data for weather stations mapped to ZIP codes of participating appliances.[56]

[56] Typical meteorological year 3 (TMY3) uses median daily values for a variety of weather data collected from 1991 to 2005.

**Table A-52. 2022 Appliance Recycling Program
Participant Mean Explanatory Variables and Model Coefficients**

Measure	Independent Variables	2022 Mean Value	2022 Model Coefficient
Refrigerator	Intercept	1.00	0.81
	Age (years)	18.88	0.021
	Dummy: Manufactured pre 1990s	0.08	1.04
	Size (cu. ft.)	19.80	0.06
	Dummy: Single Door	0.02	-1.75
	Dummy: Side-by-Side	0.38	1.12
	Dummy: Primary	0.48	0.56
	Interaction: Unconditioned Space x HDDs[a]	5.27	-0.04
	Interaction: Unconditioned Space x CDDs[a]	1.59	0.03
Freezer	Intercept	1.00	-0.96
	Age (years)	23.02	0.045
	Dummy: Unit Manufactured Pre-1990	0.19	0.54
	Size (cu. ft.)	15.24	0.12
	Dummy: Chest Freezer	0.48	0.30
	Interaction: Unconditioned Space x HDDs[a]	7.11	-0.03
	Interaction: Unconditioned Space x CDDs[a]	2.15	0.08

[a] CDDs and HDDs derive from the weighted average CDDs and HDDs from TMY3 data for weather stations mapped to participating appliance zip codes. TMY3 is a typical meteorological year, using median daily values for a variety of weather data collected from 1991–2005.

Unit Energy Consumption

To determine annual and average daily per-unit energy consumption using UEC models and 2022 Appliance Recycling Program tracking data, Cadmus applied average participating refrigerator and freezer characteristics to regression model coefficients. This approach ensured that the resulting UEC was based on specific units recycled through CenterPoint Energy's program in 2022 rather than on a secondary data source.

Table A-53 shows the average per-unit UEC for refrigerators and freezers recycled during 2022 and 2021 (for comparison). In 2022, refrigerators and freezers had a higher UEC than in 2021. Note that the average per-unit UEC shown in the table does not include the part-use adjustment factor.

Table A-53. 2022 and 2021 Appliance Recycling Program – Refrigerator and Freezer Average UEC

Measure	2021 Average Unit Energy Consumption (kWh/Year)	2022 Average Unit Energy Consumption (kWh/Year)	2022 Relative Precision (90% Confidence)
Refrigerator	1,064	1,086	11%
Freezer	754	771	28%

Using values from Table A-52 above, Cadmus calculated the estimated annual UEC for 2022 freezers using the following equation:

$$\text{2022 Freezer UEC} = 365.25\ days * (-0.96 + 0.045 * [23.02\ years\ old] + 0.54 * [19\%\ units\ manufactured\ pre - 1990] + 0.12 * [15.24\ ft.^3\ ] + 0.30 * [48\%\ units\ that\ are\ chest\ freezers] + 0.08 * [2.15\ Unconditioned\ CDDs] - 0.03 * [7.11\ Unconditioned\ HDDs]) = 771\ kWh/year$$

Compared with 2021, the increase in the refrigerator UEC is primarily because of a 50% decrease in the proportion of recycled refrigerators that had a single-door configuration. The independent variable for single-door refrigerators has a negative coefficient in the gross savings model, which means a unit with this characteristic uses less energy compared with a unit without the characteristic, holding all else equal. The change in the refrigerator UEC was also because the average size of refrigerators increased by 0.47 cubic feet in 2022 compared to 2021. The independent variable for unit size has a positive coefficient in the gross savings model.

The increase in the freezer UEC is primarily because of a 5% increase in the average age of recycled freezers compared with 2021. The independent variable for unit age has a positive coefficient in the gross savings model.

Table A-54 shows a direct comparison of average values for 2021 and 2022 for all model variables.

Table A-54. Appliance Recycling Program
Participant Mean Explanatory Variables 2022 and 2021 Comparison

Measure	Independent Variables	2022 Mean Value	2021 Mean Value
Refrigerator	Age (years)	18.88	19.59
	Dummy: Manufactured pre 1990s	0.08	0.09
	Size (cu. ft.)	19.80	19.33
	Dummy: Single Door	0.02	0.04
	Dummy: Side-by-Side	0.38	0.36
	Dummy: Primary	0.48	0.48
	Interaction: Unconditioned Space x HDDs[a]	5.27	5.27
	Interaction: Unconditioned Space x CDDs[a]	1.59	1.59
Freezer	Age (years)	23.02	21.98
	Dummy: Unit Manufactured Pre-1990	0.19	0.21
	Size (cu. ft.)	15.24	15.25
	Dummy: Chest Freezer	0.48	0.44
	Interaction: Unconditioned Space x HDDs[a]	7.11	7.11
	Interaction: Unconditioned Space x CDDs[a]	2.15	2.15

[a] CDDs and HDDs derive from the weighted average CDDs and HDDs from TMY3 data for weather stations mapped to participating appliance zip codes. TMY3 is a typical meteorological year, using median daily values for a variety of weather data collected from 1991–2005.

Demand Reduction Impacts

The team used adjustment factors shown in Table A-55, drawn from the Indiana TRM (v2.2), to calculate per-measure demand reduction separately for refrigerators and freezers, using the following equation:

$$kW\ reduction = \frac{Average\ per\ Measure\ kWh\ Savings}{8{,}760} * TAF * LSAF$$

Where:

TAF = Temperature adjustment factor

LSAF = Load shape adjustment factor

Table A-55. 2022 Appliance Recycling Program Demand Reduction Assumptions for Recycled Refrigerators and Freezers

Variable	Recycled Appliance Value
Temperature Adjustment Factor	1.21
Load Shape Adjustment Factor	1.06

Part-Use

Part-use is an adjustment factor specific to appliance recycling that is used to convert the UEC into an average per-unit gross savings. The UEC itself is not equal to the gross savings because the UEC model yields an estimate of annual consumption, and not all recycled refrigerators would have operated year-round had they not been decommissioned through the program.

The part-use methodology relies on information from surveyed customers regarding their pre-program appliance use patterns. The final estimate of part-use reflects how appliances were likely to operate had they not been recycled (rather than how they previously operated). For example, a primary refrigerator, operated year-round, could have become a secondary appliance, operating part-time in a situation where the participant bought a new refrigerator for the kitchen. No survey was conducted 2022, so Cadmus used the part-use estimates from the 2021 survey for the 2022 evaluation.

Cadmus applied the part-use factors calculated for the 2021 survey to the modeled annual consumption and demand reduction for 2022 from Table A-53 above. Table A-56 shows average per-unit gross annual energy savings and demand reduction, part-use factors and the part-use adjusted per-unit gross energy savings, and peak demand reduction used as final *ex post* gross per-unit savings for 2022.

Table A-56. 2022 Appliance Recycling Program *Ex Post* Per-Unit Energy Savings and Demand Reduction

Measure	Average Unit Energy Consumption (kWh/Year)	Average Unit Energy Consumption (kW/Year)	Part-Use Factor	*Ex Post* Per-Unit Gross Unit Energy Consumption (kWh/Year)	*Ex Post* Per-Unit Gross Unit Energy Consumption (kWh/Year)
Refrigerator	1,064	0.16	0.94	1,021	0.15
Freezer[a]	754	0.11	0.86	663	0.10

[a] All freezer units are considered to be secondary.

A.7.2 Room Air Conditioner

Cadmus used the following equations from the 2015 Indiana TRM v2.2 to calculate *ex post,* per-measure energy savings and demand reduction for recycled room (window) air conditioners:

$$kWh\ savings = \frac{EFLH_{clg} * \text{BTUh}}{1{,}000} * \left(\frac{1}{EER_{exist}} - \frac{\%_{replaced}}{EER_{new}}\right)$$

$$kW\ reduction = \frac{BTUh * CF}{1{,}000} * \left(\frac{1}{EER_{exist}} - \frac{\%_{replaced}}{EER_{new}}\right)$$

Where:

$EFLH_{clg}$ = Equivalent full-load hours to satisfy the cooling requirements for residents in Evansville, Indiana

BTUh = Actual size of the recycled room air conditioner in BTUh units (where 1 ton = 12,000 BTUh)

EER_{exist} = Energy efficiency rating of the recycled room air conditioner

% Replaced = Average percentage of recycled room air conditioners replaced with a new room air conditioner

EER_{new} = Energy efficiency rating of the newly installed room air conditioner

CF = Coincidence factor, a number between 0 and 1 indicating how many room air conditioners are expected to be in use and saving energy during the peak summer demand period

Table A-57 summarizes the recycled room air conditioners' savings assumptions and identifies each assumption's source.

Table A-57. Appliance Recycling Program Variable Assumptions for Recycled Room Air Conditioners

Variable	Room Air Conditioner Value	Source
Equivalent Full-Load Hours (EFLHclg)	445	2015 Indiana TRM v2.2
BTUh	11,357	
Energy Efficiency Rating-Existing (EERexist)	7.7	
% Replaced	76%	
Energy Efficiency Rating-New (EERnew)	10.9	
Coincidence Factor (CF)	0.30	

A.8 Smart Cycle Program

Cadmus' impact evaluation of the Smart Cycle Program focused on smart thermostats with attributable electric savings. Table A-58 provides per-unit annual gross savings. The 2015 Indiana TRM v2.2 does not assign coincident peak demand savings for smart thermostats, so Cadmus assigned 0 kW from normal use of the smart thermostats.

Table A-58. Smart Cycle Program Per-Unit Gross Savings

Program Component	Measure Group	Measure	Annual Gross Savings (kWh)		Annual Gross Savings (Coincident Peak kW)	
			Reported	Evaluated	Reported	Evaluated
Standard	Thermostats	Smart Cycle Thermostat - Dual Fuel	518.97	289.15	1.10	0
Standard	Thermostats	Smart Cycle Thermostat - Electric	518.97	924.16	1.10	0

A.8.1 Smart Thermostats

Using the same savings methodology used to calculate smart thermostat savings in the 2022 Residential Prescriptive Program, Cadmus calculated ecobee thermostat savings using the following equations (excluding in-service rate):

$$Annual\ kWh\ Savings = \Delta kWh_{HEATING} + \Delta kWh_{COOLING}$$

$$\Delta kWh_{HEATING} = FLH_{HEAT} * BTUH_{HEAT} * ESF_{AdjustedBaseline_{HEAT}} * \left(\frac{1}{\eta_{HEAT\ PUMP} * 3412}\right) * TStat\_Type_{DiscountRate}$$

$$\Delta kWh_{Cooling} = \Delta Cooling_{AdjustedBaseline} * TStat_{Type_{COOLING\ DiscountRate}} * \%AC$$

Table A-59 shows the inputs Cadmus used to evaluate impacts for the smart (learning) thermostats. The Smart Cycle Program tracking database does not have information on home heating equipment capacity, so Cadmus used the average heat pump capacity from the 2022 Residential Prescriptive Program tracking database for the BTUH capacity in the electric heating savings calculation.

Cadmus used a heat pump efficiency of 2.40 coefficient of performance (COP) based on the federal standard. To determine full load hours (FLH), each installation was matched to its nearest 2015 Indiana TRM v2.2 reference city using the installation location's zip code. The full load hours associated with that reference city was then used in the savings calculation for the installation. Cadmus applied additional assumptions from the 2019 participant survey. Cadmus did not conduct a participant survey for the 2021 or 2022 Smart Cycle Program due to the small population size.

Table A-59. 2022 Smart Cycle Per-Unit Savings Inputs

Variable	Value	Units	Source
$\eta_{HEAT\ PUMP}$	2.40	N/A	Federal standard (COP)
η_{ER}	1.0	N/A	2015 Indiana TRM v2.2 (COP)
$BTUH_{HEAT}$	33,407	BTUH	Average of 2022 Residential Prescriptive Program heat pump tracking data capacities
$\%_{HEAT\ PUMP}$	18% for program; 59% for electric only	%	2019 participant survey
$\%_{GAS}$	68% for program; 98% for dual fuel	%	2019 participant survey
$\%_{PROPANE}$	1% for program; 2% for dual fuel	%	2019 participant survey
$\%_{ELECTRIC\ FURNACE}$	13% for program; 41% for electric only	%	2019 participant survey
Manual thermostat saturation	38%	%	2019 participant survey
Programmable thermostat saturation	62%	%	2019 participant survey
$TStat\_Type_{\mathrm{DiscountRate}}$	31% non-learning 100% learning	%	The 2013-2014 Programmable and Smart Thermostat Evaluation indicates that heating savings are highly dependent on thermostat technology (learning vs. non-learning) and that cooling savings are not. All ecobee thermostats are learning thermostats, so this value is 100% for this program.
$TStat\_Type_{COOLING\ Disco}$	100%	%	The 2013-2014 Thermostat Evaluation indicates that heating savings are highly dependent on thermostat technology and that cooling savings are not. No cooling savings adjustment can be directly derived from the comparative study of smart Wi-Fi thermostats to programmable thermostats.
$ESF_{AdjustedBaseline_{HEAT}}$	10.36%	%	Calculated, example below
$\%AC$	100%	%	Program design assumption; all Smart Cycle participants much have central air conditioning to participate in the program
$\Delta Cooling_{AdjustedBaselin}$	298	kWh	Calculated, example below in 2013–2014 Thermostat Evaluation and Adjusted Baseline section

2013–2014 Thermostat Evaluation and Adjusted Baseline

Cadmus' analysis of the thermostat savings for the 2022 Smart Cycle Program used the results of a separate Cadmus evaluation of programmable and Nest Wi-Fi thermostats in Vectren's Indiana South territory in 2013 and 2014.[57] This evaluation reports household cooling energy savings of 332 kWh and a household heating energy saving factor (ESF) of 5% for programmable thermostats. It reports household cooling energy savings of 429 kWh and a household heating ESF of 12.5% for Nest Wi-Fi thermostats.

This study used a 100% manual thermostat baseline for both programmable and Nest Wi-Fi thermostats. However, the 2022 Smart Cycle Program includes participants regardless of their existing thermostat type. Therefore, Cadmus used results from the 2019 Smart Cycle Program participant survey to inform methodology inputs. Survey data indicated a saturation of 38% for manual thermostats and 62% for programmable thermostats.

57 Cadmus. January 29, 2015. *Evaluation of the 2013–2014 Programmable and Smart Thermostat Program.*

Cadmus used the reported household cooling and heating savings for programmable thermostats from its thermostat study for the 2013-2014 program and a weighted average to adjust the savings for learning thermostats from a manual thermostat baseline to a mixed manual and programmable thermostat baseline.

Cadmus used these equations:[58,59]

$$\Delta Cooling_{AdjustedBaseline} = [38\% * 429 + 62\% * (429 - 332)] * 100\% = 298\ kWh$$

$$\mathrm{ESF}_{\mathrm{AdjustedBaseline}_{\mathrm{HEAT}}} = 38\% * 12.5\% + 62\% * (12.5\% - 3.46\%) = 10.36\%$$

Cadmus performed equivalent calculations to obtain adjusted baseline values for the heating energy saving factor. The 2013-2014 thermostat evaluation investigated only homes with gas heating, so Cadmus assumed that the percentage of gas savings from that evaluation apply to electric heating as well.

A.9 Community Based LED Specialty Bulb Distribution

Cadmus' impact evaluation of the Community Based LED Specialty Bulb Distribution Program included two measures with attributable electric savings:

- 4-watt candelabra
- LED night light

A.9.1 4W Candelabra

Cadmus applied the savings algorithm in the Residential ENERGY STAR Lighting (CFL and LED) section of the 2015 Indiana TRM v2.2. Cadmus used the lumen equivalence method to determine the baseline bulb wattage. Cadmus used these equations to calculate savings per LED bulb installed:

$$kWh\ Savings = \left(\frac{Watts_{BASE} - Watts_{EFF}}{1{,}000}\right) * HOURS\ * (1 + WHF_E)$$

$$kW\ Savings = \left(\frac{Watts_{BASE} - Watts_{EFF}}{1{,}000}\right) * (1 + WHF_D) * CF$$

Table A-60 shows the input values and the source for each value.

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58 Cadmus. January 29, 2015. *Evaluation of the 2013–2014 Programmable and Smart Thermostat Program* .

59 In the ΔCooling_AdjustedBaseline calculation, the 177.8 represents the cooling savings (332 kWh multiplied by 54% correct use factor) for programmable thermostats. The 54% cooling correct use factor is from the 2022 Residential Prescriptive Program participant survey, which asks homeowners with programmable thermostats about their thermostat usage habits related to cooling.

Table A-60. Community Based LED Specialty Bulb Distribution 4-Watt Candelabra Per-Unit Gross Savings

Cadmus Assumptions	Inputs	Source
HOURS – Hours of use per year	902	2015 Indiana TRM v2.2[a]
$Watts_{BASE}$ – Equivalent baseline wattage of program bulb	35	Baseline bulb wattage based on wattage equivalency table from IL TRM v10.0
$Watts_{EFF}$ – Wattage of program bulbs	4	Spec sheets of program bulb
WHF_E – Waste heat factor to account for cooling and heating savings	-0.034	2015 Indiana TRM v2.2—weighted average of weighted average heating types. Cities were Evansville (98%) and Indianapolis (2%), based on 2019-2021 survey data.[b]
WHF_D – waste heat factor for demand to account for cooling kW	0.092	
WHF_G – Waste heat factor to account for gas impacts	-0.002	
CF – Coincidence factor	0.11	2015 Indiana TRM v2.2

[a] Cadmus et al. July 28, 2015. *Indiana Technical Reference Manual, Version 2.2.* https://www.nrel.gov/docs/fy17osti/68562.pdf

[b] The 2021 survey sample was too small to generate adequate precision. Cadmus used the cumulative results from 2019 to 2021 to estimate weather city weights.

A.9.2 LED Night Light

Cadmus applied the savings algorithm in the LED night lights section of the 2015 Indiana TRM v2.2. Cadmus used these equations to calculate savings per LED bulb installed:

$$kWh\ Savings = \left(\frac{Watts_{BASE} - Watts_{EFF}}{1{,}000}\right) * HOURS$$

$$kW\ Savings = 0$$

Table A-61 shows the input values and the source for each value.

Table A-61. Community Based LED Specialty Bulb Distribution LED Night Llight Per-Unit Gross Savings

Cadmus Assumptions	Inputs	Source
HOURS – Hours of use per year	2,920	2015 Indiana TRM v2.2[a]
$Watts_{BASE}$ – Equivalent baseline wattage of program bulb	5	
$Watts_{EFF}$ – Wattage of program bulbs	0.5	Spec sheets of program bulb
Deemed kW savings	0	2015 Indiana TRM v2.2[a]

[a] Cadmus et al. July 28, 2015. *Indiana Technical Reference Manual, Version 2.2.*

A.9.3 Measure Verification

Cadmus verified measure installations in 2022 by using the estimated in-service rate and leakage from the 2022 participant survey, which Cadmus designed to follow the Residential Lighting Evaluation Protocol in the Uniform Methods Project.[60]

Cadmus conducted a phone survey with 2022 bulb recipients and received 32 responses, a response rate of 2% of the postcard population and 17% of those who opted into the survey. This response rate is comparable to other similar programs, and the small number of completes may not be fully representative due to the data collection method.

Table A-62 shows the overall measure verification of the Community Based LED Specialty Bulb Program. Adjustments for in-service rate are grouped by program component but distilled by measure.[61] For leakage, Cadmus grouped program components and measures to simplify the survey for respondents.

Table A-62. 2022 Community Based LED Specialty Bulb Measure Verification Results – In-Service Rates

Program Component	Measure Group	Measure	Installations[a]				Adjustments		
			Reported	Audited	Verified (ISR)	Verified (ISR and Leakage)	ISR	Leakage[b]	Total (ISR and Leakage)[c]
Food Bank Events	Lighting	4W Candelabra	62,400	62,400	45,240	45,240	73%	0%	73%
Food Bank Events	Lighting	LED Night Light	15,600	15,600	15,022	15,022	96%	0%	96%
Total			**78,000**	**78,000**	**59,959**	**59,959**	**77%**	**0%**	**77%**

[a] When applying in-service rate and leakage, total installations may not sum due to rounding.
[b] The percentage of bulbs that stayed in the service territory is 100%.
[c] Total adjustment rate equals ISR multiplied by (1-leakage rate).

Table A-63 shows the absolute precision at different confidence levels for the program's in-service rates.

Table A-63. 2022 Community Based LED Specialty Bulb Distribution Comparison of Absolute Precision at Different Confidence Levels

Program Component	Measure Group	Measure	ISR
Food Bank Events	Lighting	4W Candelabra	73%
Food Bank Events	Lighting	LED Night Light	96%

60 Dimetrosky, S., K. Parkinson, and N. Lieb. October 2017. "Chapter 6: Residential Lighting Evaluation Protocol." *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* https://www.nrel.gov/docs/fy17osti/68562.pdf

61 There were not enough responses to distill measures by program component to reach 85% confidence at ±15% precision.

Leakage Calculation

To estimate leakage—that is, bulbs distributed to non-CenterPoint Energy customers—Cadmus asked survey respondents who installed at least one program bulb if CenterPoint Energy provides their electricity service. All survey respondents indicated their bulbs were installed in CenterPoint Energy's territory, resulting in a 0% leakage rate.

A.10 Commercial and Industrial Prescriptive Program

Cadmus' impact evaluation of the Commercial and Industrial Prescriptive Program included measures with attributable electric savings, including these:

- Chillers
- Compressed air systems
- Controls
- HVAC
- Kitchen equipment
- Lighting
- Refrigeration
- Thermostats
- Other
- VFDs/motors

A.10.1 Chillers

Equation and assumptions for each measure.

Chiller Replacements

Cadmus used the 2015 Indiana TRM v2.2 algorithms for chiller replacements:

$$\Delta kWh = TONS \times \left(\frac{3.516}{IPLV_{BASE}} - \frac{3.516}{IPLV_{EE}}\right) \times EFLH$$

$$\Delta kW = TONS \times \left(\frac{3.516}{COP_{BASE}} - \frac{3.516}{COP_{EE}}\right) \times CF$$

Where, in the kWh equation:

TONS	=	New chiller's size in tons
$IPLV_{EE}$	=	New chiller's integrated part-load value
3.516	=	Conversion factor to IPLV in kW/ton
$IPLV_{BASE}$	=	Assumed baseline IPLV that depends on the chiller type and size and is derived from the ASHRAE 90.1–2007 standard
EFLH	=	Estimated full-load hours selected based upon city, building type, and chiller type

The kW equation uses coefficient of performance (COP) instead of integrated part load value (IPLV) because COP is an instantaneous efficiency, rather than a seasonal average efficiency like IPLV. The coincidence factor, CF, is assumed to be 74%. For early replacement savings, Cadmus assumed that the $IPLV_{BASE}$ and COP_{BASE} values came from IECC 2006 standards.

Chiller Tune-Ups

Cadmus used the 2015 Indiana TRM v2.2 algorithms for chiller tune-ups:

$$\Delta kWh = TONS \times \frac{3.516}{IPLV_{BASE}} \times EFLH \times ESF$$

$$\Delta kW = TONS \times \frac{3.516}{COP_{BASE}} \times DSF \times CF$$

Where, in the kWh equation:

TONS	=	Existing chiller's size in tons
$IPLV_{BASE}$	=	Assumed baseline IPLV that depends on the chiller type and size and is derived from the ASHRAE 90.1–2007 standard
3.516	=	Conversion factor to IPLV in kW/ton
COP_{BASE}	=	Assumed baseline COP that depends on the chiller type and size and is derived from the ASHRAE 90.1–2007 standard
EFLH	=	Estimated full-load hours selected based upon city, building type, and chiller type
ESF	=	Energy savings factor, 8%

The kW equation uses coefficient of performance (COP) instead of integrated part load value (IPLV) because COP is an instantaneous efficiency, rather than a seasonal average efficiency like IPLV. The coincidence factor, CF, is assumed to be 74%. The demand savings factor (DSF) is 8%.

Chilled Water Reset

Cadmus used the 2015 Indiana TRM v2.2 algorithm for chilled water reset controls measures:

$$\Delta kWh = TONS * \Delta kWh_{ton}$$

$$\Delta kW = TONS * \Delta kW_{ton} * CF$$

Where:

TONS	=	Rated capacity of unit controlled by reset controller (= actual, to collect with application)
ΔkWh_{ton}	=	Energy savings per ton (=dependent on whether chiller is air cooled or water cooled)
ΔkW_{ton}	=	Demand reduction per ton (=dependent on whether chiller is air cooled or water cooled)
CF	=	Summer peak coincident factor (= 0.74)

A.10.2 Compressed Air Systems

Efficient Air Compressors

Cadmus used the 2015 Indiana TRM v2.2 algorithms for the efficient air compressor project (manufacturing process application):

$$\Delta kWh = Bhp * \frac{0.746}{\eta_{motor}} * HOURS * ESF$$

$$\Delta kWh = \frac{\Delta kWh}{HOURS} * CF$$

Where Bhp is the full load brake horsepower, η_{motor} is the motor efficiency, and ESF is the energy savings factor based on the load control type, an ESF of 10% for no load, 17% for variable displacement, and 26% for variable frequency drive compressed air audits.

For compressed air audits, Cadmus used the algorithms in the 2021 Wisconsin Focus on Energy TRM:[62]

$$\Delta kWh = CFM\ Reduction/\left(\frac{CFM}{BHP}\right) \times 0.746 \times HOURS/Eff$$

$$\Delta kWh = \frac{\Delta kWh}{HOURS} * CF$$

Where:

CFM Reduction	=	Total CFM reduction in entire compressed air system, actual from program
CFM/BHP	=	Average amount of CFM per brake horsepower, 4.2
0.746	=	Motor brake horsepower to kilowatt conversion factor
HOURS	=	Average annual compressor run hours, actual from program
Eff	=	Air compressor deemed motor efficiency, 90%
CF	=	Peak coincident factor of air compressor systems, 38%, from the Indiana TRM

Compressed Air No-Loss Condensate Drains

Cadmus used the 2022 Illinois TRM v10.0 algorithms for the no-loss condensate drains:

$$\Delta kWh = CFM_{reduced} * kW_{cfm} * Hours$$

62 Public Service Commission of Wisconsin. *Wisconsin Focus on Energy 2021 Technical Reference Manual, Section, "Compressed Air System Leak Survey and Repair."* https://www.focusonenergy.com/sites/default/files/inline-files/Focus%20on%20Energy%202021%20TRM.pdf.

Where:

$CFM_{reduced}$	=	Reduced air consumption (CFM) per drain, 3 CFM.
kW_{cfm}	=	System power reduction per reduced air demand (kW/CFM) depending on the type of compressor control
HOURS	=	Compressed air system pressurized hours, 6,136 Hours.

Summer peak demand savings were calculated as:

$$\Delta kW = \Delta kWh/Hours * CF$$

Where:

CF	=	Peak coincident factor of air compressor systems, 95%

A.10.3 Controls

Boiler Tune-Up

Cadmus used the energy savings algorithms in the 2015 Indiana TRM v2.2 for boiler tune-ups:

$$\Delta Therms = CAP \times EFLH_H \times ESF$$

Here, CAP is the capacity of the boiler in therms, EFLH is the estimated full-load hours (which depend on the building type and location recorded in the program tracking data and confirmed in the participant survey), and ESF is a 2% energy savings factor.

A.10.4 HVAC

Air Conditioners and Heat Pumps

For unitary or split air conditioning units and heat pumps, Cadmus followed the algorithm in the 2015 Indiana TRM v2.2 for time-of-sale measures (or replace-on-burnout) and early replacement measures:

$$\Delta kWh = kBTU \times \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}}\right) \times EFLH_{Cool} + kBTU \times \left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}}\right) \times EFLH_{Heat}$$

$$\Delta kW = kBTU \times \left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right) \times CF$$

Here, kBtu, $SEER_{ee}$, and EER_{ee} are the capacity and efficiency specifications of the installed cooling equipment or heat pump equipment. For heat pump systems, there is also $HSPF_{ee}$, which is the heating efficiency of the heat pump. The heating and cooling hours are denoted by $EFLH_{Cool}$ and $EFLH_{Heat}$, which come from the 2015 Indiana TRM v2.2. Baseline efficiency terms are equal to the current federal baseline based on equipment size. The early replacement savings assume IECC 2006 standards as the baseline.

Advanced Rooftop Controls

Cadmus followed the energy savings algorithms in the 2022 Illinois TRM v10.0 for Advanced Rooftop Controls measures:

$$\Delta kWh = (Capacity_{cool} * Normalized\ Electric\ Cooling\ Energy\ Savings) + (Capacity_{heat} * Normalized\ Electric\ Heating\ Energy\ Savings)$$

Where:

$Capacity_{cool}$ = capacity of the cooling equipment in tons (nominal tonnage may be used)

$Normalized\ Electric\ Cooling\ Energy\ Savings$ = kWh/ton savings for the appropriate combination of building type, climate zone, and measure scenario

Furnace

Cadmus used this evaluated savings algorithm from the 2015 Indiana TRM v2.2 for efficient furnaces installed with electronically commutated motor (ECM) fans and adjusted it due to the new federal standard furnace fan requirement:

$$\Delta kWh = CAP \times EFLH_H * \left(10 * \frac{n_{EE}}{n_{BASE}} - 5\right)$$

$$\Delta Therms = CAP \times EFLH_H \times \left(\frac{n_{BASE}}{n_{EE}} - 1\right)/100\ - Therms_{ECM}$$

$$Therms_{ECM} = 0.019 \times CAP \times EFLH_H \times \frac{n_{BASE}}{n_{EE}}/100 \times AdjRatio$$

Where:

CAP = Heating input capacity of installed equipment in kBtuh

$EFLH_H$ = Equivalent full load heating hours selected based upon city and building type

10 = Non-ECM kWh per MMBtu of heating fuel consumption

5 = ECM kWh per MMBtu of heating fuel consumption

n_{EE} = Installed equipment efficiency, in units of AFUE

n_{BASE} = Baseline equipment efficiency, in AFUE

1 = Constant, based on algebraic manipulation of efficiency ratios

100 = Conversion to therms

$Therms_{ECM}$ = Increased heating fuel consumption due to fan motor waste heat, if no ECM, set to 0

0.019 = Conversion factor

12% = Ratio of the deemed residential-sized furnace fan savings from the 2021 Wisconsin Focus on Energy TRM of 70 kWh to the average savings of the previous standard of 583 kWh. There is less of a therms penalty because the furnace fan requirement adjusts the baseline. Cadmus assumes the baseline shifts occur linearly.

The tracking database provided Cadmus with the capacity, installed efficiency, and if an ECM fan was present. The baseline annual fuel utilization efficiency (AFUE), n_{BASE}, was the federal standard of 80%. The existing AFUE was 64.4%, which Cadmus used when project documentation indicated replacement of working equipment.[63]

Furnace Tune-Up

Cadmus used the following equation from the 2020 Illinois TRM v8.0 to calculate savings for furnace tune-ups:

$$ThermSavings = \frac{\left(CAPInput_{pre} * EFLH * \frac{1}{AFUE * (1 - Derating_{pre})} - \frac{1}{AFUE * (1 - Derating_{post})}\right)}{100{,}000}$$

Since savings inputs are based on single-family values, therm savings is reduced by the ratio of the average square footage for a single-family home to a multifamily apartment. The savings inputs Cadmus used for its *ex post* calculations are shown in Table A-64**.**

Table A-64. Multifamily Direct Install Program Furnace Tune-Up Savings Inputs

Input	Assumption	Source
$CAPInput_{pre}$	53,273	2019 IQW program installation data
EFLH	1,341	2015 Indiana TRM v2.2 Indianapolis value
AFUE	0.848	2012 baseline study
$Derating_{pre}$	0.064	2020 Illinois TRM v8.0
$Derating_{post}$	0.000	2020 Illinois TRM v8.0
Conversion from Btu to therms	100,000	Conversion factor

A.10.5 Kitchen Equipment

The kitchen equipment measure category contains a variety of commercial appliances including convection ovens, dishwashers, griddles, and ice machines, some of which are not included in the 2015 Indiana TRM v2.2.

Convection Ovens, Combination Ovens, and Electric Griddles

For convection ovens, combination ovens and electric griddles, Cadmus used the following 2015 Indiana TRM v2.2 equations:

$$\Delta kWh = kWh_{base} - kWh_{EFF}$$

$$kWh_{base} = \left(\frac{LB * E_{food}}{EFF_{Base}} + \frac{IDLE_{Base}}{1{,}000} * \left(HOURS_{DAY} - \frac{LB}{PC_{Base}} - \frac{PRE_{TIME}}{60}\right) + PRE_{ENERGY,B}\right) * DAYS$$

[63] Illinois Commerce Commission. September 25, 2020. *2021 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 9.0—Volume 2: Commercial and Industrial Measures*. https://ilsag.s3.amazonaws.com/IL-TRM_Effective_0-10-120_v8.0_Vol_2_C_and_I_10-17-19_Final.pdf.

$$kWh_{EFF} = \left(\frac{LB * E_{food}}{EFF_{EFF}} + \frac{IDLE_{EFF}}{1{,}000} * \left(HOURS_{DAY} - \frac{LB}{PC_{EFF}} - \frac{PRE_{TIME}}{60}\right) + PRE_{ENERGY,EFF}\right) * DAYS$$

Where:

LB	=	Pounds of food cooked per day (Combination Oven = 200 lb/day, Convection Oven/Griddle = 100 lb/day)
E_{Food}	=	ASTM Energy to Food; the amount of energy absorbed by the food during cooking (= 0.00732 kWh/lb)
Eff_{base}	=	Heavy load cooking energy efficiency of baseline oven (Combination Oven = 44%, Convection Oven = 65%, Electric Griddle = 60%)
Eff_{ES}	=	Heavy load cooking energy efficiency of ENERGY STAR oven (Combination Oven = 60%, Convection Oven = 74%, Electric Griddle = 75%)
$IDLE_{Base}$	=	Idle energy rate of baseline model (Combination Oven = 7.5 kW, Convection Oven = 2 kW, Electric Griddle = 2.4 kW)
$IDLE_{EFF}$	=	Idle energy rate of ENERGY STAR model (Combination Oven = 3.0 kW, Convection Oven = 1.3 kW, Electric Griddle = 0.05 kW)
$HOURS_{DAY}$	=	Daily operating hours (= 12)
PC_{BASE}	=	Production capacity of baseline oven (Combination Oven = 80 lb/hr, Convection Oven = 70 lb/hr, Electric Griddle = 35 lb/hr)
PC_{EFF}	=	Production capacity of ENERGY STAR oven (Combination Oven = 100 lb/hr, Convection Oven = 80 lb/hr, Electric Griddle = 51 lb/hr)
PRE_{TIME}	=	Preheat time to reach operating temperature (= 15 min/day)
$PRE_{ENERGY,B}$	=	Baseline preheat energy (Combination Oven = 3.0 kWh, Convection Oven = 1.5 kWh, Electric Griddle = 4 kWh)
$PRE_{ENERGY,EFF}$	=	ENERGY STAR preheat energy (Combination Oven = 1.5 kWh, Convection Oven = 1 kWh, Electric Griddle = 2 kWh)
DAYS	=	Operating days per year (= 365)

Hot Food Holding Cabinets

For convection ovens, Cadmus used the following 2022 Illinois TRM v10.0 equations:

$$\Delta kWh = HFHCBaselinekWh - HFHCENERGYSTARkWh$$

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

$$HFHCBaselinekWh = PowerBaseline * HOURSday * Days/1000$$

$$HFHCENERGYSTARkWh = PowerENERGYSTAR * HOURSday * Days/1000$$

Where:

PowerBaseline = Full Size HFHC = 2,500 W, ¾ Size HFHC = 1,200 W, ½ Size HFHC = 800 W

PowerENERGYSTAR = Full Size HFHC = 800 W, ¾ Size HFHC = 480 W, ½ Size HFHC = 320 W

HOURS = Average Daily Operation (= 15)

DAYS = Operating days per year (= 365.25)

CF = Summer peak coincidence factor

Freezers and Refrigerators

For freezers and refrigerators, Cadmus used the following 2015 Indiana TRM v2.2 equations:

$$\Delta kWh = (kWh_{base} - kWh_{EFF}) * 365$$

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

Where:

kWh_{base} = Baseline maximum daily energy consumption in kilowatt hours

kWh_{EFF} = Efficient maximum daily energy consumption in kilowatt hours

HOURS = Number of hours equipment is operating (= 8,760)

CF = Summer peak coincidence factor (= 1.0)

Ice Machines

Cadmus used the following formulas to determine energy savings and demand reduction from the 2015 Indiana TRM v2.2:

$$\Delta kWh = \frac{kWh_{base} - kWh\_EE}{100} * DC * H * 365$$

$$\Delta kW = \frac{\Delta kWh}{HOURS * DC} * CF$$

Where:

kWh_{base} = baseline kWh consumption per 100 pounds of ice, using 2018 federal standards[64]

kWh_{EE} = ENERGY STAR kWh consumption per 100 pounds of ice, (= actual)

100 = Conversion factor from 100 lbs of ice to per pound of ice

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[64] Code of Federal Regulations. Automatic Commercial Ice Makers: 10 CFR §431.136(c). "Energy conservation standards and their effective dates." https://www.ecfr.gov/cgi-bin/text-idx?SID=a25116a0785a0c488243d01bddb84f90&mc=true&node=se10.3.431_1136&rgn=div8.

DC	=	Duty cycle of ice machine (= 0.57)
H	=	Harvest rate of ice machine (= actual)
365	=	Days per year
Hours	=	Hours per year (= 8,760 hours)
CF	=	Summer peak coincident factor (= 0.772)

A.10.6 Lighting

Retrofits

Retrofits were the predominant type of lighting measure, and the basic algorithm is the same regardless of the replaced or efficient lighting technology (LED panels, high output T8 fixtures, refrigerated LEDs, etc.). Cadmus evaluated all retrofit lighting measures using this 2015 Indiana TRM v2.2 algorithm:

$$\Delta kWh = (WATTS_{BASE} - WATTS_{EE}) \times Hours \times \frac{(1 + WHF_E)}{1000}$$

$$\Delta kW = (WATTS_{BASE} - WATTS_{EE}) \times CF \times \frac{(1 + WHF_D)}{1000}$$

In these equations:

$WATTS_{ee}$	=	Wattage of the new lighting
$WATTS_{base}$	=	Wattage being replaced
Hours	=	Hours the lights are on per year
CF	=	Peak demand coincidence factor
WHF_E	=	Waste heat factors for energy
WHF_D	=	Waste heat factor for demand

Program tracking data reported savings and new and replaced wattages for each lighting project. In accordance with the 2015 Indiana TRM v2.2, Cadmus used actual wattages (from the program tracking data) for $WATTS_{ee}$ and $WATTS_{base}$.

New Construction

The program also offered a number of new construction lighting measures, which Cadmus evaluated using the lighting power density reduction method described in the 2015 Indiana TRM v2.2:

$$\Delta kWh = (LPD_{BASE} - LPD_{EE}) \times AREA \times Hours \times \frac{(1 + WHF_E)}{1000}$$

$$\Delta kW = (LPD_{BASE} - LPD_{EE}) \times AREA \times CF \times \frac{(1 + WHF_D)}{1000}$$

In these equations:

LPD	=	Lighting power density (lighting wattage per square foot)
AREA	=	Area (in square feet) that has its lighting power density reduced
LPD_{BASE}	=	Minimum lighting power density required by the ASHRAE 90.1–2007 standard
LPD_{ee}	=	Final lighting power density after fixture removal, efficient lighting installation, and/or other methods have been applied to the area

The difference between LPD_{BASE} and LPD_{EE} multiplied by the area produces a reduction in overall wattage.

Occupancy Sensors

Cadmus categorized occupancy sensors as a lighting measure for the purposes of the evaluation and used the 2015 Indiana TRM v2.2 to evaluate savings:

$$\Delta kWh = kW_{CONTROLLED} \times Hours \times (1 + WHF_E) \times ESF$$

$$\Delta kW = kW_{CONTROLLED} \times (1 + WHF_D) \times CF$$

Here, $kW_{CONTROLLED}$ is the amount of lighting wattage controlled by the occupancy sensor, ESF is an energy savings factor that depends on the type of occupancy sensor, and CF is a coincidence factor that also depends on the type of occupancy sensor.

A.10.7 Refrigeration

The predominant measure upgrade for refrigeration was upgrading commercial freezers and/or refrigerators to an ENERGY STAR model. Cadmus based evaluated savings on the 2015 Indiana TRM v2.2 equations:

$$\Delta kWh = (kWh_{BASE} - kWh_{EE}) * 365$$

$$\Delta kW = \frac{\Delta kWh}{HOURS} \times CF$$

However, Cadmus used the updated federal standards as the baseline and pulled the daily energy consumption of the efficient unit (kWh_{EE}) from the ENERGY STAR Qualified Products List. For the equation, kWh terms are available in the 2015 Indiana TRM v2.2 based on the size of the unit. Hours equal 8,760, and coincidence factor equals 1.

Anti-Sweat Heater Controls

For anti-sweat door heater controls, Cadmus used the following equations from the door heater controls for cooler or freezer measure from the 2015 Indiana TRM v2.2:

$$\Delta kWh = kW_{base} * NUM_{doors} * ESF * BF * 8{,}760$$

Where:

kW_{base}	=	Connected load kilowatts for typical reach-in refrigerator or freezer door and frame with a heater (= actual; otherwise assume 0.195 kW for freezers and 0.092 kW for coolers)
NUM_{doors}	=	Number of reach-in refrigerator or freezer doors controlled by sensor (= actual)
ESF	=	Energy savings factor (= 55% for humidity based controls, = 70% for conductivity based controls)
BF	=	Bonus factor (=1.36 for low-temperature applications, =1.22 for medium temperature applications, =1.15 for high-temperature applications)

A.10.8 Thermostats

The program implementer currently uses an energy modeling tool to determine savings for Wi-Fi and programmable thermostat measures because the 2015 Indiana TRM v2.2 does not provide savings algorithms for thermostats in commercial applications. In 2022, as in the previous six program years, the implementer used energy savings intensity factors (which estimate energy savings per square foot of building served by the thermostat) based on an eQuest model of a 15,000-square-foot office building. The eQuest model simulates the heating, cooling, and ventilation savings for 360 different thermostat configurations for two different weather locations: Indianapolis and Evansville. Configurations vary by degree heating/cooling setback, hours of setback per day, and days the business was closed per week. Savings are assigned on a project-by-project basis according to the project's reported thermostat setback schedule and facility square footage.

Cadmus performed an in-depth review of the implementer's model as part of the 2017 and 2018 evaluations. Cadmus determined that the implementer's approach was reasonable for thermostats, considering the available data, and found no reason to adjust thermostat savings based on the *ex ante* model.

A.10.9 Other

Barrel Wrap

For injecting molding barrel wrap, Cadmus used the following equations from the 2015 Indiana TRM v2.2 to determine savings:

$$\Delta kWh = \frac{\Delta E_{loss} * LEN_{barrel} * D_{barrel} * pi}{1{,}000} * Hours$$

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

Where:

ΔE_{loss}	=	Difference in heat loss between an injection molding barrel with insulation and injection molding barrel without insulation
LEN_{barrel}	=	Length of barrel (= actual)
D_{barrel}	=	Diameter of barrel (=actual)
Pi	=	3.14159
$1{,}000$	=	Conversion factor from watts to kilowatts
$Hours$	=	Annual operating hours (= actual, otherwise assume 3,952)

Window Film

For window film measures, Cadmus used the following equations from the 2015 Indiana TRM v2.2 to determine savings:

$$\Delta kWh = \frac{SF}{100} * \Delta kWh_{100sf}$$

$$\Delta kW = \frac{SF}{100} * \Delta kW_{100sf} * CF$$

Where:

SF	=	Glazing surface area of installed window film in square feet
ΔkWh_{100sf}	=	Unit energy savings per 100 square feet of window film
ΔkW_{100sf}	=	Unit demand reduction per 100 square feet of window film
CF	=	Summer peak coincident factor (=0.74)

A.10.10 VFD/Motors

Variable frequency drive (VFD) controls added to HVAC fans, pumps, and cooling towers were the predominant measure type in this measure category. Cadmus evaluated savings using the Illinois TRM V10.0.[65] The 2015 Indiana TRM v2.2 had limited building types.

VFDs for HVAC applications

Cadmus used the following equations to determine savings:

$$\Delta kWh = \frac{BHP}{Eff_i} * Hours * ESF$$

[65] Sections 4.4.17 for pumps and cooling tower fans and 4.4.26 for supply and return fans. Illinois Energy Efficiency Stakeholder Advisory Group. Final September 25, 2020; effective January 1, 2021. *2021 Illinois Statewide Technical Reference Manual for Energy Efficiency.* https://www.ilsag.info/technical-reference-manual/il-trm-version-9/

$$\Delta kW = \frac{BHP}{Eff_i} * DSF$$

Where:

BHP	=	System brake horsepower (= nominal motor HP * load factor [65%])
Eff_i	=	Motor efficiency installed (= 93%)
Hours	=	Operating hours, varies by building type and equipment type
ESF	=	Energy savings factor, varies by equipment type
DSF	=	Demand savings factor, varies by equipment type

A.11 Commercial and Industrial Custom Program

Cadmus' impact evaluation of the Commercial and Industrial (C&I) Custom Program included measures with attributable electric savings from eight end-use type, as shown in Table A-65.

Table A-65. 2022 Commercial and Industrial (C&I) Custom Program Measures

End Use	Quantity of Measures	Reported Annual Energy Savings (kWh)	Reported Demand Savings (kW)
HVAC	28	248,097	122.4
Compressed Air Systems	4	283,725	93.8
Cooling Chillers	1	86,054	0.0
Insulation	2	10,883	2.7
Lighting	8	501,583	22.9
Motors	1	9,834	8.5
Refrigeration	1	479,302	174.7
VFD	2	46,383	0.0

Each customer (or participating contractor) provided initial documentation of the project's energy savings and demand reduction, which the program implementer then reviewed, adjusted where necessary, and finalized. To evaluate the reasonableness of the savings calculations, Cadmus reviewed all project documentation, including invoices, technical specifications, and verification reports (if applicable) supplied by the program implementer.

Cadmus then reviewed each project's analysis workbook (supplied by the program implementer), upon which each project's incentives were based, to verify these items:

- Calculation assumptions matched equipment specifications and supporting project documentation (including verification reports)
- Reported savings calculations follow accepted engineering methodologies
- All assumed baselines are appropriate for project type (new construction, retrofit, etc.)
- All calculation assumptions were reasonable, justified, and properly cited
- Reported savings fell within a reasonable range given the project's scope

Cadmus performed desk reviews (no on-site verification) on 15 C&I Custom Program projects (electric application IDs), which accounted for all of the program's electric savings in 2022. Cadmus determined that eight measures required a savings adjustment, as shown in Table A-66.

Table A-66. 2022 Commercial and Industrial (C&I) Custom Program Measures

Application ID	Project Description	Annual Energy Savings (kWh)		Demand Savings (kW)		Adjustments
		Reported	Evaluated	Reported	Evaluated	
286	Process upgrade	162,485	3,168	26.2	0.5	Process equipment load profile
311	Process upgrade	55,200	43,119	53.1	33.2	Process equipment load profile
363	ERUs and Advanced Rooftop Control	13,582	13,267	2.2	2.1	Supply fan load profile
523	Whole Building	81,754	77,284	26.1	26.1	Baseline lighting wattage and hours of operation
870	Whole Building Upgrades	87,183	67,912	28.4	26.8	VFD load profile
1,208	Lighting	169,664	69,541	18.3	9.2	Lighting peak demand load profile
1,858	Chiller and Compressed Air	139,627	139,627	10.2	8.2	Compressed air system peak load profile
2,578	Lighting	25,978	0	0.0	0.0	Savings qualification

A.12 Small Business Energy Solutions Program

A.12.1 Lighting – Controls

Cadmus adhered to the 2015 Indiana TRM v2.2 guidelines for evaluating savings for occupancy sensors. Savings for this measure are largely a reflection of the total connected wattage controlled by each sensor. Cadmus found that evaluated savings aligned with the tracking database.

A.12.2 Lighting – Exit Signs

Cadmus identified differences between *ex ante* and evaluated calculations in one record (2% of exit sign records), where the program tracking data used a different waste heat factor than assigned by Cadmus.

Cadmus adhered to the 2015 Indiana TRM v2.2 guidelines for evaluating savings for LED exit signs but used a coincidence factor of 100%, which aligns with the annual operating hours of 8,760 hours. As in previous years, Cadmus used an in-service rate of 100% rather than the 98% in-service rate stipulated in the TRM because the program is direct-install and should be claiming savings for equipment directly installed by the contractor.

A.12.3 Lighting – Exterior

Cadmus used the hours of use and baseline wattages as reported in the tracking database and a coincidence factor of 0%, as stated in the 2015 Indiana TRM v2.2. Lighting installed in unconditioned spaces does not have any interactive effects with HVAC equipment, so no waste heat factors were applied to the exterior lighting measures.

A.12.4 Lighting – Interior

Cadmus applied waste heat factors and coincidence factors in accordance with Appendix B of the 2015 Indiana TRM v2.2. Cadmus looked up waste heat factors for the type of HVAC equipment serving the facility and facility type and looked up coincidence factors for the building type. Cadmus found that 36 records (4% of interior lighting records) used a different energy waste heat factor in the *ex ante* and *ex post* calculations.

A.12.5 Lighting – Refrigerated Cases

Savings for LED case lighting are a result of the installed lamp length as well as the installation location. Cadmus evaluated savings in accordance with the 2015 Indiana TRM v2.2. Evaluated savings aligned with the tracking database.

A.12.6 Wi-Fi and Programmable Thermostats

The program implementer currently uses an energy modeling tool for determining savings for thermostat measures because the 2015 Indiana TRM v2.2 does not provide savings algorithms for Wi-Fi or programmable thermostats in commercial applications.[66]

In 2022, as in previous program years, the implementer used energy savings intensity factors (which estimate energy savings per square foot of building served by the thermostat) based on an eQuest model of a 15,000-square-foot office building. The eQuest model simulates the heating, cooling, and ventilation savings for 360 different thermostat configurations for two different weather locations: Indianapolis and Evansville. Configurations vary by degree heating/cooling setback, hours of setback per day, and days the business is closed per week. Savings are assigned on a project-by-project basis according to the project's reported thermostat setback schedule and facility square footage.

In 2022, thermostats had an energy savings realization rate of 191%. The deviation from 100% is mainly because six projects (59% of installed thermostats) reported only cooling season fan savings. Heating season fan savings is a large contributor to overall savings, particularly where there is natural gas heating. This was the case for all thermostats in 2022.

A.12.7 Vending Machine Occupancy Sensors

Cadmus relied on the 2015 Indiana TRM v2.2 to determine evaluated savings for vending machine occupancy sensors. The evaluated savings matched the per-unit deemed kWh savings as reported.

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66 The same eQuest model is used for both programmable and smart Wi-Fi thermostats. Approximately 31% of the thermostats rebated in 2021 were programmable and the balance (69%) were smart Wi-Fi thermostats.

Appendix B. Net-to-Gross Detailed Findings

Cadmus calculated the savings that were directly attributable to CenterPoint Energy's programs (net savings) by estimating program-specific (or measure-specific, where applicable) net-to-gross (NTG) ratios. The NTG ratios were used to adjust the verified gross savings estimates to account for freeridership and spillover.

For CenterPoint Energy's portfolio of programs, Cadmus used three methods for determining NTG ratios:

- ***Self-report surveys*** use survey results to derive net savings by adjusting *ex post* gross savings to account for an NTG ratio. To mitigate self-report bias, Cadmus used a battery of freeridership questions that collect data on each participant's *intention* and factors that might have had *influence*. The *intention* and *influence* scores contributed equally to the total freeridership score. Cadmus computed a freeridership score for each participant by calculating the arithmetic mean of the intention and influence scores.
  - ***Participant spillover*** is the program's influence on customers' decisions to invest in additional energy efficiency measures for which they did not receive any CenterPoint Energy incentives. Cadmus gathered the necessary data from the self-report surveys to calculate participant spillover. Cadmus included measures that are program-eligible (known as like spillover) as well as any non-program-eligible measures (known as non-like spillover) for which Cadmus could provide a reasonable savings documentation.
  - ***Nonparticipant spillover (NPSO)*** is created by CenterPoint Energy's marketing and education efforts among residential customers who did not participate in any program.
- ***Deemed NTG*** is applied to programs where the participant is unlikely to have taken energy-saving action without program intervention (for example, programs targeting low-income and student households). Cadmus also applied deemed NTG ratios from the 2019 or 2021 impact evaluation for programs for which a participant survey was not conducted in 2022 or if the 2022 survey did not generate a significant response (given small program population).
- ***Benchmarking*** using publicly available historical evaluation results and NTG calculations for similar residential upstream lighting measures in other jurisdictions to determine an appropriate benchmark for Residential Specialty Lighting Program net savings.
- ***Control group*** comparison generates inherently net savings. Cadmus used billing/regression analysis to estimate net impacts for the Residential Behavioral Savings Program. In this method, Cadmus calculated net savings by developing a comparison (control) group, which isolates the program impacts from exogenous effects.

Table B-1 lists the NTG approach Cadmus used for each program. This appendix further details the specific methodology Cadmus used to determine each program's NTG ratio.

Table B-1. Net-to-Gross Method by Program

Program	Self-Report Surveys	Deemed NTG	Benchmarking	Control Group
Residential Programs				
Residential Specialty Lighting			✓	
Residential Prescriptive	✓	✓[a]		
Residential New Construction		✓[b]		
Income Qualified Weatherization		✓		
Energy Efficient Schools		✓		
Residential Behavioral Savings				✓
Appliance Recycling		✓[c]		
Smart Cycle		✓[d]		
Community Based LED Specialty Bulb Distribution		✓		
Commercial and Industrial Programs				
Commercial and Industrial Prescriptive	✓			
Commercial and Industrial Custom	✓			
Small Business Energy Services		✓[e]		

[a] Cadmus used 2021 survey data based NTG results to calculate NTG for Residential Prescriptive Midstream program channel.
[b] Cadmus used 2021 survey data based NTG results to calculate NTG for Residential New Construction.
[c] Cadmus used 2021 survey data based NTG results to calculate NTG for Appliance Recycling.
[d] Cadmus used 2019 survey data based NTG results to calculate NTG for Smart Cycle.
[e] Cadmus used 2021 survey data based NTG results to calculate NTG for Small Business Energy Services.

B.1 Residential Specialty Lighting Program

Cadmus calculated NTG for the Residential Specialty Lighting program as the average of seven different utilities using findings from a benchmarking study conducted in 2021 (details are in the 2021 Electric Memo appendix). The program resulted in a 35% NTG ratio.

Table B-2 lists the presents the NTG results applied to for the 2022 program year.

Table B-2. Residential Specialty Lighting Program Net-to-Gross Ratio

Measure	Freeridership	Spillover	NTG Ratio
LED Reflector	69%	0%	31%
LED Specialty	58%	0%	42%
Total Program	**65%**	**0%**	**35%**

B.2 Residential Prescriptive Program

Cadmus calculated NTG for the Residential Prescriptive Program using findings from surveys conducted with 1,702 Standard and Online Marketplace channel program participants and the 2021 Midstream NTG results.[67] Table B-3 summarizes the freeridership, spillover, and NTG estimates by program channel. The overall program NTG ratio of 58% is weighted by the combination of electric and natural gas gross evaluated program population savings.

Table B-3. 2022 Residential Prescriptive Net-to-Gross Ratio by Program Channel

Program Channel	Freeridership	Spillover	NTG Ratio	Total Program *Ex Post* MMBTU Savings
Standard and Online Marketplace	41%	0%	59%	121,348
Midstream	59%	0%	41%	7,563
Total Program	**42%[1]**	**0%**	**58%[a]**	**128,911**
Electric-Specific NTG			**60%**	**8,389**
Demand-Specific NTG			**54%**	**3.49[b]**
Natural Gas-Specific NTG			**58%**	**120,522**

[a] Weighted by evaluated *ex post* program population MMBtu savings
[b] MMBTU/hour savings

B.2.1 Standard and Online Marketplace

Cadmus calculated NTG for the Residential Prescriptive Program Standard and Online Marketplace channels using findings from a survey conducted with 1,702 program participants; 1,360 answered the freeridership questions and 756 program participants answered the spillover questions. Table B-4 summarizes the freeridership, spillover, and NTG estimates by measure category. The overall program NTG ratio of 59% is weighted by the combination of electric and gas gross evaluated program population savings.

The electric-specific NTG ratio of 67% presented in Table B-4 is weighted specifically to electric savings due to the application of measure category level NTG estimates. The overall NTG ratio is heavily weighted toward the natural gas-specific NTG estimate of 58% because *ex post* gross gas savings account for 95% of the total 2022 energy savings in the Standard and Online Marketplace channels.

67 For the 2022 Residential Prescriptive Program Midstream program channel, Cadmus applied 2021 Midstream NTG results due to an insufficient response rate to the NTG questions by participating distributors in 2022. Only two of 6 participating distributors interviewed in 2022 answered the NTG questions, representing 9% of population gross energy savings. In 2021, participating distributors interviewed who answered the NTG questions represented 24% of the population gross energy savings.

Table B-4. 2022 Residential Prescriptive Program Standard and Online Marketplace Net-to-Gross Ratio

Measure Category	Freeridership	Spillover	NTG Ratio	Total Program *Ex Post* MMBTU Savings
Furnace/Boiler (n=354 for FR, 177 for SO)	47%	0%	53%	84,568
Heat Pump/CAC (n=75 for FR, 55 for SO)	47%	0%	53%	2,446
Thermostat (n=628 for FR, 69 for SO)	23%	1%	78%	23,643
Water Heater (n=136 for FR, 19 for SO)	44%	2%	58%	4,230
Weatherization (n=35 for FR, 63 for SO)	33%	0%	67%	5,498
Other (n=132 for FR, 0 for SO)	25%	0%	75%	963
Total Program (n=1,702)[a]	**41%[b]**	**0%[b]**	**59%[b]**	**121,348**
Electric-Specific NTG			**67%**	**5,982**
Demand-Specific NTG			**55%**	**3.06[c]**
Natural Gas-Specific NTG			**58%**	**115,366**

[a] Through all survey efforts, 1,360 respondents answered freeridership questions and 756 respondents answered spillover questions. 1,702 unique participants answered either the freeridership questions or spillover questions. 414 answered freeridership and spillover questions. 577 answered only freeridership questions. 342 answered only spillover questions. Not all respondents surveyed answered the freeridership and spillover questions.

[b] Weighted by evaluated *ex post* program population MMBtu savings

[c] MMBTU/hour savings

B.2.2 Detailed Freeridership Findings

Cadmus estimated freeridership by combining the standard self-report intention method and the intention/influence method.[68] Cadmus calculated the arithmetic mean of the savings weighted *intention* and *influence* freeridership components to estimate measure category freeridership estimates,[69] as shown in this equation:

$$\text{Final Freeridership }\% = \frac{\textit{Intention}\text{ FR Score}(0\%\text{ to }100\%) + \textit{Influence}\text{ FR Score}(0\%\text{ to }100\%)}{2}$$

Intention Freeridership Score

Cadmus estimated *intention* freeridership scores for all participants based on their responses to *intention*-focused freeridership questions. As part of previous CenterPoint Energy evaluations, Cadmus developed a transparent, straightforward matrix approach to assign a single score to each participant based on their objective responses. Determining *intention* freeridership estimates from a series of questions rather than using a single question helps to form a picture of the program's influence on the participant. Use of multiple questions also checks consistency.

Table B-5 illustrates how initial responses are translated into whether the response is "yes," "no," or "partially" indicative of freeridership (in parentheses). The value in brackets is the scoring decrement associated with each response option. Each participant freeridership score starts with 100%, which Cadmus then decrements based on their responses to the questions.

68 *Intention* and *influence* freeridership scores both have a maximum of 100%.

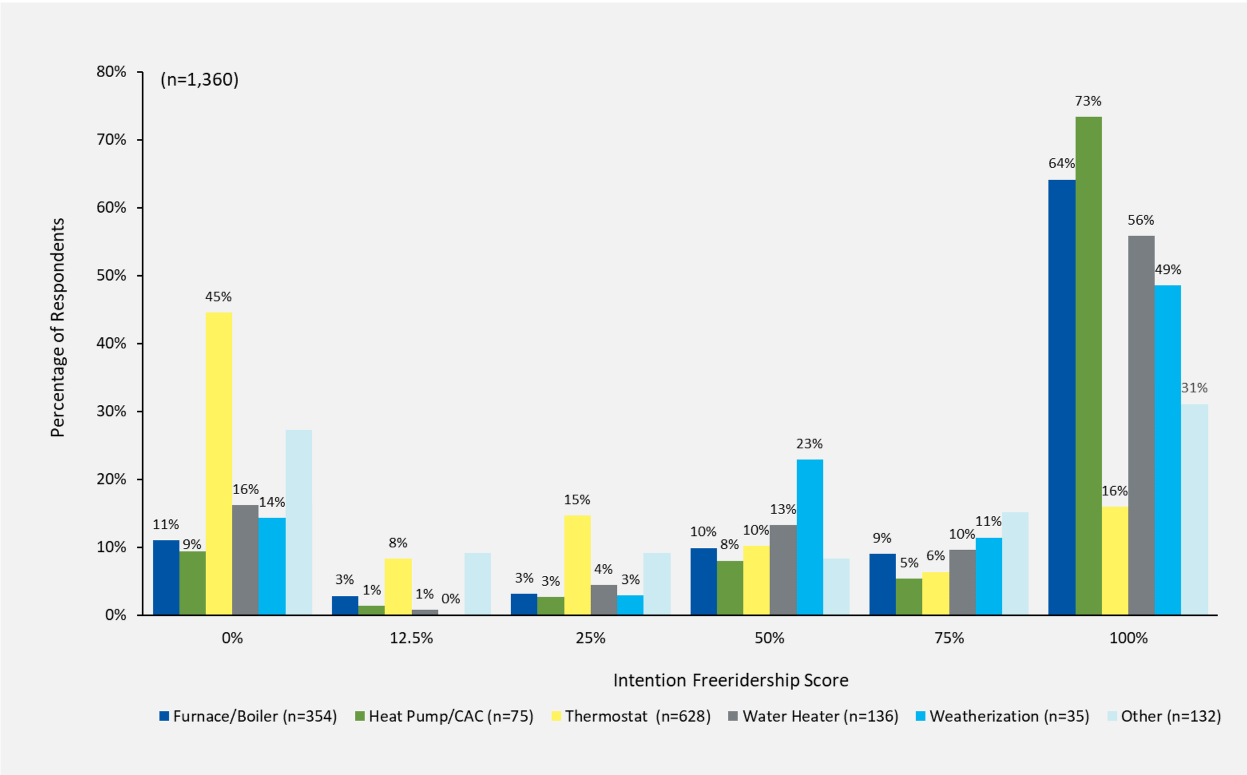
69 *Ex post* gross program savings.

Table B-5. Raw Survey Responses Translation to *Intention* Freeridership Scoring Matrix Terminology Residential Prescriptive Program and Scoring

BEFORE you heard about the CenterPoint Energy Residential Efficient Products Rebate Program, had you already PLANNED [If purchase: purchase the/if tune-up: schedule a tune-up or annual check-up of your] [MEASURE 1]?	Before you heard anything about the CenterPoint Energy Residential Rebate program, had you already had you already [If purchase: purchased or installed/if tune-up: scheduled the tune-up or annual check-up of] [MEASURE 1]?	To confirm, you [If purchase: installed your new/if tune-up: scheduled a tune-up for your] [MEASURE 1] before you heard anything about the CenterPoint Energy Residential Efficient Products Rebate Program, correct?	[If purchase] Would you have installed the same [MEASURE 1] without the rebate from CenterPoint Energy? [If tune-up] Would you have scheduled a [MEASURE_1] tune-up without the rebate from CenterPoint Energy?	[If purchase] Would you have installed a different type of [MEASURE_1] without the CenterPoint Energy rebate or would you have decided not to purchase it?	[If purchase] Without the rebate from CenterPoint Energy, would you have purchased and installed a [MEASURE_1] that was just as efficient, less efficient or more efficient than what you purchased?	Without the rebate from CenterPoint Energy, what kind of thermostat would you have installed?	[If purchase] Would you have installed the same quantity of [MEASURE_1]s without the incentive from CenterPoint Energy?	Thinking about timing, without the CenterPoint Energy rebate, when would you have [If purchase: installed/if tune-up: scheduled a tune-up for] the [MEASURE_1]?...
Yes (Yes) [-0%]	Yes (Yes) [-0%]	Yes, that is correct (Yes) [100% FR Assigned]	Yes (Yes) [-0%]	I would have installed a different MEASURE_1 (Yes) [-0%]	Just as efficient (Yes) [-0%]	A smart or learning thermostat (Yes) [-0%]	Yes, the same quantity (No) [-0%]	At the same time (No) [-0%]
No (No) [-50%]	No (No) [-0%]	No, that's not correct (No) [-0%]	No (No) [-25%]	I would have decided not to replace it (No) [-25%]	Less efficient (No) [-100%]	A Wi-Fi thermostat (non-learning) (Yes) [-0%]	No, would have installed fewer (Partial2) [-50%]	Within the same year (Partial2) [-50%]
DK/RF (Partial) [-25%]	DK/RF (No) [-0%]	DK/RF (No) [-0%]	DK/RF (Partial) [-0%]	DK/RF (Partial) [-25%]	More efficient (Yes) [-0%]	A programmable thermostat (No) [-100%]	No, would have installed more (No) [-0%]	One to two years out (No) [-100%]
					DK/RF (Partial) [-25%]	A manual thermostat (Yes) [-100%]	DK/RF (Partial) [-25%]	More than two years out (No) [-100%]
						Would not have installed a new thermostat (Yes) [-100%]		Never (No) [-100%]
						DK/RF (Partial) [-25%]		DK/RF (Partial) [-25%]

Figure B-1 shows the distribution of *intention* freeridership estimates Cadmus assigned to participant responses to the pure intention-based freeridership method.

Figure B-1. Residential Prescriptive Program Self-Report
***Intention* Freeridership Distribution by Estimate**



Influence Freeridership Score

Table B-6 shows the distribution of responses to the question: "Please rate the influence of the following program elements on your decision to purchase and install [the product]. Please use a scale from 1, meaning *not at all influential*, to 4, meaning the item was *very influential* to your decisions." Cadmus assessed influence freeridership from participants' ratings to how important various program elements were in their decision to purchase energy-efficient products.

Table B-6. Residential Prescriptive Program Freeridership *Influence* Responses by Measure Category (n=1,360)

Response Options	Influence Score	Information about the program from your contractor						Rebates for the equipment						Information about energy efficiency that CenterPoint Energy provided						Previous participation in a CenterPoint Energy efficiency program					
		Furnace/Boiler	Heat Pump/CAC	Thermostat	Water Heater	Weatherization	Other	Furnace/Boiler	Heat Pump/CAC	Thermostat	Water Heater	Weatherization	Other	Furnace/Boiler	Heat Pump/CAC	Thermostat	Water Heater	Weatherization	Other	Furnace/Boiler	Heat Pump/CAC	Thermostat	Water Heater	Weatherization	Other
1 - Not at all influential	100%	27	7	9	6	0	3	27	7	17	8	0	6	27	7	17	8	0	6	27	7	17	8	0	6
2 - Not too influential	75%	13	6	4	3	1	1	14	6	17	4	1	6	14	6	17	4	1	6	14	6	17	4	1	6
3 - Somewhat influential	25%	93	17	29	34	10	16	93	17	98	43	10	30	93	17	98	43	10	30	93	17	98	43	10	30
4 - Very influential	0%	210	43	139	69	23	18	210	43	490	81	23	84	210	43	490	81	23	84	210	43	490	81	23	84
Not Applicable	50%	10	1	4	0	1	3	10	2	6	0	1	6	10	2	6	0	1	6	10	2	6	0	1	6
Average Rating		**3.4**	**3.3**	**3.6**	**3.5**	**3.6**	**3.3**	**3.4**	**3.3**	**3.7**	**3.4**	**3.6**	**3.5**	**3.4**	**3.3**	**3.7**	**3.4**	**3.6**	**3.5**	**3.4**	**3.3**	**3.7**	**3.4**	**3.6**	**3.5**

Cadmus used the maximum rating given by each participant for any factor in Table B-6 to determine the participant's influence score, presented in Table B-7. Cadmus weighted individual influence scores by their respective total survey sample *ex post* gross savings to arrive at savings-weighted average influence scores by measure category.

Table B-7. Residential Prescriptive Program Influence Freeridership Score (n=1,360)

Maximum Influence Rating	Influence Score	Furnace/Boiler	Heat Pump/CAC	Thermostat	Water Heater	Weatherization	Other
1 – Not at all influential	100%	27	7	17	8	0	6
2 – Not too influential	75%	14	6	17	4	1	6
3 – Somewhat influential	25%	93	17	98	43	10	30
4 – Very influential	0%	210	43	490	81	23	84
Not Applicable	50%	10	2	6	0	1	6
Average Maximum Influence Rating - Simple Average		**3.5**	**3.4**	**3.3**	**3.7**	**3.4**	**3.6**
Average Influence Score - Weighted by *Ex Post* Savings		**18%**	**18%**	**10%**	**16%**	**7%**	**10%**

Cadmus then calculated the arithmetic mean of the intention and influence freeridership components to estimate final freeridership by measure category, weighted by *ex post* gross program savings. The higher the freeridership score, the more savings are deducted from the gross savings estimates. Table B-8 summarizes the intention, influence, and overall freeridership scores for each measure category.

Table B-8. Residential Prescriptive Program Intention, Influence and Overall Freeridership Scores by Measure Category

Measure Category	n	Intention Score	Influence Score	Freeridership Score
Furnace/Boiler	354	75%	18%	47%
Heat Pump/CAC	75	76%	18%	47%
Thermostat	628	36%	10%	23%
Water Heater	136	71%	16%	44%
Weatherization	35	57%	7%	32%
Other	132	39%	10%	25%

B.2.3 Detailed Spillover Findings

Sixteen participants reported installing a total of 20 high-efficiency measures after participating in the program. These respondents did not receive an incentive and said participation in the program was very influential on their decision to install additional measures. Cadmus attributed spillover savings to measures including high-efficiency ENERGY STAR clothes washers, refrigerators, air purifiers, dehumidifiers, a pool pump and a room air conditioner, water heaters, and a smart thermostat.

Cadmus used *ex post* savings estimated for the 2022 Residential Prescriptive Program evaluation in combination with the Indiana TRM v2.2 to estimate savings for all spillover measures attributed to the program. Cadmus divided the total survey sample spillover savings for each measure category by the gross program savings from the survey sample to obtain the measure category spillover estimates in Table B-9.

Table B-9. Residential Prescriptive Standard and Online Marketplace Spillover Estimates by Measure Category

Measure Category	Survey Sample Spillover MMBtu Savings	Survey Sample Program MMBtu Savings	Percentage Spillover Estimate
Furnace/Boiler	10.0	2,255.2	0%
Heat Pump/CAC	0.0	68.1	0%
Thermostat	13.3	1,646.2	1%
Water Heater	6.4	315.7	2%
Weatherization	0.0	233.8	0%
Other	0.3	97.9	0%

B.3 Commercial and Industrial Prescriptive Program

Cadmus calculated freeridership and spillover for the C&I Prescriptive Program using findings from a survey conducted with 14 program participants. After including spillover, the program resulted in a 63% NTG ratio. Table B-10 presents the freeridership, spillover, and NTG results for the 2022 C&I Prescriptive Program.

Table B-10. 2022 Commercial and Industrial Prescriptive Program Net-to-Gross Ratio

Measure	Freeridership	Spillover	NTG Ratio
Total Program	37%[a]	0%	63%

[a] Weighted by evaluated *ex post* program MMBtu savings.

NTG results rely completely on self-reported responses and therefore can change from one year to the next, especially when population and sample sizes are small, and when there is potential for large variation in gross program energy savings of participants' projects. The 2022 program population was smaller than prior years. The 2022 survey population at the time of survey fielding was 101 participants and 14 participants completed a survey, a 14% response rate. In 2022, three respondents' projects accounted for 55% of the program energy savings in the analysis sample and their combined program energy savings weighted freeridership was 59%.

B.3.1 Detailed Freeridership Findings

Intention Freeridership Score

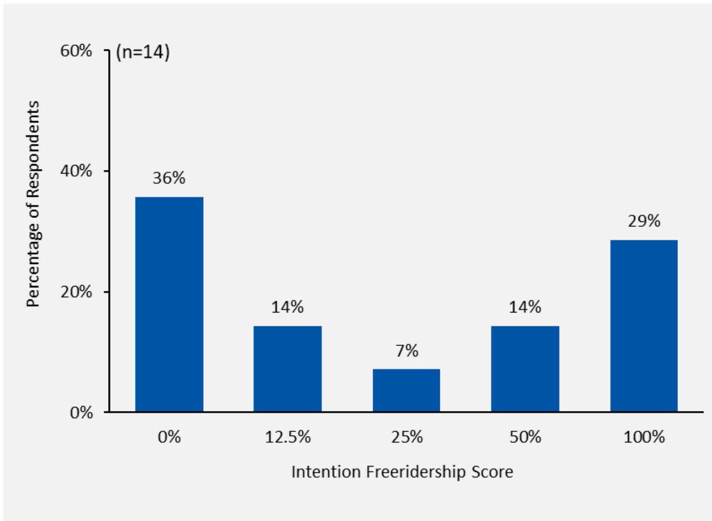
Cadmus estimated intention freeridership scores for all participants based on their responses to the intention-focused freeridership questions. Table B-16 illustrates how initial responses are translated into whether the response is "yes," "no," or "partially" indicative of freeridership (in parentheses). The value in brackets is the scoring decrement associated with each response option. Each participant freeridership score starts with 100%, which Cadmus then decrements based on their responses to the questions. After assigning an *intention* freeridership score to every survey respondent, Cadmus calculated a savings-weighted average *intention* freerider score of 62% for the program.

Table B-11. 2022 Raw Survey Responses Translation to *Intention* Freeridership Scoring Matrix Terminology Commercial and Industrial Prescriptive Program and Scoring

First, did your organization have specific plans to install the [MEASURE] before learning about CenterPoint Energy's Business Rebate Program?	Had you already purchased or installed the new [MEASURE] before you learned about the program?	Just to be clear, you installed the [MEASURE] before you heard anything about the CenterPoint Energy program, correct?	Would you have installed a [MEASURE] that (was/were) just as energy-efficient without the CenterPoint Energy program and rebates?	And would you have installed the same quantity of [MEASURE] in absence of the CenterPoint Energy program and rebates?	Without the CenterPoint Energy program and rebates, when would you have installed the [MEASURE]?	Did the incentive help the [MEASURE] project receive implementation approval from your organization?	Prior to participating in the Business Rebate Program, was the purchase and installation of the [MEASURE] included in your organization's capital budget?
Yes (Yes) [-0%]	Yes (Yes) [-0%]	Yes, that is correct (Yes) [100% FR Assigned]	Yes, just as energy-efficient (Yes) [-0%]	Yes, same quantity (Yes) [-0%]	Within the same year? (Yes) [-0%]	Yes (No) [-50%]	Yes (No) [-50%]
No (No) [-50%]	No (No) [-0%]	No, that's not correct (No) [-0%]	No, less energy efficient (No) [-50%]	No, I would have installed less (Partial2) [-50%]	Within one to two years? (Partial2) [-50%]	No (Yes) [-0%]	No (Yes) [-0%]
DK/RF (Partial) [-25%]	DK/RF (No) [-0%]	DK/RF (No) [-0%]	No, more energy efficient (Yes) [-0%]	No, I would have installed more (Yes) [-0%]	Within three to five years? (No) [-100%]	DK/RF (Partial) [-25%]	DK/RF (Partial) [-25%]
				Would not have installed anything at all (No) [-100%]	In more than five years? (No) [-100%]		
				DK/RF (Partial) [-25%]	Never (No) [-100%]		
					DK/RF (Partial) [-25%]		

Figure B-2 shows the distribution of *intention* freeridership estimates Cadmus assigned to participant responses to the pure intention-based freeridership method.

Figure B-2. 2022 Commercial and Industrial Prescriptive Program Self-Report *Intention* Freeridership Distribution by Estimate



Influence Freeridership Score

Table B-12 shows the distribution of responses to the influence question: "Please rate each item on how important it was to your decision to complete the [MEASURE] project the way it was done. Please use a scale from 1, meaning *not at all important*, to 4, meaning the item was *very important* to your decisions." Cadmus assessed influence freeridership from participants' ratings to the relative importance of various program elements in their purchasing decisions, as shown in Table B-12.

Table B-12. 2022 Commercial and Industrial Prescriptive Program Freeridership Influence Responses (n=14)

Response Options	Influence Score	CenterPoint Energy or Implementer staff	Rebates for the equipment	Information about energy efficiency provided by CenterPoint Energy	Information about energy efficiency from my contractor	Previous participation in a CenterPoint Energy efficiency program
1 – Not at all important	100%	3	0	2	2	2
2 – Not too important	75%	1	0	1	0	0
3 – Somewhat important	25%	1	6	5	4	2
4 - Very important	0%	6	8	6	5	6
Don't Know	50%	2	0	0	3	3
Not Applicable	50%	1	0	0	0	1
Average		**2.3**	**2.9**	**3.6**	**3.1**	**3.1**

Cadmus used the maximum rating given by each participant for any factor in Table B-12 to determine the participant's influence score presented in Table B-13. Cadmus weighted individual influence scores by each participant's respective total survey sample *ex post* gross savings to arrive at a savings-weighted average influence score of 12% for C&I Prescriptive Program participants.

Table B-13. 2022 Commercial and Industrial Prescriptive Program Influence Freeridership Score (n=14)

Maximum Influence Rating	Influence Score	Count[a]	Total Survey Sample *Ex Post* MMBtu Savings	Influence Score MMBtu Savings
1 – Not at all important	100%	0	0	0
2 – Not too important	75%	0	0	0
3 – Somewhat important	25%	6	1,723	431
4 - Very important	0%	8	1,744	0
Average Maximum Influence Rating - Simple Average		**3.6**		
Average Influence Score - Weighted by *Ex Post* Savings		**12%**		

[a] Refers to the number of responses for each factor/influence score response option.

Final Freeridership Score

Cadmus calculated the arithmetic mean of the intention and influence freeridership components to estimate a final freeridership value of 37%, weighted by *ex post* gross program savings. The higher the freeridership score, the more savings are deducted from the gross savings estimates. Table B-14 presents the intention, influence, and freeridership scores for the C&I Prescriptive Program.

Table B-14. 2022 Commercial and Industrial Prescriptive Program Intention/Influence Freeridership Score

n	Intention Score	Influence Score	Freeridership Score
14	62%	12%	37%

B.3.2 Detailed Spillover Findings

None of the interviewed participants reported that, after participating in the program, they had installed additional high-efficiency equipment for which they did not receive an incentive and that participation in the program was very important in their decision. Therefore, no spillover is attributed to the program.

B.4 Commercial and Industrial Custom Program

Cadmus calculated freeridership and spillover for the C&I Custom Program as a whole using findings from a survey conducted with six program participants. After including spillover, the program resulted in a 58% NTG ratio.

Table B-15 presents the freeridership, spillover, and NTG results for the 2022 C&I Custom Program.

Table B-15. 2022 Commercial and Industrial Custom Program Net-to-Gross Ratio

Measure	Freeridership	Spillover	NTG Ratio
Total Program	42%[a]	0%	58%

[a] Weighted by evaluated *ex post* program MMBtu savings

B.4.1 Detailed Freeridership Findings

Intention Freeridership Score

Cadmus estimated *intention* freeridership scores for the program based on surveyed participants' responses to the *intention*-focused freeridership questions. Table B-16 illustrates how initial responses are translated into whether the response is "yes," "no," or "partially" indicative of freeridership (in parentheses). The value in brackets is the scoring decrement associated with each response option. Each participant freeridership score starts with 100%, which Cadmus then decrements based on responses to the questions. After assigning an *intention* freeridership score to every survey respondent, Cadmus calculated a savings-weighted average *intention* freerider score of 70% for the program.

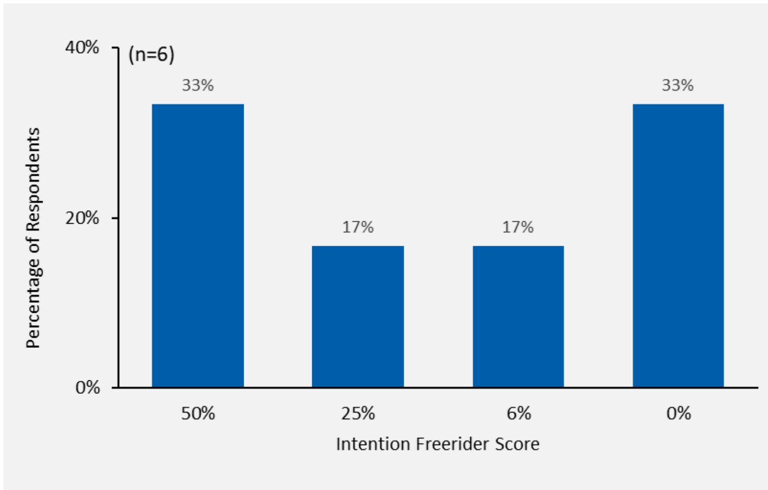
Table B-16. 2022 Raw Survey Responses Translation to *Intention* Freeridership Scoring Matrix Terminology C&I Custom Program and Scoring

First, did your organization have specific plans to install the [Field-MEASURE_FINAL] BEFORE learning about CenterPoint Energy's Commercial Custom Program rebate?	Had you already purchased or installed the new [Field-MEASURE_FINAL] before you learned about the program?	Just to be clear, you installed the [Field-MEASURE_FINAL] before you heard anything about the CenterPoint Energy program, correct?	Would you have installed a [Field-MEASURE_FINAL] that (was/were) just as energy-efficient without the CenterPoint Energy program and rebates? [READ LIST IF NECESSARY]	And would you have installed the same quantity of [Field-MEASURE_FINAL] in absence of the CenterPoint Energy program and rebates? [READ LIST IF NECESSARY]	Without the CenterPoint Energy program and rebates, would you have installed the [Field-MEASURE_FINAL]¦ [READ LIST]?	Did the incentive help the [Field-MEASURE_FINAL] project receive implementation approval from your organization?	Prior to participating in the Commercial Custom Program, was the purchase and installation of the [Field-MEASURE_FINAL] included in your organization's capital budget?
Yes (Yes) [-0%]	Yes (Yes) [-0%]	Yes, that is correct (Yes) [100% freerider Assigned]	Yes, just as energy-efficient (Yes) [-0%]	Yes, same quantity (Yes) [-0%]	Within the same year? (Yes) [-0%]	Yes (No) [-50%]	Yes (Yes) [-0%]
No (No) [-50%]	No (No) [-0%]	No, that's not correct (No) [-0%]	No, less energy efficient (No) [-100%]	No, I would have installed less (partial2) [-50%]	Within one to two years? (Partial2) [-25%]	No (Yes) [-0%]	No (No) [-50%]
DK/NA (Partial) [-25%]	DK/NA (No) [-0%]	DK/NA (No) [-0%]	No, more energy efficient (Yes) [-0%]	No, I would have installed more (Yes) [-0%]	Within three to five years? (No) [-100%]	DK/NA (Partial) [-25%]	DK/NA (Partial) [-25%]
			DK/NA (Partial) [-25%]	Would not have installed anything at all (no) [-100%]	In more than five years? (No) [-100%]		
				DK/NA (Partial) [-25%]	DK/NA (Partial) [-25%]		

DK = don't know; RF = refused

Figure B-3 shows the distribution of *intention* freeridership estimates Cadmus assigned to participant responses using the pure intention-based freeridership method.

Figure B-3. 2022 C&I Custom Program Self-Report *Intention* Freeridership Distribution by Estimate



Influence Freeridership Score

Table B-17 shows the distribution of responses to the influence question: "Please rate each item on how influential it was to your decision to complete the project the way it was done. Please use a scale from 1, meaning 'not at all influential', to 4, meaning the item was 'very influential' to your decisions." Cadmus assessed influence freeridership from participants' ratings to the relative importance of various program elements in their purchasing decisions, as shown in Table B-17.

Table B-17. 2022 C&I Custom Program Freeridership Influence Responses (n=6)

Question F9 Response Options	Influence Score	CenterPoint Energy or implementer staff	Rebates for the equipment	Information about energy efficiency provided by CenterPoint Energy	Information about energy efficiency from my contractor	Previous participation in a CenterPoint Energy energy efficiency program
1 – Not at all influential	100%	2	1	0	1	2
2	75%	0	0	1	1	1
3	25%	1	3	4	2	1
4 - Very influential	0%	2	2	1	2	0
Don't Know	50%	1	0	0	0	1
Not Applicable	50%	0	0	0	0	1
Average		**2.6**	**3.0**	**3.0**	**2.8**	**1.8**

Cadmus used the maximum rating given by each participant for any factor in Table B-17 to determine the participant's influence score presented in Table B-18. Cadmus weighted individual influence scores by each participant's respective *ex post* gross savings associated with the total survey sample to arrive at a savings-weighted average influence score of 14% for C&I Custom Program participants.

Table B-18. 2022 C&I Custom Program Influence Freeridership Score (n=6)

Maximum Influence Rating	Influence Score	Count[a]	Total Survey Sample *Ex Post* MMBtu Savings	Influence Score MMBtu Savings
1 – Not at all influential	100%	0	0	0
2	75%	0	0	0
3	25%	3	19,975	4,994
4 - Very influential	0%	3	14,671	0
Average Maximum Influence Rating - Simple Average		**3.5**		
Average Influence Score - Weighted by *Ex Post* Savings		**14%**		
[a] Refers to the number of responses for each factor/influence score response option.				

Final Freeridership Score

Cadmus calculated the arithmetic mean of the intention and influence freeridership components to estimate a final freeridership value of 42%, weighted by *ex post* gross program savings. The higher the freeridership score, the more savings are deducted from the gross savings estimates. Table B-19 presents the intention, influence, and freeridership scores for the C&I Custom Program.

Table B-19. 2022 C&I Custom Program Intention/Influence Freeridership Score

n	Intention Score	Influence Score	Freeridership Score
6	70%	14%	42%

B.4.2 Detailed Spillover Findings

None of the surveyed participants reported that, after participating in the program, they had installed additional high-efficiency equipment for which they did not receive an incentive and that participation in the program was very important in their decision. Therefore, no spillover is attributed to the program.

Appendix C. Market Performance Indicators

The primary objective of the market performance indicators evaluation was to assess changes and trends from 2011 to 2022 in the activities and key performance indicators (KPIs) for the demand-side management (DSM) programs in CenterPoint Energy's Indiana territory. During interviews and surveys, Cadmus asked program staff, trade allies, and participants about fundamental shifts in the energy marketplace (market transformation) and current market practices and compared these responses with the KPIs and findings from previous evaluation years. Their responses to the market performance indicator questions informed updates to program logic models.

The main objective of updating the logic models was to develop an understanding of each program and define its underlying theory and assumptions. The logic models include market actors, market barriers uncovered by the evaluation, current and expected intervention strategies and activities, and the expected outcomes if current program intervention strategies were implemented.

Cadmus assessed market performance indicators for most CenterPoint Energy electric only and integrated dual fuel DSM programs with available longitudinal data.

C.1 Residential Specialty Lighting Program

RESIDENTIAL SPECIALTY LIGHTING PROGRAM

Market Actor: End-Use Customer | Lighting Product Purchasers

Market Barriers

- Higher cost of efficient lighting products
- Customer preference for the familiar
- Lack of program awareness
- Lack of energy efficiency awareness
- Negative associations with energy-efficient lighting
- Lighting products do not match customer's aesthetic preferences (e.g., shape, color)
- Low penetration in hard to reach communities (i.e. income-qualified)
- Skepticism of true energy savings

Intervention Strategies / Activities

- Lighting product discounts at point of purchase
- Target retailers in hard to reach communities
- In-store program signage
- Lighting product discounts for multiple specialty and reflector bulbs
- Recruit wide variety of retailers (superstore, discount, wholesale, hardware, and general)
- Hosted informal, pop-up events at store locations
- Information on CenterPoint Energy website

Outcomes

- Increased awareness
- Increased participation
- Increased customer satisfaction
- Increased participation among income-qualified customers
- Improved customer perception of efficient lighting
- Increased energy savings
- Increased penetration of efficient lighting technologies

Key Indicators

- Efficient lighting saturation/penetration in CenterPoint Energy's territory
- Percentage of income-qualified customers purchasing discounted bulbs
- Product satisfaction ratings
- Achievement of program participation and savings goals
- Number of participating retailers

Market Actor: Trade Allies | Retail Store Staff

Market Barriers

- Lack of program awareness
- Lack of understanding of efficient lighting benefits

Intervention Strategies / Activities

- In-store program signage
- Retail staff training on the program and efficient lighting
- Lighting brochures for retail personnel use
- Implementer-hosted in-store events to support retail personnel

Outcomes

- Increased awareness
- Increased participation
- Increased energy savings
- Increased retailer participation

Key Indicators

- Efficient lighting saturation/penetration in CenterPoint Energy's territory
- Achievement of program participation and savings goals
- Number of participating retailers

C.2 Residential Prescriptive Program – Non-Midstream Channels

RESIDENTIAL PRESCRIPTIVE PROGRAM

STANDARD, ONLINE MARKETPLACE, INSTANT REBATES CHANNELS

Market Actor: End-Use Customer | Residential Customers

Market Barriers

- Higher upfront costs for efficient equipment
- Energy-efficiency home upgrades are low priority
- Customer perception of application process as a hassle
- Lack of customer knowledge about efficiency of existing equipment
- Lack of awareness about monetary benefits of high-efficiency equipment
- Lack of program awareness
- Customer uncertainty about which energy efficiency claims to trust

Intervention Strategies / Activities

- Program information, eligibility requirements, and educational content available on CenterPoint Energy's website and Online Marketplace
- Program marketing (mailings and digital)
- Trade ally option to provide rebate as a direct discount to customers at time of purchase (trade allies apply for rebate)
- Incentives for equipment tune-up provide a low-cost option to increase efficiency and receive expert assessment of existing equipment
- Online Marketplace and Instant Rebates coupon apply discount at time of purchase
- Multiple methods available for rebate submission, including mail and online applications
- Marketing campaigns coordinated with trade allies
- Rebates for energy-efficient products
- Program sets clear equipment eligibility criteria

Outcomes

- Increased program awareness
- Increased participation
- Increased installations of high-efficiency equipment
- Increased availability of high-efficiency equipment through distribution and retail channels
- Increased customer satisfaction
- Reduced energy use

Key Indicators

- Likelihood to recommend rating
- Achievement of program participation and savings goals
- Customer familiarity with marketing materials
- Program satisfaction rating

Market Actor: Trade Allies | Retailers and Installation Contractors

Market Barriers

- Trade ally perception of application process is a hassle
- Perceived risk of carrying upfront cost of instant discount
- Perceived difficulty selling high-efficiency equipment with higher upfront cost

Intervention Strategies / Activities

- Multiple methods available for rebate submission, including mail and online applications
- Rebates used as a sales tool
- Experienced program implementer who continually works with trade allies to promote program's success
- Program support with rebate applications
- Reliable and timely rebate payment
- Marketing material and messages for contractors to use with customers

Outcomes

- Increased sales of high-efficiency equipment
- Increased number of trade allies participating in program
- Increased trade ally satisfaction with program

Key Indicators

- Percentage of participants learning about the program through a contractor or retailer
- Achievement of program participation and savings goals
- Number of trade allies participating in program
- Trade ally satisfaction with program

C.3 Residential Prescriptive Program – Midstream Channel

RESIDENTIAL PRESCRIPTIVE PROGRAM
MIDSTREAM CHANNEL

Market Actor	Market Barriers	Intervention Strategies / Activities	Outcomes	Key Indicators
End-Use Customer Homeowners	• Lack of program awareness • Lack of understanding of benefits of energy-efficient HVAC/water heating equipment • Upfront cost of energy-efficient HVAC/water heating equipment • Lack of availability of efficient HVAC/water heating equipment	• Program promotion via contractors and participating distributors • Follow-up notice to thank homeowners for participating • Incentives to distributors/contractors to sell energy-efficient HVAC/water heating equipment • Incentives to help offset increased costs passed on to homeowner	• Increased awareness of energy-efficient HVAC/water heating equipment • Increased demand for energy-efficient HVAC/water heating equipment • Increased energy savings Increased program participation	• Achievement of program participation and savings goals • Number of participating homeowners
Trade Allies Distributors	• Lack of program awareness • Lack of understanding of benefits of energy-efficient HVAC/water heating equipment • Low demand for high-efficiency HVAC/water heating equipment • Lack of understanding of how to use program portal • Perceived administrative burden of participation	• Outreach to qualified distributors to encourage program enrollment • Program information and materials that highlight energy-efficient equipment and program benefits • Trainings on how to use program portal • Distributors encourage contractors to promote instant rebate and benefits of energy-efficient HVAC/water heating equipment • Program promotion via CenterPoint Energy website • Program staff assist with rebate processing issues	• Increased program awareness • Increased program satisfaction • Increased program participation and uptake per distributor • Increased stocking and sales of energy-efficient HVAC/water heating equipment • Increased energy savings	• Achievement of program participation and savings goals • Number of participating distributors • Distributor satisfaction with program • Percentage of stocked program-qualified HVAC/water heating equipment • Market share of program-qualified equipment
Trade Allies Contractors	• Lack of program awareness • Lack of understanding of benefits of energy-efficient HVAC/water heating equipment • Lack of availability of energy-efficient HVAC/water heating equipment • Lack of ability to provide needed customer information	• Incentives to help lower cost of equipment purchase • Participating distributors stock qualified equipment • Contractors promote instant rebate and benefits of energy-efficient HVAC/water heating equipment • Outreach to trade ally network to drive program awareness	• Reduced administrative burden from simplified rebate applications • Increased contractor participation • Increased sales of energy-efficient HVAC/water heating equipment	• Achievement of program participation and savings goals • Contractor satisfaction with the program • Number of participating contractors • Percentage of program-qualified HVAC/water heating equipment sales

C.4 Income Qualified Weatherization Program

INCOME QUALIFIED WEATHERIZATION PROGRAM

Market Actor	Market Barriers	Intervention Strategies / Activities	Outcomes	Key Indicators
End-Use Customer Income-Qualified Customers	• Lack of program awareness • Lack of disposable income to make home improvements • Lack of energy efficiency awareness • Health and safety issues that prevent efficient product installation • Skepticism of true energy savings • Lack of time available for assessments and installation process	• Program marketing (direct mail, bill inserts, email, events, door-to-door canvassing, leave-behind referral materials) • Information on CenterPoint Energy website • Direct installation of products at no cost to the customer • Energy education provided during in-home assessment • Budget for health and safety improvements • Turnkey installation services • Easy-to-use online scheduling tool • Customer appointment reminders	• Increased awareness • Increased participation • Increased customer satisfaction • Improved customer perception of energy efficiency • Increased energy savings • Increased adoption of energy efficiency measures • Increased adoption of energy-saving behaviors • Increased health and safety of the home • Increased savings per home • Fewer appointment cancellations	• Achievement of program participation and savings goals • Number of participating homes • Number of measures installed • Persistence of measures • Measure satisfaction ratings • Program satisfaction ratings • Number of participant-adopted energy-saving behaviors • Ease of participation rating • Average kWh per household
Program Implementer Assessors	• Inability to reach eligible customers • Health and safety issues that prevent product installation	• RFPs to attract qualified program implementer • Open communication with participants to address concerns • Budget for health and safety improvements	• Increased program awareness • Increased participation • Assurance of quality work • Increased customer satisfaction • Increased savings per home • Continuation of program services	• Achievement of program participation and savings goals • Number of participating homes • Program satisfaction ratings • Average kWh per household
Trade Allies Installers	• Participant uncertainty about installer qualifications	• Interviews to hire qualified pool of installers • Open communication with participants to address concerns	• Assurance of quality work • Increased customer satisfaction • Continuation of program services	• Program satisfaction ratings • Achievement of program participation and savings goals

C.5 Residential Behavioral Savings Program

RESIDENTIAL BEHAVIORAL SAVINGS PROGRAM

Market Actor	End-Use Customer | Residential Home Energy Report Recipients (Treatment Group Customers)		
Market Barriers		• Lack of engagement with home energy reports • Lack of engagement with online energy efficiency resources • Lack of home energy use benchmark	• Lack of understanding of how home uses energy • Lack of awareness of energy efficiency options • Lack of energy education among hard to reach customers (e.g., income-qualified)
Intervention Strategies / Activities	• Print reports mailed 4 times per year and online reports emailed monthly • Home energy use comparison to a group of similar homes included in report • High bill alerts and combined bill forecasting reports sent to customers throughout the year	• Embed energy usage widget within customer's CenterPoint Energy's online account • Historical energy use data shown in the reports and available in online widget • Incorporation of income-qualified customers in treatment wave	• Customer segment-targeted energy-saving tips included in reports and online widget • Cross-promotion of other CenterPoint Energy DSM programs
Outcomes	• Increased adoption of energy-saving behaviors • Increased participation in other CenterPoint Energy DSM programs • Reduced per-customer energy use and demand	• Increased readership of reports • Increased customer understanding of energy efficiency actions • Increased engagement with online energy efficiency resources • Increased energy education among income-qualified customers	
Key Indicators	• Percentage of customers who read the reports • Annual logins to the online widget • Program uplift	• Average energy savings per treatment home • Achievement of program participation and savings goal	• Percentage of customers adopting energy-saving behaviors • Percentage of income-qualified customers adopting energy-saving behaviors

Market Actor	Program Implementer | Home Energy Reports Distributor		
Market Barriers	• Delivering the same content and design of the reports/widget disengages customers	• Lack of detailed energy use data make it difficult to deliver accurate, disaggregated reports	• Lack of customer information make it difficult to incorporate personalized tips
Intervention Strategies / Activities		• Integrate AMI weekly data and home energy analysis survey data for more accurate, detailed, and personalized reports • Send targeted messages and content to segments of treatment customers	• Update content and look of the reports/widget • With CenterPoint Energy, regularly review and update tips library
Outcomes	• An effective, well-designed report/widget that delivers strong and reliable energy savings		
Key Indicators	• Achievement of program participation and savings goals • High realization rate		

C.6 Appliance Recycling Program

APPLIANCE RECYCLING PROGRAM

Market Actor: End-Use Customer | Residential Customers

Market Barriers	• Lack of program awareness • Health/safety concerns with pick-up process due to COVID-19	• Customer perception of scheduling process as a hassle • Physical limitations preventing self removal of an inefficient appliance	• Lack of awareness of monetary and environmental benefits of removing an inefficient appliance • Skepticism of true energy savings
Intervention Strategies / Activities	• Multiple marketing channels • Cross-promotion through other CenterPoint Energy programs • Program information and eligibility requirements available on CenterPoint Energy website, bill inserts, and in retail stores	• Incentives for removal of working appliances • Enhanced scheduling process with multiple options (phone, online, and mobile) and resolution specialists and improved customer service software to address issues	• Pick-up of appliances within two to three weeks of initial customer contact • Text alerts to notify customers that pick-up staff are on their way • Pick-up staff deliver appliances to recycling center • Contactless pickup option
Outcomes	• Increased program awareness • Increased program participation • Increased customer satisfaction with program	• Increased customer understanding of energy efficiency benefits • Fewer inefficient appliances available on the secondary market • Reduced energy use	• Environmentally responsible disposal of waste materials from recycled appliances • Increased customer satisfaction with scheduling and pickup processes
Key Indicators	• Achievement of program participation and savings goals • Program satisfaction ratings • Appliance pick-up experience satisfaction ratings	• Likelihood to recommend ratings • Saturation of used appliances on the secondary market • Ease of scheduling ratings	

Market Actor: Program Implementer | Appliance Pick-Up Staff

Market Barriers		• Insufficient pick-up staff qualifications • Increased cost of drivers and transportation resources	• Participant concerns about pick-up staff entering home • Decline in appliance purchases
Intervention Strategies / Activities	• Route optimization and tracking software	• RFPs to attract qualified program implementer • Open communication with participants to address concerns • Option for contactless pick-up	• Checklist followed by pick-up staff upon arrival at every home • Offer bonus incentives to boost participation • Build in-house transportation network to improve resource availability
Outcomes	• Assurance of quality work	• Increased customer satisfaction with pick-up experience	• Fewer inefficient appliances in operation
Key Indicators	• Achievement of program participation and savings goals		• Appliance pick-up experience satisfaction ratings

C.7 Community Based LED Specialty Bulb Distribution Program

COMMUNITY BASED LED SPECIALTY BULB DISTRIBUTION PROGRAM

Market Actor	End-Use Customer	Bulb Recipients	
Market Barriers		• Lack of program awareness • Higher cost of efficient specialty LEDs • Lack of energy efficiency education • Low brand awareness of CenterPoint Energy	• Skepticism of true energy savings • Negative associations with energy-efficient lighting • COVID-19 creates concern about social distancing when receiving bulbs
Intervention Strategies / Activities	• Specialty LEDs offered to customers at no cost • Program signage prominent at giveaway event locations	• CenterPoint Energy logo, website, and program information on bulb box • ENERGY STAR-certified bulbs to ensure quality • Contactless option for bulb pickup	
Outcomes	• Increased participation • Increased customer satisfaction • Increased awareness	• Increased energy savings • Improved customer perception of efficient lighting technologies • Continuation of program services	• Increased saturation of efficient lighting technologies • Increased awareness of Center-Point Energy efficiency programs
Key Indicators	• Achievement of program participation and savings goals • Installation rate • Persistence of measures		• Efficient lighting saturation in CenterPoint Energy territory • Conversion to other CenterPoint Energy energy efficiency programs • Bulb satisfaction ratings

Market Actor	Trade Allies	Food Bank and Trustee Office Staff	
Market Barriers	• Lack of program understanding • COVID-19 creates health/safety concern for distribution staff	• Inability to encourage survey participation	• Lack of understanding of benefits of efficient lighting
Intervention Strategies / Activities	• Program implementer trains event staff how to deliver program • Contactless option for bulb pickup		• Incentive for survey participation • Program signage prominent at giveaway event locations
Outcomes	• Bulbs effectively distributed to customers • Ability to confirm product installations	• Increased saturation of energy efficient lighting • Continuation of program services	• Increased program understanding
Key Indicators	• Achievement of program participation and savings goals • Number of bulbs distributed • Installation rate	• Efficient lighting saturation in CenterPoint Energy's territory • Survey response rate	

C.8 Commercial and Industrial Prescriptive Program

C&I PRESCRIPTIVE PROGRAM

Market Actor	End-Use Customer | C&I Customers		
Market Barriers	• Lack of program awareness or knowledge of energy conservation benefits	• Large out-of-pocket expenses • Time commitment • Large customers opt out of programs	• Perception that project is not cost-effective for business or that business does not need improvements
Intervention Strategies / Activities	• Participation in industry associations and events, program handouts, and ongoing communication with customers • Word-of-mouth and one-on-one marketing	• Workshops and incentive bonus targeting large, opt-out eligible customers • Energy manager dedicated to large customers, and implementer staff support studies and projects	• Program incentives for efficient technologies to offset initial upfront cost • Participating trade ally base to make installation timely and convenient
Outcomes	• Increased program awareness and participation • Improved customer perception of energy efficiency programs	• Increased market saturation of energy-efficient measures • Increased energy savings	
Key Indicators		• Likelihood to recommend ratings • Achievement of program participation and savings goals	• Participant satisfaction with the program

Market Actor	Trade Allies | Installation Contractors		
Market Barriers		• Administrative burden such as program eligibility and paperwork requirements	• Lack of program awareness
Intervention Strategies / Activities	• Program outreach staff train and communicate with trade allies about program offerings • Contractor Network portal simplifies access to marketing materials to promote program to customers	• Program outreach staff cross-promote prescriptive and custom programs to deliver project assistance through a single procedure	• Provide project-level assistance to encourage trade ally engagement and adoption
Outcomes	• Increased contractor awareness of program offerings • Increased and sustained contractor participation with program	• Streamlined program participation for customers • Increased number of participating contractors	• Increased number of contractors promoting multiple C&I programs • Increased number of projects per contractor
Key Indicators	• Contractor satisfaction with the program • Number of contractors participating in multiple C&I programs • Achievement of program participation and savings goals	• Number of contractors participating in multiple years • Number of actively participating contractors • Average number of projects per contractor	

C.9 Commercial and Industrial Custom Program

C&I CUSTOM PROGRAM

Market Actor	End-Use Customer — C&I Customers		
Market Barriers	• Lack of program awareness • Lack of knowledge of energy conservation benefits • Lack of knowledge of energy audit benefits	• Large out-of-pocket expenses • Perception that project is not cost-effective for business or that business does not need improvements • Large customers opt out of programs	• Lack of knowledge about project eligibility • Concern with the complexity of project and time taken from business operations
Intervention Strategies / Activities	• Participation in industry associations and events, program handouts, and ongoing communication with customers • Energy manager and workshops dedicated to large customers	• Incentives up to 50% of qualified project cost • Explanation of customer's payment responsibility and calculation of payback period	• Participating trade ally base to make installation timely and convenient • Provide savings values, sample applications, and rebate process charts
Outcomes	• Increased program awareness • Increased participation • Incentive contribution allows energy efficiency customization to be viable option to C&I customers	• Increased market saturation of energy-efficient measures • Increased energy savings • Improved customer perception of energy efficiency programs	
Key Indicators		• Program satisfaction ratings • Average kWh per project	• Likelihood to recommend ratings • Achievement of participation and savings goals

Market Actor	Trade Allies — Installation Contractors		
Market Barriers	• Lack of program awareness • Inability to communicate directly with decision-maker	• Lack of customer awareness • Perception that design team engagement will slow down new construction project schedule	• Perception that time spent promoting program and helping customer with application is burdensome
Intervention Strategies / Activities	• Advertisement through trade associations and events • Facilitate trade ally relationships with decision-maker through account managers and energy manager • Outreach representatives dedicated to new construction and HVAC participation, recruiting trade allies, and promoting the Contractor Network		• Group and individual training sessions detailing program operations and requirements, application forms, and invoicing requirements • Contractor Network portal simplifies access to marketing materials to promote program to customers
Outcomes	• Increased program awareness • Increased energy savings • Increased engagement with new construction design firms and architects	• Streamlined project communication and implementation • Faster application processing times due to reduced errors	• Trade allies exposed to greater number of potential customers, thus increasing overall revenue and customer relationship
Key Indicators	• Number of contractors participating in multiple years • Number of actively participating contractors	• Number of new construction projects • Application processing time • Contractor satisfaction ratings	

C.10 Small Business Energy Solutions Program

SMALL BUSINESS ENERGY SOLUTIONS PROGRAM

Market Actor	End-Use Customer: Small Business Customers		
Market Barriers	• Time constraints, difficulty dedicating time to an energy efficiency project	• Lack of program awareness • Upfront costs affiliated with purchase and installation of efficient measures	• Lack of understanding of benefits of program-recommended energy-efficient products
Intervention Strategies / Activities	• Information on CenterPoint Energy website • Discounts for lighting, refrigeration, furnace tune-ups, steam trap replacements, thermostats, and water-saving devices		• Efficient product discounts at point of purchase • Contractor Network promoting benefits of energy-efficient products through energy assessments
Outcomes	• Increased awareness • Increased participation • Increased customer satisfaction	• Improved customer perception of efficient products • Increased energy savings	• Increased penetration of efficient technologies
Key Indicators	• Achievement of program participation and savings goals • Number of participating small businesses	• Measure satisfaction ratings	

Market Actor	Trade Allies: Installation Contractors		
Market Barriers		• Lack of program understanding • Lack of contractor engagement	• Concern that the program is not profitable enough to offset the time involved in delivering it
Intervention Strategies / Activities	• Group and individual training sessions detailing program operations and requirements, application forms, invoicing requirements, and sales strategies	• Trade allies required to complete a minimum number of assessments per year • Referrals to potential customers who are interested in participating in the program	• Program incentives and detailed energy assessment reports that entice customers to install low-cost measures • Online Contractor Network portal provides program resources and simplifies program adoption
Outcomes	• Increased program awareness • Increased participation • Deeper savings per project	• Increased energy savings • Increased market penetration of energy-efficient measures	• Increased sales volume per trade ally • Increased program satisfaction
Key Indicators	• Achievement of program participation and savings goals • Number of participating trade allies • Average number of recruited participants per trade ally • Average kWh per project		• Trade ally reported impact of program on sales • Conversion rate of energy assessments to low-cost measure installations • Program satisfaction ratings

Appendix D. Process Evaluation

For the process evaluation of the 2022 CenterPoint Energy demand-side management (DSM) portfolio, Cadmus assessed program strengths, areas for improvement, and best practices to optimize the customer experience.

Table D-1 lists the process evaluation research topics by data collection activity. In addition to interviews and surveys, Cadmus reviewed status reports and other program materials to obtain a complete understanding of all activities conducted to reach program goals.

Table D-1. Process Evaluation Topics by Research Activity

Data Collection Activity	Research Topics	
Program Staff Interviews	• Evaluation goals and research questions • Program goals and objectives • Implemented and proposed program changes • Program design, delivery, and administration • Quality control	• Marketing strategies and effectiveness • Program tracking and key performance indicators (KPIs) • Market barriers and reasons for nonparticipation • Target audiences and program participation
Trade Ally and Market Actor Interviews	• Program awareness and motivations • Freeridership and spillover • Aspects of program delivery and effectiveness • Interactions with program staff • Market barriers and reasons for nonparticipation (among trade allies and customers)	• Program satisfaction and value • Effectiveness of marketing materials/channels • Changes in business practices or performance as a result of program participation • Program strengths and suggestions for improvement
Participant Surveys	• Program awareness • Reasons for participation and installation of specific measures • Customer experience including program satisfaction and likelihood to recommend	• Trade ally experience • Freeridership and spillover • Verification of measure installation • Program strengths and suggestions for improvement

Table D-2 shows the number of interviews and surveys Cadmus completed for the 2022 CenterPoint Energy DSM portfolio evaluation.[70]

70 Cadmus conducted telephone surveys and interviews with the Residential Prescriptive Program's Midstream trade allies, C&I Prescriptive Program's chiller trade allies, and C&I Custom Program's participants. All other programs' surveys were conducted online.

Table D-2. Survey Respondent Groups by Program

Respondent Group	Population[a]	Included in Sample Frame[b]	Target Completes	Achieved Completes
Residential Programs				
Residential Specialty Lighting				
CenterPoint Energy Staff	1	1	1	1
CLEAResult Staff	1	1	1	1
Residential Prescriptive – Standard and Marketplace				
CenterPoint Energy Staff	1	1	1	1
CLEAResult Staff	1	1	1	1
Participating Customers (Quarterly Freeridership and Customer Experience Surveys)	14,365	11,068	1,000 (70 per measure category)	1,678
Participating Customers (Annual Spillover Surveys)	14,365	9,436	300 (50 per measure category)	818
Residential Prescriptive - Midstream				
CenterPoint Energy Staff	1	1	1	1
CLEAResult Staff	1	1	1	1
Participating Distributors	16	16	10	8
Participating Contractors	51	51	10	14
Residential New Construction				
CenterPoint Energy Staff	1	1	1	1
CLEAResult Staff	1	1	1	1
Income Qualified Weatherization				
CenterPoint Energy Staff	1	1	1	1
CLEAResult Staff	1	1	1	1
Residential Behavioral Savings				
CenterPoint Energy Staff	1	1	1	1
Oracle Staff	1	1	1	1
Appliance Recycling				
CenterPoint Energy Staff	1	1	1	1
ARCA Staff	1	1	1	1
Smart Cycle				
CenterPoint Energy Staff	1	1	1	1
Threshold	1	1	1	1
Community Based LED Specialty Bulb Distribution				
CenterPoint Energy Staff	1	1	1	1
CLEAResult Staff	1	1	1	1
Participating Customers	10,704+	N/A	70	32
Commercial and Industrial Programs				
C&I Prescriptive				
CenterPoint Energy Staff	1	1	1	1
Resource Innovations Staff	1	1	1	1

Respondent Group	Population[a]	Included in Sample Frame[b]	Target Completes	Achieved Completes
Participating Customers	104	101	70	14
Chiller Trade Allies	18	18	10	1
C&I Custom				
CenterPoint Energy Staff	1	1	1	1
Resource Innovations Staff	1	1	1	1
Participating Customers	14	8	8	6
Small Business Energy Solutions				
CenterPoint Energy Staff	1	1	1	1
Resource Innovations Staff	1	1	1	1

[a] Population includes both electric and gas participants.
[b] Cadmus removed customers from the sample frames if they were contacted about their participation in another program, they had been recently surveyed through another evaluation effort, or they had missing contact information.

D.1 Residential Specialty Lighting Program

RESIDENTIAL SPECIALTY LIGHTING PROGRAM

2022 Process Analysis Activities

1 CenterPoint Energy staff interview

1 CLEAResult staff interview

Program Overview

Customers were offered instant discount at the point of purchase when purchasing energy-efficient lightbulbs

CLEAResult provided clear labels at the shelf and identified the most efficient lightbulbs

CLEAResult conducted store visits

2022 Program Changes

Returned to hosting in-store events since the start of COVID-19; small in-store pop-up events, rather than formally planned in-store events

Expanded offerings to include outdoor sensor lights

Promoted along other energy efficiency programs

Provided emails to customers advising them to purchase lighting products before **EISA backstop** takes place

2023 Planned Program Changes

In response to the **EISA backstop**, CenterPoint Energy plans to continue offering the program through 2023

Key Process Evaluation Findings

Due to **EISA backstop**, scaled back effort to bring in more retailers into the program

CLEAResult will explore the possibility of integrating the Residential Lighting program into other existing programs

D.2 Residential Prescriptive Program – Non-Midstream Channels

RESIDENTIAL PRESCRIPTIVE PROGRAM
STANDARD, ONLINE MARKETPLACE, INSTANT REBATES CHANNELS

2022 Process Analysis Activities

1 CenterPoint Energy staff interview

1 CLEAResult staff interview

2,035 quarterly online participant customer surveys

624 spillover responses

1,411 customer experience responses

2022 Program Changes

No planned program changes for 2022

2023 Planned Program Changes

- Include SEER2 heat pumps; CLEAResult will evaluate cost-effectiveness of this tier of heat pumps
- Launch a commercial midstream channel
- Change SEER rating tiers of eligible equipment to comply with SEER2

Key Process Evaluation Findings

Marketing challenges with the Online Marketplace channel due to administrative turnover

CenterPoint Energy evaluated customer eligibility in Online Marketplace to avoid customers receiving more than one measure, affecting savings

Where **Online Marketplace Participants** First Learned About the Program (n=457)

62%	Email from CenterPoint Energy
12%	CenterPoint Energy website
12%	Mail from CenterPoint Energy
5%	Word of mouth
4%	Utility bill insert
2%	Internet search
1%	Contractor
2%	Other

Where **Standard Participants** First Learned About the Program (n=905)

50%	Contractor
13%	CenterPoint Energy website
11%	Retailer or store
7%	Word of mouth
5%	Internet search
4%	Email from CenterPoint Energy
3%	Utility bill insert
2%	Mail from CenterPoint Energy
5%	Other

	Standard Participants	Online Marketplace Participants
Satisfied with program overall	97% (n=892)	96% (n=431)
Satisfied with measure	98% (n=887)	97% (n=386)
Likely to recommend program	96% (n=96)	88% (n=441)

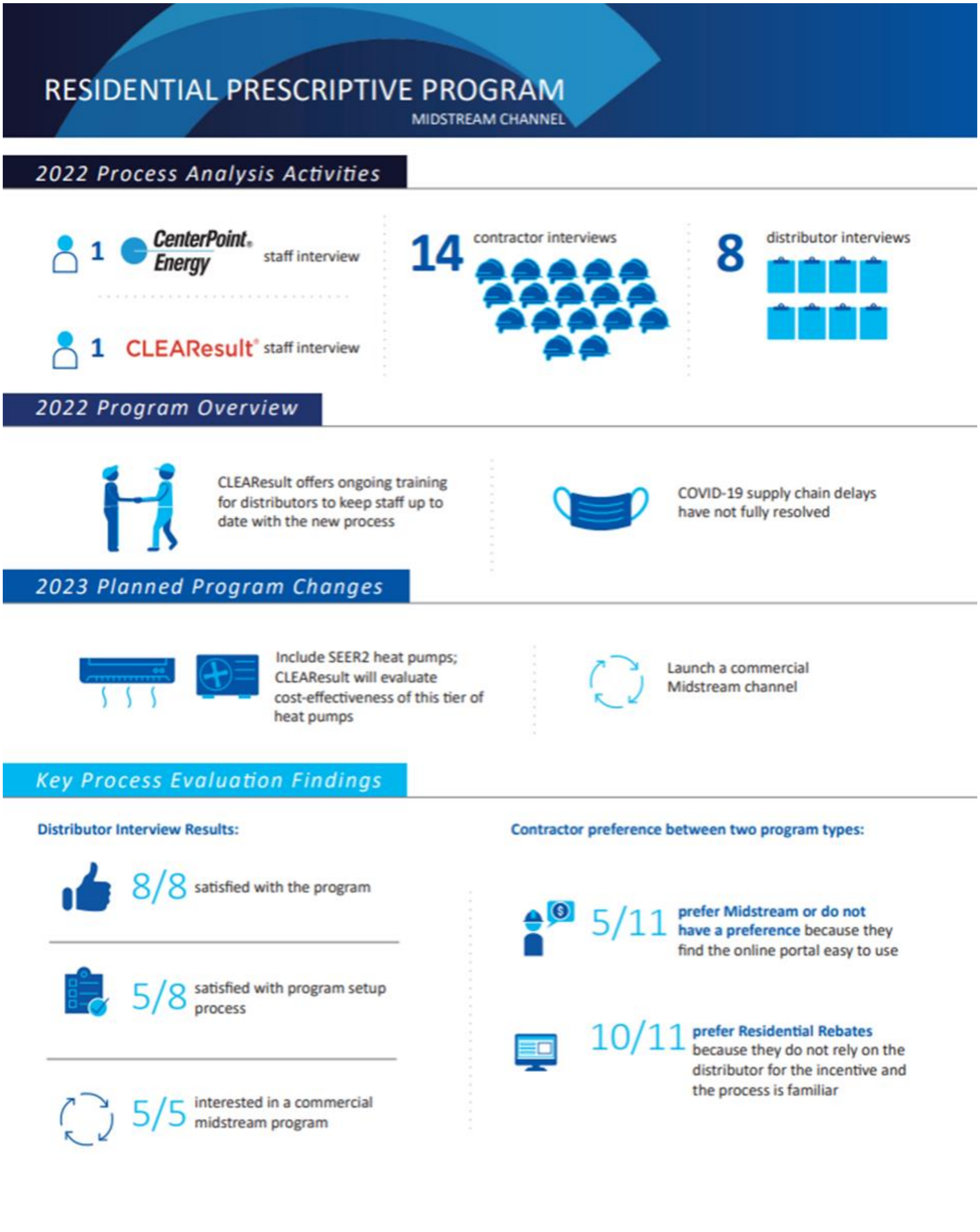
Online Marketplace Participant Experience

96%

(n=418)	Satisfied with navigating the online store
(n=408)	Satisfied with product selection
(n=416)	Satisfied with order completion process
(n=410)	Satisfied with time for shipping and delivery
(n=409)	Satisfied with discount amount

88% (n=769) **Standard** participants who worked with a contractor were **satisfied** with their contractor

D.3 Residential Prescriptive Program – Midstream Channel



D.4 Income Qualified Weatherization Program

INCOME QUALIFIED WEATHERIZATION PROGRAM

2022 Process Analysis Activities

1 CenterPoint Energy staff interview

1 CLEAResult staff interview

2022 Program Changes

Healthier Homes initiative integrated as a component of the program

Air purifiers and dehumidifiers added through the Healthier Homes initiative

New recruitment approach: **$10 cards** for participant referrals

2023 Planned Program Changes

Additional marketing and outreach to increase participation

Program Overview

Customer Intake

Customer is recruited or submits application independently/with the help of a Community Action Agency

Program Components

For customers ≤ 300% FPL → Healthier Homes Initiative

- Provides H&S funds to be used for health measures that may not be directly related to reducing energy usage, such as air purifiers or duct cleaning
- Allows customers who may not be eligible for the standard Income Qualified Weatherization program to still receive select, needed H&S measures

For customers ≤ 200% FPL → Standard Audit

- Energy auditor completes home visit
- Participants receive **direct installation of measures** *(such as showerheads, aerators, smart strips, and LEDs)* and **identification of additional areas** of improvement

Follow-Up Appointment (as needed)

None

- **Depending on the home's needs**, participants are eligible for follow-up appointments with partnering contractors and trade allies
- Additional appointments may include the **installation of additional measures** *(such as furnaces, water heaters, air sealing, or HVAC tune ups)*
- Through **the Whole Home** portion of the program, **homes with unique needs** *(such as non-standard sized equipment or unexpected H&S issues)* receive the measures needed/recommended during follow up appointments

Note: FPL = Federal Poverty Level and H&S = Health and Safety

D.5 Residential Behavioral Savings Program

RESIDENTIAL BEHAVIORAL SAVINGS PROGRAM

2022 Process Analysis Activities

1 CenterPoint Energy staff interview

1 ORACLE staff interview

Program Overview

CenterPoint Energy sends home energy reports to educate customers about their energy consumption patterns

The program is designed as a randomized control trial wherein customers are randomly assigned to either

a **treatment group** (recipients of home energy reports) OR or a **control group** (non-recipients)

Treatment group customers receive a targeted, individualized report intended to motivate engagement in energy-saving actions

CenterPoint Energy cross-promoted the Appliance Recycling and Low-Income Kit programs in the 2022 home energy reports

2022 Program Changes

Rolling enrollment on a weekly basis for new treatment group customers

Implemented intelligent tip targeting, which provides customers with energy-saving tips based on their usage trends

TIPS

2023 Planned Program Changes

Oracle will:

Begin sending hourly AMI participant usage reports to CenterPoint Energy weekly

Send customers combined bill forecasting alerts, which will encourage customers to lower their usage before the bill period ends by giving them a better picture of their full energy usage

Investigate the use of short, informational videos within digital home energy reports as an additional educational tool

Key Process Evaluation Findings

Oracle reported that, due to delays, the planned program changes for 2022 (combined bill forecasting alerts and weekly AMI data) did not happen. These planned program changes will be implemented in 2023.

2022 2023

D.6 Appliance Recycling Program

APPLIANCE RECYCLING PROGRAM

2022 Process Analysis Activities

1 CenterPoint Energy staff interview

1 ARCA Incorporated staff interview

Program Overview

CenterPoint Energy removed and recycled old, operable appliances, refrigerators, freezers, and room air conditioners. Customers received a **$50** incentive for their program participation.

Flow Map

Customer has an old appliance → Customer applies for the removal and recycling → Customer and ARCA schedule a pick-up time → ARCA picks up the appliance and recycles the appliance following Environmental Protection Agency best practices → Customer receives **$50** check via mail

2022 Program Changes

ARCA ran the **Oldest Fridge Contest** in November to encourage recycling the oldest model possible

Increased incentive from **$50 to $75** as a limited time offer in April in honor of Earth Day

ARCA was in transition of implementing their own transportation network, but went back to using a third-party pick-up company due to lack of in-house resources

2023 Planned Program Changes

Investigate best marketing practices to increase demand for the program

Explore partnerships with retail stores to host in-store promotions

Key Process Evaluation Findings

Minimal complaints for the pick-up service and high levels of satisfaction reported by ARCA

Higher than normal cancellation rate **41%** reported by ARCA

Participation decreased from prior year
ARCA suggests that decrease is due to

- High inflation
- An increase in fuel costs and labor costs
- Consumers buying fewer products

D.7 Smart Cycle Program

SMART CYCLE

2022 Process Analysis Activities

1 CenterPoint Energy staff interview

1 THRESHOLD energysolutions staff interview

Program Overview

CenterPoint Energy, with help from Threshold, installs Ecobee smart thermostats in residential homes to call load control events during the summer peak season

The program targets demand reductions during the summer peak hours but also achieves energy savings throughout the year

2022 Program Changes

Reduced installation goal from **1,000** to **500** homes

Only Ecobee thermostats to be installed from now on due to ease of installation, procurement, and operation

70

2023 Planned Program Changes

Threshold will not be returning as the installation contractor for 2023. A new installation contractor will be selected in 2023 and installations will resume then

Update marketing tactics to focus on the **free installation service** and investigate alternative channels of communication beyond email

Consider increasing the bill credit for participation in the program

BILL

Key Process Evaluation Findings

The program recruited customers once in April 2022 and performed installations during that summer, completing a total of **84 installs for 2022**

The decision to change installation contractors was due to CenterPoint Energy and Threshold not agreeing on marketing and recruitment tactics that drive enrollment

17%

Only met **17%** of the installation goal (or 83 installs). CenterPoint Energy reported unsuccessful marketing campaigns as a reason for low enrollments in addition to discontinuing further work with the installation contractor, Threshold, midway through the program year

D.8 Community Based LED Specialty Bulb Distribution Program

COMMUNITY BASED LED SPECIALTY BULB DISTRIBUTION PROGRAM

2022 Process Analysis Activities

1 CenterPoint Energy staff interview

1 CLEAResult staff interview

32 online surveys with bulb recipients

2022 Program Changes

Ad hoc distributions at community events removed; bulbs only dropped off at food banks and trustee offices

2023 Planned Program Changes

Kit items will be revised:

LED candelabras *removed*

advanced power strips and door and window stripping will be *added*

Key Process Evaluation Findings

Participant Survey Results:

6/28 were aware CenterPoint Energy sponsored the program

24/28 satisfied with the program overall and **28/28** want to see it continued

28/28 satisfied with LED candelabras

27/28 satisfied with LED nightlights

20/29 had installed LEDs in their home prior to the program

Trend Shift:
In previous years, most respondents had not installed any LED bulbs prior to the program

9/28 bulb recipients said there were **no particularly useful bulbs** for their households **outside of traditional, A-Line bulbs**

7/28 said **candelabras** would be most useful

8/28 said **3-way bulbs** would be most useful

Respondents were most likely to have previously purchased bulbs from:

11/28 mass market retailers

8/28 national hardware stores

or

5/28 discount retailers

Participant Housing (n=27)

13 Single-Family Home

12 Multifamily Home

2 Manufactured Home

& 16/27 renters

3/28 participated in another CenterPoint Energy program as a result of this program; **1 person** participated in the Income Qualified Weatherization program

18/28 satisfied with variety of programs offered by CenterPoint Energy; ***8/28*** *said don't know*

19/28 satisfied with CenterPoint's efforts to help them manage their monthly usage; ***4/28*** *said don't know*

D.9 Commercial and Industrial Prescriptive Program

C&I PRESCRIPTIVE PROGRAM

2022 Process Analysis Activities

1 CenterPoint Energy staff interview

1 resource innovations staff interview

14 online participant customer surveys

1 chiller trade ally interview

2022 Program Changes

Resource Innovations hired an outreach representative who focuses on improving trade ally engagement and HVAC participation. Contractor network grew **from 77 to 136 contractors.**

2023 Planned Program Changes

- Increase program incentive cap to **$300k per project or $500k per account** to bolster electric savings
- Pursue opportunities in healthcare
- Target HVAC systems with refrigeration potential
- Conduct educational outreach on compressed air leaks
- Phase out midstream on natural gas side due to insufficient staffing

Key Process Evaluation Findings

Participant Survey Findings:

How Participants Heard About the Program

5/14	CenterPoint Energy website
4/14	Past participation
2/14	Contact through trade ally/contractor/vendor
2/14	Outreach from Resource Innovations (Implementer)

13/13 said they were very satisfied with the program

13/14 said they were very likely to recommend the program to another business

Chiller Interview Findings:

Only one contractor was interviewed. Findings are qualitative and based on this sole contractor.

Interviewed contractor responsible for **40% of chiller tune-ups** completed in 2022

Respondent gave the following **reasons** for low uptake of chillers:

1. Customers are hesitant to select program-qualified chillers for their projects
2. Cost outweighs added efficiency benefits when deciding to install chillers
3. Cost difference is not completely offset by the elevated price of program-qualified chillers given the life of a chiller
4. No monetary incentive for contractors to recommend program-qualified chillers

D.10 Commercial and Industrial Custom Program

C&I CUSTOM PROGRAM

2022 Process Analysis Activities

1 CenterPoint Energy staff interview

1 resource innovations staff interview

6 phone surveys with participating customers

Program Overview

Main offerings include:

- Custom incentives
- Commercial new construction
- Building tune-up
- Strategic energy management

Project marketed through trade allies → Potential participants to determine project eligibility → Submit program application → Receive approval from CenterPoint Energy → Submit project documentation to receive incentives for custom measure installation

2022 Program Changes

Resource Innovations hired an outreach representative who focuses on improving trade ally engagement and HVAC participation. Contractor network grew from **77 to 136** contractors.

Updated program branding and marketing/outreach efforts including the energy-savings workshops and program kickoff meetings

2023 Planned Program Changes

Increase program incentive cap to **$300k per project or $500k per account** to bolster electric savings

Increase participation goal to 59 projects and increase energy savings goal to 5,000,000 kWh

Key Process Evaluation Findings

3/6 of participant respondents heard about the program from trade allies/contractors/vendors who participate in the program

2/6 of participant respondents said the program website was very user-friendly

4/6 of participant respondents said they were very satisfied and two said they were somewhat satisfied with the contractor/vendor

3/6 of participant respondents said the program incentive helped their project receive implementation approval from their organization

2/6 of participant respondents said they encountered delays in getting projects completed due to the COVID-19 pandemic

D.11 Small Business Energy Solutions Program

C&I SMALL BUSINESS ENERGY SOLUTIONS (SBES)

2022 Process Analysis Activities

1 CenterPoint Energy staff interview

1 resource innovations staff interview

Program Overview

2023 SBES Offerings:

- Free energy assessment
- Free installation of select energy-savings products
- Free energy assessment report recommending energy efficiency improvements (TIPS)
- Discounts on installation costs for energy savings improvements

Customer eligibility → SBES program application → On-site energy assessment → Energy assessment recommendations → Energy-saving measure installation

2022 Program Changes

Offered an increased incentive for high bay lighting projects to bolster electric savings

Resource Innovations hired an outreach representative who focuses on improving trade ally engagement and HVAC participation

2023 Planned Program Changes

New HVAC check-up offering to encourage HVAC contractors to conduct energy assessments

Develop a separate SBES Trade Ally Network focusing on HVAC measures

Update marketing and outreach to promote the new HVAC offering

Thermostat incentive to be based on service contracts rather than equipment replacement to boost customer volume

Key Process Evaluation Findings

Based on staff interviews, SBES natural gas savings fell short of its savings goal due to funds running out early in the year, resulting in fewer marketing campaigns

Resource Innovations reported that the project conversion rate **(% of assessments to installations)** fell from

66%→52%

Could be due to time of year the data were gathered for conversion rate as many projects were still in the pipeline but not completed