FILED
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INDIANA UTILITY
REGULATORY COMMISSION

STATE OF INDIANA

INDIANA UTILITY REGULATORY COMMISSION

IN THE MATTER OF THE VERIFIED PETITION OF INDIANAPOLIS POWER & LIGHT FOR APPROVAL OF DEMAND SIDE MANAGEMENT (DSM) PLAN, INCLUDING ENERGY EFFICIENCY (EE) PROGRAMS, AND ASSOCIATED ACCOUNTING AND RATEMAKING TREATMENT, INCLUDING TIMELY RECOVERY, THROUGH IPL'S EXISTING STANDARD CONTRACT RIDER NO. 22, OF ASSOCIATED COSTS INCLUDING PROGRAM OPERATING COSTS, NET LOST REVENUE, AND FINANCIAL INCENTIVES.	)	**CAUSE NO. 45370**

SUBMISSION OF DSM EVALUATION REPORT (Volume 2)

Ex Post Gross Savings Realization Rates

Table 218 shows the realization rates (of 110% for energy savings and 27% for demand reduction) and verification adjustments for 2019 Retro-Commissioning measures. To calculate the *ex post* gross impacts, the team applied the sample's realization rates to the population *ex ante* energy savings and demand reduction.

Table 218. Application of 2019 Retro-Commissioning Realization Rates

Metric	Population *Ex Ante*	Realization Rate (from Evaluation Sample)	Population *Ex Post* Gross
Electric Energy Savings (kWh/year)	10,796,597	110%	11,875,187
Peak Demand Reduction (kW)	284.5	27%	76.0

Ex Post Net Savings

The evaluation team calculated 32% freeridership and 0% spillover using the methods described in Appendix B and survey data collected from all three 2019 Retro-Commissioning participants. As shown in Table 219, the team estimated a 68% NTG for Retro-Commissioning measures.

Table 219. 2019 Retro-Commissioning Net-to-Gross

Responses (n)	Freeridership [a]	Spillover	NTG
3	32%	0%	68%

[a] The team weighted freeridership by the survey sample *ex post* gross program kilowatt-hour savings.

The team estimated the 32% Retro-Commissioning freeridership using self-reported responses. Note that because of the newness of the program and the small sample size, we might expect to see large variation year-to-year until the program matures.

Freeridership

The overall 32% freeridership is an average of the savings-weighted *intention* and *influence* freeridership scores from the three respondents.

***Intention* Freeridership**

The evaluation team estimated *intention* freeridership scores for all three participants based on their responses to the *intention*-focused freeridership questions. The team translated responses into a matrix value and applied a consistent, rules-based calculation to obtain the final score. As shown in Table 220, Retro-Commissioning had an *intention* freeridership score of 64%.

Table 220. 2019 Retro-Commissioning *Intention* Freeridership Results

Responses (n)	*Intention* Freeridership Score
3	64%

Table 221 shows the unique Retro-Commissioning participant response combinations resulting from the *intention* freeridership questions, along with the *intention* freeridership score assigned to each combination and the number of responses for each combination. An "x" indicates a question that was skipped due to the participant's response to a previous question. The "Yes," "Partial," and "No" values represent whether the respondent's answer to a given question was indicative of freeridership.

Table 221. 2019 Retro-Commissioning Frequency of *Intention* Freeridership Scoring Combinations

1. Would have pursued Retro-Commissioning without incentive?	2. Already identified and planned to implement measures identified in Retro-Commissioning study before you heard about IPL program?	3. Planned to conduct Retro-Commissioning before learning about IPL program?	4. In capital budget?	[Ask if Q1 is No] 5. Confirm, would not have pursued Retro-Commissioning study or implemented measures this year without program?	6. Would have pursued as many measures without program?	7. Installed same efficiency?	8. Pursued and installed at the same time?	8. Organization has ROI goal?	[Ask if Q8 is Yes] 10. Program incentive was key to meeting ROI goal?	Freeridership score	Response Frequency
Yes	Yes	Yes	Partial	x	Yes	N/A	Yes	No	x	75%	1
Yes	Yes	Yes	Yes	x	Yes	N/A	Partial	Yes	Yes	75%	1
Yes	No	Yes	No	Yes	No	N/A	No	Yes	No	0%	1

Influence Freeridership

The evaluation team assessed *influence* freeridership by asking participants how important various Retro-Commissioning elements were in their purchasing decisions. Table 222 shows the elements participants rated for importance, along with a count and average rating for each factor.

Table 222. 2019 Retro-Commissioning *Influence* Freeridership Responses

Influence Rating	*Influence* Score	Survey Response Counts				
		The IPL rebate for the study	The IPL incentive for energy savings	The information provided by IPL on energy-saving opportunities	Recommendation from contractor or vendor	Previous participation in an IPL energy efficiency program
1 - Not at all important	100%	0	0	1	0	0
2	75%	0	1	2	0	1
3	25%	0	0	0	2	1
4 - Very important	0%	1	2	0	1	1
Not applicable	50%	2	0	0	0	0
Average Rating		**4.0**	**3.3**	**1.7**	**3.3**	**3.0**

The team determined each respondent's *influence* freeridership score for each measure category using the maximum rating provided for any factor included in Table 222. As shown in Table 223, the respondents' maximum *influence* ratings ranged from 1 (*not at all important*) to 4 (*very important*). A maximum score of 1 meant the customer rated all factors from the table as *not at all important*, while a maximum score of 4 meant the customer rated at least one factor as *very important*. Counts refer to the number of "maximum *influence*" responses for each factor, or *influence* score, response option.

Table 223. 2019 Retro-Commissioning *Influence* Freeridership Score

Maximum *Influence* Rating	*Influence* Score	Count	Total Survey Sample *Ex Post* Savings (kWh)	*Influence* Score Savings (kWh)
1 - Not at all important	100%	0	0	0
2	75%	0	0	0
3	25%	0	0	0
4 - Very important	0%	3	11,875,186	0
Not applicable	50%	0	0	0
Average Maximum *Influence* Rating - Simple Average		**3**	**11,875,186**	**0**
Average *Influence* Score - Weighted by *Ex Post* Kilowatt-Hour Savings				**0%**

The team weighted the average *influence* score of 0% for the 2019 Retro-Commissioning component by *ex post* kilowatt-hour component savings.

Final Freeridership

The evaluation team calculated the mean of *intention* and the *influence* of freeridership components to estimate final freeridership for the program of 32%:

$$Final\ Freeridership\ (32\%) = \frac{Intention\ FR\ Score\ (64\%) + Influence\ FR\ Score\ (0\%)}{2}$$

A higher freeridership score translates to more savings being deducted from the gross savings estimates. Table 224 lists the *intention*, *influence*, and final freeridership for 2019 Retro-Commissioning measures.

Table 224. 2019 Retro-Commissioning Freeridership Score

Responses (n)	*Intention* Score	*Influence* Score	Freeridership Score
3	64%	0%	32%

Spillover

The evaluation team estimated spillover measure savings using specific information about participants, as determined through the evaluation, and employing the Indiana TRM (v2.2) as a baseline reference. The team planned to estimate spillover by dividing the sum of additional spillover savings (as reported by survey respondents) by the total gross savings achieved by all Retro-Commissioning respondents. However, none of the participants attributed their program participation as an influence on additional energy-efficient purchases. Therefore, the spillover estimate for Retro-Commissioning is 0%.

Table 225 summarizes the percentage of freeridership, spillover, and NTG for Retro-Commissioning.

Table 225. 2019 Retro-Commissioning Net-to-Gross

Responses (n)	Freeridership	Spillover	NTG
3	32%	0%	68%

Evaluated Net Savings Adjustments

Table 226 shows the energy savings, realization rate, and NTG for Retro-Commissioning measures.

Table 226. 2019 Retro-Commissioning *Ex Post* Net Savings

Savings Type	*Ex Ante* Gross Savings	*Ex Post* Gross Savings	Realization Rate	NTG	*Ex Post* Net Savings
Electric (kWh)	10,796,597	11,875,187	110%	68%	8,075,125
Demand (kW)	284.3	76.0	27%	68%	51.7

Strategic Energy Management

IPL launched SEM in early 2019, with 11 participants in the education and health care sectors. Through the program, participants created energy teams to adopt behavioral, operations and maintenance, and capital improvements to reduce their energy consumption. To be eligible, the commercial or industrial facility must be served by IPL and participated in a series of workshops, where they were provided with tools, coaching, and resources needed to achieve energy savings. Table 227 shows that in 2019, 23 facilities participated in SEM and contributed savings to the Custom Incentives program.

Table 227. 2019 Strategic Energy Management Participants

Participant Sector	Number of Facilities	Description
Schools/School Districts	17	Local elementary, middle, and high schools
Health Care/Medical Facilities	6	Various hospital, clinics, and office building associated with IU Health

Program interventions began in February 2019. IPL reported savings for the first year of program intervention, covering February 2019 through February 2020: the evaluation team assessed savings for this same time period. Table 228 shows the participants and number of facilities in each participant sector. Health care participants contributed the majority of SEM savings across its six facilities. Education participants, however, tended to save more as a percentage of their baseline energy consumption, averaging energy reductions of 8% across all facilities in the sector.

Table 228. 2019 Strategic Energy Management Participating Facilities and *Ex Ante* Savings

Participant Sector	Participant	Number of Facilities	*Ex Ante* Savings (kWh)	*Ex Ante* Savings (%) [a]
Education	Pike School District	8	183,978	3%
	Wayne School District	6	68,578	3%
	University High School	1	77,400	23%
	Ivy Tech – Illinois Fall Creek Center	1	300,191	12%
	Ivy Tech – Glick Technology Center	1	166,143	12%
	Sector Total	**17**	**796,290**	**6%**
Health Care	IU Health Clinical Labs	1	251,921	5%
	IU Heath Fairbanks	1	48,731	4%
	IU Health Gateway	1	441,486	12%
	IU Health Methodist	1	472,720	1%
	IU Health North	1	509,581	4%
	IU Health West	1	527,376	6%
	Sector Total	**6**	**2,251,815**	**3%**
Program Total		**23**	**3,039,879**	**3%**

Note: The *ex ante* savings do not include savings from capital projects incentivized through the Custom or Prescriptive Equipment programs.

[a] Percentage savings are relative to the model-predicted consumption provided by CLEAResult. The model-predicted consumption established the baseline for estimating the savings at each facility.

The evaluation team estimated energy savings for SEM participants following industry best-practices for evaluating facility-level savings as outlined in the UMP (Stewart 2017), which aligns with IPMVP Option C and ASHRAE Guideline 14-2014. These protocols use a regression analysis of whole-building energy data on relevant energy drivers, such as weather and building occupancy, in the pre-intervention period (the *baseline period*) to estimate savings from behavioral and operations and maintenance adoptions that cannot be quantified accurately through an engineering analysis. *Baseline* models rely on data from the baseline period only in order to capture "business-as-usual" energy trends and provide a counterfactual for energy consumption in the reporting period had the program not launched. (The counterfactual energy consumption is referred to as the *adjusted baseline consumption*.) Comparing metered energy consumption provides an estimate of facility energy savings.

The evaluation team built individual models for each health care facility and stand-alone school and district-wide regression models for the two school districts to evaluate savings. CLEAResult provided data that covered the beginning of the baseline period through the end of the reporting period. CLEAResult also produced its own regression models and provided the evaluation team with a summary of its model parameters and findings. The evaluation team confirmed that it could replicate CLEAResult's models and savings estimates using the energy data and model specification provided in the facility-level reports before building independent baseline models.

The evaluation team built independent baseline models in four steps:

- We downloaded weather data from the National Oceanic and Atmospheric Administration for each participating facility by mapping the facilities' zip codes to the nearest weather station and calculating HDDs and CDDs for a range of base temperatures.
- We investigated and accounted for any non-routine events or activities that took place during the baseline period, either adjusting the metered consumption for known non-routine events effects or including a variable indicating the event in the model.
- Because commercial buildings are primarily driven by their heating and cooling usage and occupancy, we tested all meaningful models that used a combination of one or more of these variables. We selected model specifications that met the threshold values provided in the protocols and provided the best reductions in unexplained variance.[42]
- We reviewed the final model specifications to ensure they made sense, both in terms of the size and magnitude of coefficient estimates and based on the site documentation and data collected on the site. We selected the final model using this review in conjunction with a thorough investigation of model fit using the multiple statistical criteria outlined in both ASHRAE Guideline 14 and the UMP.

The evaluation team's baseline model selection approach differed for schools in the Pike and Wayne school districts. Instead of building individual models for each school, we built one baseline model using the baseline data for all schools within a district. The evaluation team used school fixed effects to account for the differing consumptions at each school.

We calculated the adjusted baseline consumption by using the final baseline model to predict what consumption in the reporting period would have been if SEM not been implemented. The team estimated *facility* savings as the difference in the adjusted baseline and metered energy consumption during the reporting period.

Two facilities underwent expansion during the performance period. To account for this, the evaluation team used 2013 U.S. EIA survey data[43] to estimate the energy use intensity for health care facilities, and adjusted the consumption based on construction size. This followed the methodology that CLEAResult used when evaluating IU Health West.

Participants of SEM installed capital projects as part their engagement. Savings from projects that were rebated through another IPL program were captured in the regression analysis and estimates of facility

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42 The evaluation team used Akaike's Information Criterion and adjusted R-squared values to compare the reduction in unexplained variance between model specifications.

43 U.S. Energy Information Administration. 2019. *Commercial Buildings Energy Consumption Survey (CBECS).* https://www.eia.gov/consumption/commercial/data/2012/c&e/cfm/c17.php

savings. The evaluation team removed these savings from the regression-based facility savings to estimate the savings attributable to SEM engagement.

Audited and Verified Savings

The evaluation team was provided with CLEAResult's regression analysis workbooks for all 23 SEM facilities. These workbooks included CLEAResult's final regression models as well as facility and SEM savings. Across all facilities, CLEAResult estimated a total of 3,048,105 kWh in SEM savings. CLEAResult's estimated SEM savings aligned with the *ex ante* saving in the Custom Incentives VisionDSM extract.

Ex Post Gross Savings

The following sections detail the facility savings estimates and model results, capital project savings adjustment, and final SEM savings estimates.

Facility Savings

Table 229 shows the reported and evaluation facility savings for each 2019 SEM participant. Facility savings include savings from capital projects rebated through IPL's other commercial energy efficiency programs. The evaluation team estimated savings of 4,287,326 kWh for the 2019 program year, 96% of the reported facility savings provided by CLEAResult. Differences in reported and evaluation facility savings largely result from the availability of energy data for the duration of the reporting period. CLEAResult estimated reported facility savings before the close of the program year and extrapolated savings estimates from the first nine months of the SEM intervention to the remaining three months. The months for which CLEAResult extrapolated savings included larger heating demand, and therefore larger savings capacity, than the first nine months. Since we collected facility data through the end of 2019, the evaluation team calculated higher facility savings than CLEAResult for many facilities, resulting in realization rates greater than 100%.

Another driver of the realization rate included differences in how the evaluation team and CLEAResult accounted for capital improvements made during the baseline period. Capital projects installed during the baseline period result in lower consumption not related to the SEM program. The evaluation team either controlled for these changes in the consumption by controlling for the project in the baseline model or adding the savings from projects to the metered energy consumption for the period of time after the project was installed. CLEAResult did not make similar adjustments, resulting in non-100% realization rates for some sites.

Table 229. 2019 Strategic Energy Management Facility Savings

Participant	Reported Facility Savings (kWh/year)	Evaluation (kWh/year)				Realization Rate
		Savings	90% Lower Bound	90% Upper Bound	Savings (%) [a]	
Education						
Pike School District [b]	183,978	596,253	577,076	615,430	6.9%	324%
Wayne School District [b]	68,578	166,942	162,584	171,301	5.2%	243%
University High School	77,400	85,777	81,510	90,044	16.7%	111%
Ivy Tech – Illinois Fall Creek Center	300,191	260,258	255,899	264,617	8.2%	87%
Ivy Tech – Glick Technology Center	166,143	152,054	149,227	154,881	8.8%	92%
Sector Total	**796,290**	**1,261,285**	**1,251,911**	**1,270,658**	**7.2%**	**158%**
Health Care						
IU Health Clinical Labs	404,275	31,813	31,569	32,056	0.5%	8%
IU Heath Fairbanks	48,731	54,813	54,290	55,335	3.6%	112%
IU Health Gateway	441,486	426,485	422,224	430,745	8.2%	94%
IU Health Methodist	830,623	152,100	151,000	153,200	0.2%	18%
IU Health North	1,042,278	905,324	897,380	913,268	5.4%	85%
IU Health West	909,997	1,455,507	1,445,141	1,465,872	6.7%	160%
Sector Total	**3,677,390**	**3,026,041**	**3,012,222**	**3,039,860**	**1.5%**	**82%**
Total	**4,473,680**	**4,287,326**	**4,270,628**	**4,304,024**	**2.0%**	**96%**

Note: Savings include impacts from capital projects rebated through IPL's other commercial energy efficiency programs.
[a] Percentage savings are relative to the adjusted baseline consumption for each facility.
[b] Savings include the individual facility savings from each school in the district.

Table 230 shows the major energy drivers included in each participating facility's baseline model and the models' adjusted R-squared values.[44] For each facility, we indicated whether the model aligned with the baseline model developed by CLEAResult. The evaluated models differed from CLEAResult's models either by adding a weather variable (either HDD or CDD), including an indicator for holidays, or accounting for rebated capital improvements. As expected, weather and occupancy explained most of the variability in energy consumption at the participating facilities. For most facilities CLEAResult captured the majority of variation and in general followed best practices to develop their baseline models.

44 The adjusted R-squared value shows the proportion of variance in energy consumption explained by the model and ranges between 0% and 100%. Models with higher adjusted R-squared values (closer to 100%) explain a greater proportion of energy consumption variability and are associated with better fits than models with lower adjusted R-squared values.

Table 230. 2019 Strategic Energy Management Baseline Model Results

Site	Heating	Cooling	Holiday	School Days	Non-Routine Events	Adjusted R-Squared		Matches CLEAResult?
						Evaluation Team	CLEAResult	
IU Health Clinical Labs	X				X	0.787	0.841	Yes
IU Heath Fairbanks	X	X	X		X	0.787	0.781	Yes
IU Health Gateway	X	X	X		X	0.988	0.984	No
IU Health Methodist	X	X	X		X	0.984	0.981	No
IU Health North	X		X		X	0.983	0.984	No
IU Health West	X					0.978	0.973	Yes
University High School	X	X		X		0.845	0.816	Yes
Ivy Tech- Glick Technology Center	X	X		X	X	0.933	0.938	No
Ivy Tech- Illinois Fall Creek Center	X	X	X	X	X	0.756	0.818	No
Pike	X	X[a]	X[a]	X[a]	X	0.983	N/A	N/A
Wayne	X	X	X[a]	X[a]	X	0.973	N/A	N/A

Capital Projects

Table 231 shows the capital project savings removed by CLEAResult and the evaluation team. The evaluation team matched the capital projects provided by CLEAResult to the program extracts provided by IPL and used evaluated realization rates and installation dates to determine capital project adjustments. Like CLEAResult, the evaluation team prorated the evaluated annual savings to account for the amount of time the projects were installed during the reporting period. These savings were then subtracted from the estimated facility savings, presented in Table 229, to estimate facility saving attributed to the SEM program, presented in Table 232.

Table 231. 2019 Strategic Energy Management Capital Project Savings

Site	*Ex Ante* Capital Project Adjustments	*Ex Post* Capital Project Adjustments	Percentage Savings [a]
Pike School District	--	50,526	0.6%
Wayne School District	--	--	--
University High School	7,776	6,002	1.2%
Ivy Tech – Illinois Fall Creek Center	--	--	--
Ivy Tech – Glick Technology Center	--	--	--
IU Health Clinical Labs	152,354	142,092	2.1%
IU Heath Fairbanks	--	--	--
IU Health Gateway	--	--	--
IU Health Methodist	358,353	366,552	0.5%
IU Health North	532,697	510,316	3.1%
IU Health West	382,621	342,456	2.7%
Total	**1,433,801**	**1,417,943**	**1.1%**

[a] Percentage savings are relative to the adjusted baseline consumption for each facility.

Strategic Energy Management Savings

Table 232 shows the facility savings attributable to SEM after removing savings from capital projects rebated through other programs. Overall, the evaluation team found 2,869,383 kWh per year in SEM savings, a reduction of 1.2% of total adjusted baseline consumption across all participants.

Table 232. 2019 Strategic Energy Management Savings

Participant Sector	Participant	Reported Gross Savings	Evaluated Savings	*Ex Post* Capital Project Adjustments	*Ex Post* Gross Savings	Percentage Savings	Realization Rate
Education	Pike School District	183,978	596,253	50,526	545,727	6.2%	297%
	Wayne School District	68,578	166,942	--	166,942	5.1%	243%
	University High School	69,624	85,777	6,002	79,775	14.3%	115%
	Ivy Tech – Illinois Fall Creek Center	300,191	260,258	--	260,258	8.3%	87%
	Ivy Tech – Glick Technology Center	166,143	152,054	--	152,054	8.5%	92%
	Sector Total	**796,290**	**1,261,285**	**56,528**	**1,204,757**	**6.8%**	**151%**
Health Care	IU Health Clinical Labs	251,921	31,813	142,092	-110,279	-1.7%	-44%
	IU Health Fairbanks	48,731	54,813	--	54,813	1.7%	112%
	IU Health Gateway	441,486	426,485	--	426,485	4.3%	97%
	IU Health Methodist	472,270	152,100	366,552	-190,356	-0.1%	-40%
	IU Health North	509,581	905,324	510,316	395,008	2.5%	78%
	IU Health West	527,376	1,455,507	342,456	1,088,956	4.0%	206%
	Sector Total	**2,251,815**	**3,026,041**	**1,361,416**	**1,664,626**	**0.9%**	**74%**
Total		**3,039,879**	**4,287,326**	**1,417,994**	**2,869,383**	**1.2%**	**94%**

Ex Post Net Savings

The regression analysis used in the modeling takes into account all net effects, and no NTG is applied for SEM projects. Therefore, *ex post* gross savings are equivalent to *ex post* net and total program savings was 2,869,383 kWh.

Process Evaluation

This section describes process findings for the Custom and Retro-Commissioning components of the Custom Incentives program from the evaluation team's database and materials review, participant surveys, and stakeholder interviews. The evaluation scope did not include a process evaluation of SEM.

Custom

The evaluation team interviewed IPL's program manager and key CLEAResult staff to obtain an overview of the program design and delivery processes and any changes or challenges experienced during 2019.

Program Delivery

IPL and CLEAResult reported that the program operated smoothly in 2019. Program participation remained stable (80 projects in 2018 and 77 projects in 2019), but the per-project average *ex ante* savings increased by 38% from 2018 to 2019.

Program participants received custom rebates for nonstandard projects involving complex technologies or equipment changes with more than one-for-one replacements. IPL paid custom incentives on a performance basis, offering $0.08 per kilowatt-hour of estimated electric savings for non-lighting projects and $0.07 per kilowatt-hour for lighting projects that met the eligibility criteria (minimum cost-effectiveness requirements and lighting fixture listing by ENERGY STAR or Design Lights Consortium). To generate program interest, IPL increased the incentive offering from $0.06 per kilowatt-hour in 2018 to $0.07 per kilowatt-hour in 2019 for lighting projects.

Program Marketing and Outreach

CLEAResult reported that IPL used its energy advisors to conduct program outreach to customers and trade allies, with an increased emphasis on direct customer outreach in 2019. Outreach methods included phone calls, emails, and in-person meetings. CLEAResult targeted customers who were past participants in the Prescriptive and Custom programs and who had projects known by IPL and CLEAResult. Energy advisors divided their customer and trade ally outreach by Indianapolis geographic regions, though large trade allies were assigned to a specific Energy Advisor regardless of region. When conducting outreach to customers, energy advisors targeted a business energy manager or facility manager. CLEAResult also promoted the Custom component in its general commercial marketing messages by encouraging customers to contact a Custom representative if they are planning a project that is not represented on the Prescriptive program's list of measures.

Program Application Process

Custom customers can complete their application via email or an online application portal available for Custom Incentives, Prescriptive Rebates program Non-Midstream delivery channel, and SBDI incentives. The online application portal allows customers and trade allies to verify that their equipment meets the program requirements and to track their application status. However, the IPL program manager and CLEAResult reported that most program applications are completed via email rather than the online application portal.

Program Key Performance Indicators

In addition to energy and participation goals, CLEAResult tracked service-level key performance indicators related to program delivery. Table 233 shows the status of CLEAResult's key performance indicators for 2019. IPL revised one of CLEAResult's goals from 2018 to 2019, increasing the target time period to complete rebate applications from 15 business days to 20 business days. The increase in this target time period stemmed from CLEAResult adding a requirement that measure installation must be validated prior to the payment being made. CLEAResult achieved all its goals except one: it did not increase the trade ally network by 5% (no growth achieved). CLEAResult indicated that with the emphasis on engaging customers directly, staff were less focused on trade ally outreach than in the past.

Utility commercial programs often heavily rely on trade allies to promote program offerings to customers.

Table 233. 2019 Custom Service-Level Key Performance Indicators

Service Level	Key Performance Indicator	2019 Result
QA/QC Site Verification	100% site verification for self-installed projects with rebate payments ≥$1,000, all projects with rebate payments ≥$20,000, and 10% random for all other projects	Achieved
Trade Ally Network	Increase number of participating Custom Incentives trade allies by 5% annually (from 45 in 2018)	Did not reach goal (45 trade allies in 2019)
Days from Custom Application Receipt to Notification of Receipt	Notify 95% of applicants within three business days that an application has been received	Achieved
Custom Application Approval	Send 95% of customers a letter of intent within 15 business days of receiving application	Achieved
Incomplete Notice	Send incomplete notice within five business days of receiving application	Achieved
Rebate Payment	Issue 100% of rebate payments within 20 business days of receiving application	Achieved

Source: December 2019 CLEAResult scorecard and program-tracking data.

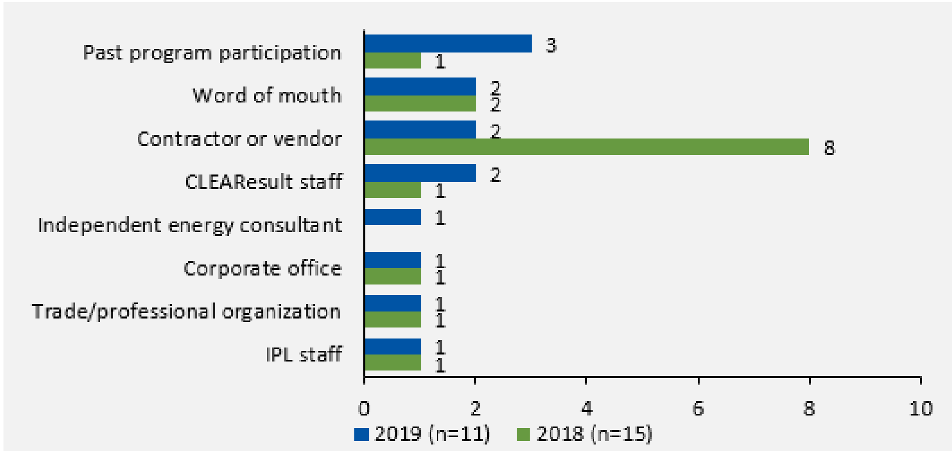
Participant Feedback

In January and February 2019, the evaluation team contacted 42 businesses that participated in the Custom component to complete a phone survey. Eleven customers responded to the survey for a 26% response rate, representing 14% of the program *ex ante* savings. As the number of responses was low for 2019 (and also for 2018, with 15 completed surveys), the evaluation team did not test for statistical differences between the 2018 and 2019 findings. The details and figures presented below show findings by number of respondents rather than by percentages.

Energy Efficiency Awareness and Marketing

In 2019, three of 11 survey respondents learned of the Custom program through participation in an IPL or another Indiana utility program. Other sources of program awareness included word of mouth, trade allies, and CLEAResult staff (Figure 85).This represents a change from 2018, when eight of 15 respondents learned of the program through direct outreach from a trade ally. Nine of 16 respondents learns of the program through trade allies in 2017.

Figure 85. 2019 Custom Program Source of Awareness



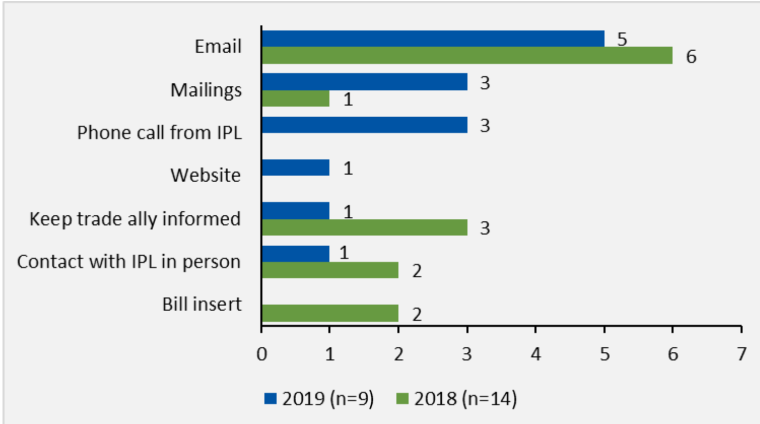
Source: 2018 and 2019 Participant Surveys Question B1. "How did you first learn about IPL's Custom Incentives program?" Single response in 2018, multiple responses allowed in 2019.

All 11 respondents said they received enough information about the program. Eight respondents provided more detail about the most useful information they received (with one respondent giving more than one response):

- Benefits of installing energy-efficient products (four respondents)
- Guidance on how to participate (two respondents)
- Information on additional IPL rebates and ways to save (two respondents)
- Information on how to complete additional efficiency projects (one respondent)

When asked how IPL can best keep organizations informed about energy-saving opportunities, 2019 respondents most commonly said they prefer to be contacted via email (five respondents), which was also the most common response in 2018. Other ways respondents would like to be kept informed is through mailings like letters and flyers (three respondents) or a phone call from IPL (three respondents). As shown in Figure 86, fewer 2019 respondents were interested in being kept informed through their trade allies (one respondent in 2019 compared to three in 2018), and none were interested in being kept informed by bill inserts (compared to two in 2018).

Figure 86. 2019 Custom Respondents Preferred Means of Staying Informed about IPL's Energy-Saving Opportunities

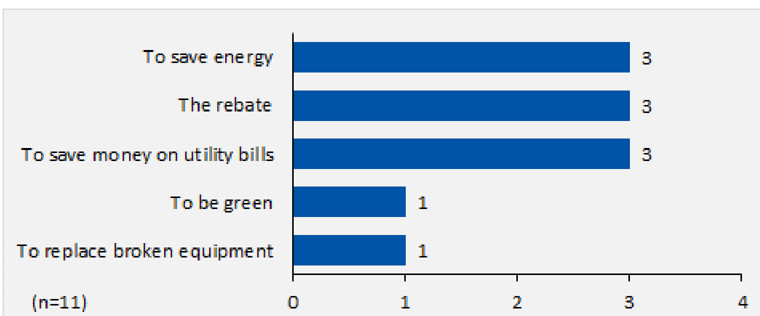


Source: 2018 and 2019 Participant Surveys Question B4. "What is the best way for IPL to keep companies like yours informed about opportunities to save energy and money?" Multiple responses allowed.

Participation Drivers

Custom participants identified the factor that was most important in their decision to participate in the program, most commonly identifying saving energy, obtaining the rebate, and saving money on energy bills, cited by three respondents each (Figure 87).

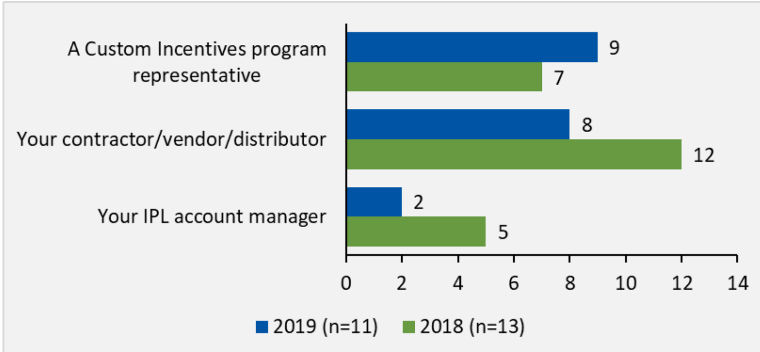
Figure 87. 2019 Custom Participation Drivers



Source: 2019 Participant Survey Question C1. "What factor was most important in your decision to make energy-saving improvements through this program?"

To understand the influence of program representatives, Custom respondents shared who helped them plan or initiate their energy efficiency project. Of the 11 respondents, nine had met with a Custom program representative; eight had met with a contractor, vendor, or distributor; and two had met with their IPL account manager. As shown in Figure 88, in 2018 customers were more likely to have received help from their contractor or vendor.

Figure 88. Source of 2019 Custom Initiation

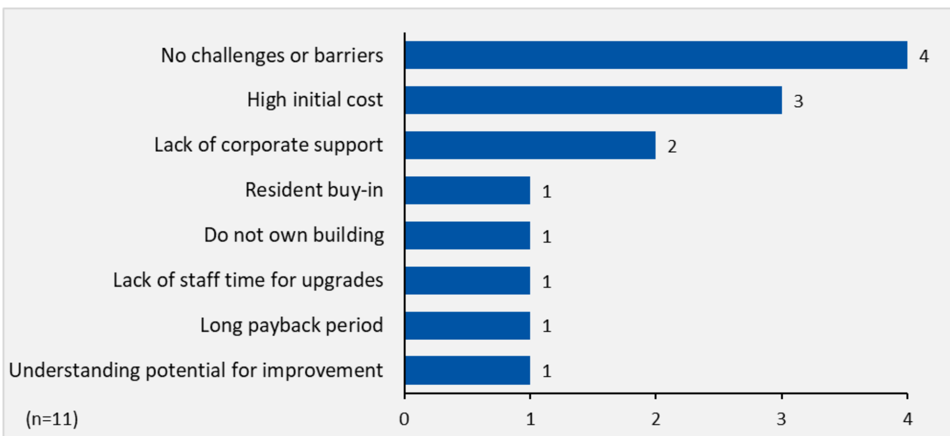


Source: 2018 and 2019 Participant Survey Question B5. "Please tell me who, if anyone, was involved in helping you plan or initiate your energy efficiency project?" Multiple responses allowed.

Participation Barriers

Businesses face many challenges with improving the energy efficiency of their facilities. For the 2019 evaluation, four Custom participants were unable to identify a challenge their facility faced in becoming more energy efficient. As shown in Figure 89, those who were able to identify a challenge most commonly noted the high initial cost (three respondents) and a lack of corporate support (two respondents).

Figure 89. 2019 Custom Participants' Challenges to Becoming More Energy Efficient



Source: 2019 Participant Survey Question D1. "What are the most significant challenges at your facility in becoming more energy efficient?" Multiple responses allowed.

Respondents were also asked if they experienced any challenges with the Custom component. Two of the 11 respondents reported challenges with participating in the 2019 Custom component, both citing issues around understanding equipment eligibility requirements.

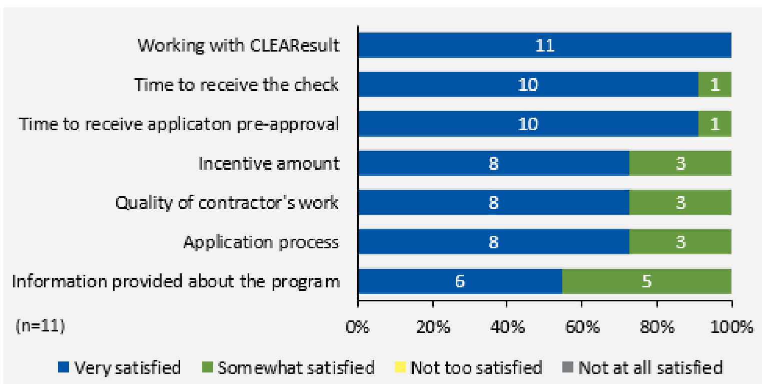
Custom participants shared what IPL could do, other than provide incentives, to help companies overcome challenges in making improvements. Eight of the 11 respondents had no suggestions. The remaining three respondents made one or more recommendations each:

- Provide education on the various ways of how customers can upgrade to LEDs (one respondent)
- Provide more information about the nature of the program (one respondent)
- Improve the application process (one respondent)
- Assist with attaining executive buy-in by joining a call or meeting in person (one respondent)

Satisfaction with Program Processes

Custom Incentives program respondents rated their satisfaction with several program aspects. As shown in Figure 90, respondents were either *very satisfied* or *somewhat satisfied* with all program aspects. Respondents were most satisfied with their experience working with CLEAResult, with all 11 rating themselves as *very satisfied*. Respondents were also highly satisfied with the time it took to receive their incentive check and with the time it took to receive pre-approval, with 10 of 11 respondents rating themselves as *very satisfied* with each of these components.

Figure 90. Customer Satisfaction with 2019 Custom Program Components



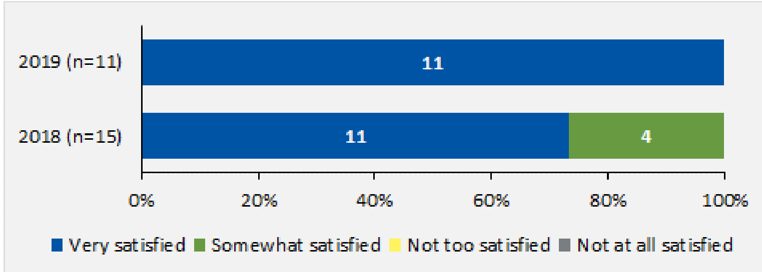
Source: 2019 Participant Survey Question H1. "Please rate your level of satisfaction with each of these components." The evaluation team omitted participants who responded "don't know" or "not applicable."

In 2019, more respondents were *very satisfied* with working with CLEAResult (all 11 respondents in 2019 compared to eight of 11 in 2018) and with the time it took too receive the incentive check (10 of 11 respondents in 2019 compared to six of 11 in 2018). However, fewer respondents in 2019 were *very satisfied* with the quality of the contractors' work (three respondents in 2019 were only *somewhat satisfied* compared to all 13 customers in 2018 who were *very satisfied*).

Overall Satisfaction and Benefits of Program Participation

For the Custom Incentives program overall, all 11 of the 2019 respondents reporting being *very satisfied*; in 2018, 11 of 15 respondents were *very satisfied* (Figure 91).

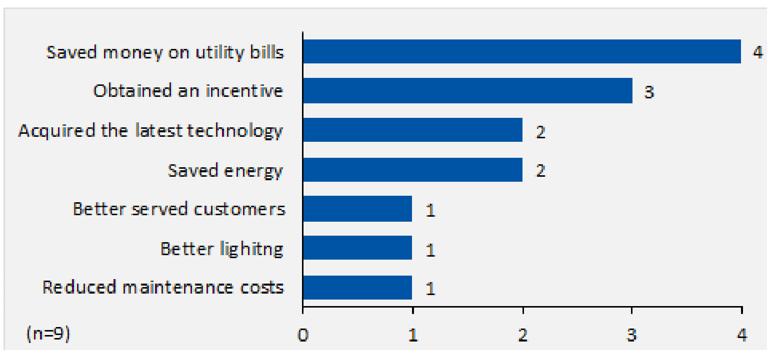
Figure 91. Overall Satisfaction with 2019 Custom Component



Source: 2018 and 2019 Participant Surveys Question H1.h. "How satisfied are you with the program overall? Would you say you are…"

When asked what benefits they had gained from participating in the Custom program, 2019 participants most commonly reported saving money on utility bills (four respondents) and receiving the incentive (three respondents). As shown in Figure 92, participants noted other benefits such as acquiring the latest technology and saving energy.

Figure 92. Benefits of 2019 Custom Participation



Source: 2019 Participant Survey Question H3. "How has your company benefitted from participating in IPL's energy efficiency program?" Multiple responses allowed.

Suggestions for Improvement

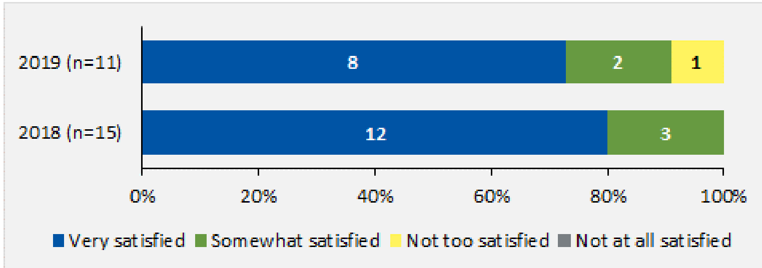
The evaluation team asked respondents to identify any suggestions for improving the Custom component. Nearly all respondents (10 of 11) did not offer any recommendations. The remaining respondent suggested simplifying the application process, as they had been confused by the application calculations for different lighting fixture types.

Satisfaction with IPL

In 2019, most Custom respondents were satisfied with IPL as their energy provider, with eight of 11 rating themselves as *very satisfied* and an additional two rating themselves as *somewhat satisfied* (Figure 93). In 2018, all respondents were *very satisfied* or *somewhat satisfied* with IPL as their energy service provider.

One respondent in 2019 rated themselves as *not too satisfied* with IPL as an energy services provider since IPL does not offer enough energy-savings programs, particularly around solar installation.

Figure 93. 2019 Custom Respondent Satisfaction with IPL as an Energy Provider

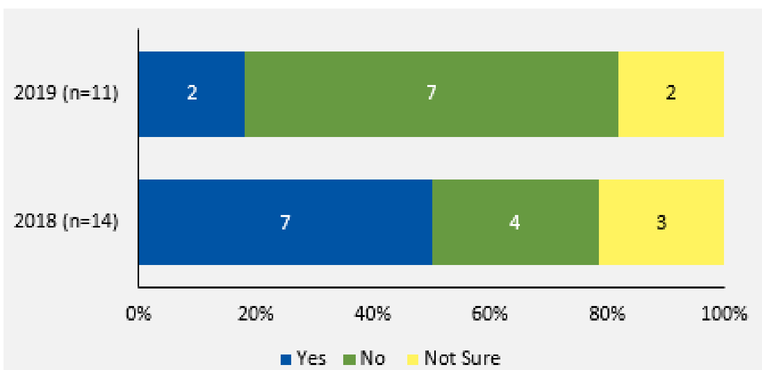


Source: 2018 and 2019 Participant Surveys Question H1.i. "How satisfied are you with IPL overall as a provider of energy service to your business?"

Plans for Future Projects

Fewer 2019 respondents than 2018 respondents had plans for other energy efficient building upgrades within the next year (Figure 94). While seven of 14 respondents from the 2018 evaluation had plans for energy efficient upgrades within the next year, just two of 11 respondents from the 2019 evaluation said that they had plans for energy efficient upgrades. Of the two respondents in 2019 who had plans for energy efficient upgrades, both had plans for lighting and HVAC projects.

Figure 94. Respondents Considering Additional Upgrades

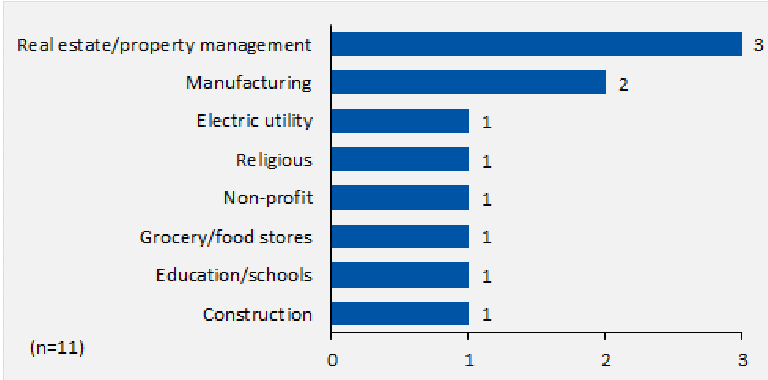


Source: 2018 and 2019 Participant Surveys Question B2. "Besides the [MEASURE] rebate you received from the program for energy-efficient technology, are you considering implementing other energy-efficient building upgrades in the next year?"

Participant Firmographics

The evaluation team asked survey respondents about various aspects of their business and the facility in which they operate. The 2019 respondents represent diverse industries, as shown in Figure 95, with real estate or property management as the most common industry.

Figure 95. 2019 Custom Respondents by Business Sector

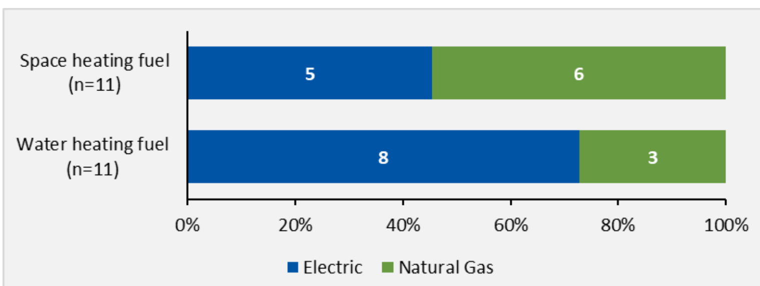


Source: 2019 Participant Survey Question I1. "What industry is your company in?"

Most 2019 Custom respondents (nine of 10) own their facilities, while one respondent leases. Nearly half (five of 11) made improvements in a facility over 100,000 square feet, while four made improvements in a facility between 50,001 and 100,000 square feet and two made improvements in a facility between 10,001 and 50,000 square feet.

When asked what fuel types are used for water and space heating, natural gas was most commonly cited for space heating (six of 11), while electric was most commonly cited for water heating (eight of 11; see Figure 96).

Figure 96. 2019 Custom Respondents Main Fuel Type for Space and Water Heating



Source: 2019 Participant Survey Questions I3 and I4. "What is the main fuel type used for [space] heating the facility?" and "What is the main fuel type used for water heating at the facility?"

Follow-Up on 2018 Evaluation Recommendations

The evaluation team reviewed the 2019 program files to follow up on the recommendation made during the 2018 evaluation, shown in Table 234.

Table 234. Custom Incentives Program 2018 Recommendation Status

2018 Evaluation Recommendation	2019 Follow Up
Review the application workflow for areas that pose challenges or bottlenecks. Identify whether the detail or process is critical to ensuring application quality or accuracy and, if critical, identify ways to effectively prompt customers or contractors for this information. Where CLEAResult staff are the bottleneck, establish stage-level goals within the preapproval processes to ensure the program meets its overall key performance indicators. As a result of this process review, all businesses may experience a streamlined application process.	***Partially Completed.*** CLEAResult did not review application workflow or identify sticking points, noting that they perceived the application was not a barrier. CLEAResult held a training in 2019 for its energy advisors and call center staff regarding how to assist contractors and customers with questions about their program application. CLEAResult also held an on-site seminar for trade allies to ask questions about applications.

Retro-Commissioning

The evaluation team interviewed IPL's program manager and key Heapy staff to obtain an overview of the program design and delivery processes and any changes or challenges experienced during 2019. IPL and Heapy reported that the program operated smoothly in 2019. Program participation in the first year of the program was robust, with 73 buildings.

Program Delivery

The Retro-Commissioning incentive structure has two parts:

- The customer may select to work with any qualified Retro-Commissioning provider. IPL reimburses the vendor directly for up to 50% of the study cost, once the study is completed and all agreed-upon measures have been implemented, through a tiered reimbursement structure.
- Customers who implement viable energy efficiency measures identified may receive Retro-Commissioning or prescriptive rebates, depending on the measures identified. There are two predefined categories for prescriptive rebates, while Retro-Commissioning incentives are available for nonstandard projects involving complex technologies or equipment changes with more than one-for-one replacements.

The intent of the program is to identify and provide rebates for Retro-Commissioning measures on a performance basis ($0.04 per kilowatt-hour) once electric savings have been verified by Heapy Engineering after implementation.

Program Marketing and Outreach

IPL and Heapy reported that they primarily conducted direct outreach via phone calls, emails, and in-person meetings to recruit customers into this program in 2019. When conducting outreach to customers, they targeted a business energy manager or facility manager. They also conducted some public outreach via online marketing materials and having IPL representatives discuss the program with customers in their region. In 2020, IPL and Heapy plan to continue using public outreach methods to recruit customers for the Custom Incentives and Prescriptive Rebates programs who are not currently taking advantage of a whole building–focused effort.

Program Application Process

Retro-Commissioning customers can access all informational documentation about the Retro-Commissioning component, along with the application for participation, from the IPL website. Customers can complete their application via email. Heapy and IPL staff review all applications to determine eligibility and resources needed. The preferred building types have a direct digital control system with room for energy improvement, and IPL designed the application process to assess these criteria quickly. If the customer does not already have a preferred vendor selected, Heapy assists them to identify an appropriate vendor to work with.

The customer and vendor must prepare a Retro-Commissioning study report within four weeks of the study start. The report must identify the intended efficiency measures and estimated savings values from implementing those measures. Savings estimates should be derived from utility or metered data, or by industry standard calculations. Once the study is complete, the customer, vendor, Heapy, and IPL discuss each efficiency measure in detail to determine which measures to implement and through which program to process the rebates. Payback, total energy savings, and total implementation costs are the dominant criteria to determine viability. Any measure or components of a measure that fall into an existing prescriptive incentive structure are rebated through the Prescriptive Rebates program, while all other qualifying measures are rebated through the Retro-Commissioning component.

The customer is required to implement all agreed-upon measures within three months of the study report meeting. Once implementation is completed, Heapy conducts four weeks of measurement and verification supported by utility data, sub-metered data, trend data, and industry standard calculations to determine the verified savings of each measure.

Participant Feedback

In February 2019, the evaluation team conducted on-site interviews with the key contacts at the three customer groups that participated in the Retro-Commissioning component in 2019. The evaluation team specifically pursued in-person interviews in order to achieve a 100% response rate (given how few customers participated in the 2019 program). These three participants represent all 60 buildings and 100% of the program *ex ante* savings.

Energy Efficiency Awareness and Marketing

In 2019, two of three survey respondents learned of the Retro-Commissioning component directly through IPL staff, while one learned from Heapy staff and one learned through participation in another IPL program (one respondent reported two ways of learning about the program). These results were expected since the program is in the first year of operation, and IPL had indicated that they pursued direct marketing to targeted businesses to boost participation in the 2019 program.

All three respondents said they received enough information about the program, and all provided more detail about the most useful information they received (again, with one respondent providing more than one response):

- How to receive rebates for implementing energy efficiency projects (two respondents)
- Additional IPL rebates and ways to save (one respondent)
- Which local providers could assist with identifying and/or implementing energy efficiency projects (one respondent)

Respondents also provided details about what additional information they did not receive that would have been helpful in their decision to pursue the program:

- How to complete additional efficiency projects (two respondents)
- How to receive rebates for implementing energy efficiency projects (one respondent)
- Additional IPL rebates and ways to save (two respondents)
- Which local providers could assist with identifying and/or implementing energy efficiency projects (one respondent)

When asked to list ways IPL could best keep organizations informed about energy-saving opportunities in the future, all 2019 respondents said they prefer to be kept informed through their IPL representative (indicating email, phone, or in person), and all respondents also said they would like their vendor to be kept informed about program offerings. This response was not unexpected since all 2019 participants were approached directly to participate in the program, demonstrating that they already have good communication established with an IPL representative(s).

Participation Drivers

Retro-Commissioning participants identified the factor that was most important in their decision to participate in the program and to implement the efficiency measures: saving money on utility bills was cited by two respondents, and optimizing the operation of existing equipment was cited by one respondent.

Participation Barriers

Businesses face many challenges when pursuing energy efficiency projects in their facilities. The 2019 participants identified several challenges they typically face when considering this type of project:

- High initial cost (two respondents)
- Funding competition with other investments/improvements (two respondents)
- Lack of staff time dedicated to energy efficiency upgrades (two respondents)
- Understanding potential areas for improvement/technical aspects of project (one respondent)
- Receiving corporate support for energy efficiency investments (one respondent)
- Long payback period/return on investment (one respondent)

Respondents also shared whether they had experienced any challenges with the Retro-Commissioning implementation. Two respondents reported that they experienced slight challenges with program participation: one said the timeline for implementation was somewhat difficult to follow, and the other said they struggled slightly with understanding measure eligibility.

Retro-Commissioning participants shared what IPL could do, other than providing incentives, to help companies overcome challenges in making improvements. One respondent had no suggestions, while two respondents provided a recommendation:

- Provide more technical and engineering support in the recommended measure discussion process and validation of energy savings, both before and after implementation
- Provide more support in identifying and selecting a qualified, local study vendor

Satisfaction with Program Processes

Retro-Commissioning respondents rated their satisfaction with several program aspects. All respondents were either *very satisfied* or *somewhat satisfied* with all program aspects. All three respondents rated themselves as *very satisfied* with their experience with the application, the incentive amount, the incentive check timeline, the quality of work by the vendor, the program overall, and with IPL overall.

All three respondents indicated that, as a result of the program, they benefited by saving money on utility bills, saving energy, and obtaining an incentive, while two of three each mentioned reducing maintenance costs and protecting the environment.

Respondents each provided a recommendation for program improvement:

- Provide assistance and guidance with tracking energy performance in order to validate the program, receive buy-in from stakeholders for the measures implemented, and track ongoing performance over time.
- Provide assistance in identifying more measures to implement, other peer groups to learn from, and best practice strategies for efficient operation.
- Provide participant’s with feedback on their energy performance.

Participant Firmographics

The evaluation team asked survey respondents about various aspects of their business and the facility in which they operate. The three 2019 respondents represent a small variety of industries in the education and retail sectors.

Two of three 2019 Retro-Commissioning respondents own their facilities, while one respondent has differing ownership/lease configurations depending on the property. All three participants have previously and are currently making active improvements to their facilities, including projects around LED lighting, domestic hot water (DHW) improvements, HVAC programming and sequencing improvements, and variable speed drive additions.

All three respondents use natural gas for both water and space heating.

Conclusions and Recommendations

Conclusion 1. The increased focus on customer engagement resulted in high customer satisfaction and greater *ex post* gross savings compared to 2018. CLEAResult met all goals except its target to increase the number of program trade allies, which may be an area to emphasize to further drive customer participation.

IPL and CLEAResult deliberately focused on increasing customer engagement in 2019 through direct outreach to customers. CLEAResult conducted outreach via combination of emails, phone calls, and in-person meetings, and CLEAResult specifically targeted previous Custom and Prescriptive program participants. Participant survey results indicated this increased customer engagement was effective. Additionally, the program achieved 15% greater *ex post* gross savings when compared to 2018 (19,693,509 kWh compared to 17,022,370 kWh).

All 2019 Custom respondents were *very satisfied* with the program overall, compared to 87% of 2018 respondents. All 11 respondents were *very satisfied* working with CLEAResult in 2019 (up from eight of 11 in 2018), and 81% of 2019 respondents worked with CLEAResult during their project planning phase (up from 54% in 2018). However, contractors and vendors as a source of program awareness fell to 18% in 2019 (down from 56% in 2017 and 54% in 2018), and trade ally Custom participation remained flat despite a CLEAResult goal to increase trade ally participation by 5% compared to 2018 levels. CLEAResult indicated that with the emphasis on engaging customers, staff were less focused on trade ally outreach than in the past. With the historical efficacy of trade allies as a major source of program awareness and customer recruitment for IPL and many other utility commercial programs, re-engagement with this sector can even further drive participation.

Recommendations:

- Increase trade ally program engagement, as trade allies have historically been a source of Custom measure awareness. Send trade allies updates on program changes, offer trainings on program offerings, and send reminders to complete their projects and submit rebate applications.
- Interview trade allies to assess the kind of support they would like to receive from IPL and CLEAResult in terms of marketing, training, and delivering the program to customers, as well as barriers to customer program participation.

Conclusion 2. In its first year, the Retro-Commissioning program completed 60 projects, but saw inconsistent application of program requirements.

The published Retro-Commissioning information and application outline the program requirements for participants, which is primarily distinguished by having a vendor perform the Retro-Commissioning study for the customer. The vendor is required to provide specific deliverables at each phase of the study, and in particular at the conclusion of the study, outlining the measures in detail.

In 2019, customers were allowed to participate in the program via the published path (using a vendor) or by performing the Retro-Commissioning study in-house (not using a vendor). If an applicant elected to pursue self-study, no rebates were provided for the Retro-Commissioning study, but the energy-savings incentives remained in place. Participants in the self-study path do not need to provide the required deliverables to IPL that a vendor would be responsible for under the vendor study path.

IPL introduced this secondary path in response to specific customers applying for the program in 2019, in order to encourage participation from key accounts. However, this created inconsistency in the program requirements and level of effort required from different participants.

Recommendations:

- If continued, make the self-study path fully published and available to any eligible customer. Define the eligibility requirements to pursue that path, outline the required program documentation and specify the elements that are necessary to report in a study.
- Enforce the Retro-Commissioning study as a required deliverable. The study report and all early project documentation serve as the primary details to determine a building's eligibility for the program, a realistic energy-savings goal for the project, individual energy conservation measures and their energy and cost impacts, and the means of quantifying and verifying energy savings that result from measure implementation. Without the study report or measure-level documentation in place, the energy savings that result from measure implementation cannot be confidently determined during measurement and verification.
- To reduce the barrier of entry for customers, pursue methods of reducing the level of effort from the customer instead of reducing energy-savings documentation. Continue to allow for self-studies, but with aid from IPL or Heapy to identify measures with robust savings. IPL could consider ways to reduce the financial burden of engaging an external vendor for customers who might require more assistance to participate in the program.

Conclusion 3. The measurement and verification strategy is well-defined and executed for the Retro-Commissioning vendor path, but not well-defined or executed for the self-study path.

For Retro-Commissioning projects that followed the vendor path, where a vendor is engaged to perform the Retro-Commissioning study and create the required deliverables, the measurement and verification process is well-defined and has been well-executed. For the verification, Heapy primarily used trend data gathered from the building before and after measure implementation. Verification is also supported as needed with smart meter interval data and submeter data installed before measure implementation, and with industry standard calculations. Heapy calculated all energy savings at the measure level instead of the building level.

In 2019, this process was not followed for self-study projects, because measure-level energy consumption data was not generated as part of the Retro-Commissioning study. Instead, Heapy conducted weather-normalized utility bill analysis to determine cumulative savings at the building level rather than at the measure level.

Recommendations:

- Prior to conducting a Retro-Commissioning study, talk to the customer about the methods to quantify each proposed measure. For the verification, the evaluation team will use the agreed-upon strategy to confirm actual energy savings from implementing each individual measure.
- We would not recommend using utility bill analysis as the primary method of verification for self-study projects, which is unreliable when cumulative savings are less than 10% of baseline, does not provide measure-level savings calculations, and it is unable to differentiate savings from implemented Retro-Commissioning versus non-Retro-Commissioning eligible measures. Instead, follow the verification methods used for the vendor path, which will provide more accurate measure-level energy-saving calculations. Use utility bill analysis as a secondary means of verification only.

Conclusion 4. Participants identified a variety of unique Retro-Commissioning measures during 2019, many of which potentially fall outside of typical eligible Retro-Commissioning measures.

Several energy conservation measures identified within the self-study projects would typically not be considered an eligible Retro-Commissioning measure. Behavior modification measures were included, where the proposed control method was human dependent rather than mechanically programmed. Human-dependent measures are difficult to implement uniformly, it is difficult to measure and verify the savings that result, and it is difficult to ensure that first-year savings will be sustained. Preventive maintenance measures were also included, which are typically routine scheduled inspections and repairs that aim to prevent equipment failure.

Recommendations:

- Determine what types of Retro-Commissioning measures IPL would recommend, ensuring they are quantifiable and result in meaningful energy savings. Publish these recommended eligible Retro-Commissioning measures as guidance literature for the program or discuss them with potential customers as part of the application phase.
- Behavior modification measures can be encouraged as part of a larger conservation strategy but do not provide rebates for them as individual, stand-alone measures.
- Preventive maintenance measures can be identified during the Retro-Commissioning study, but do not provide rebates for implementing these actions. These measures are in the best interest of the customer to ensure equipment health and longevity, and to ensure that the customer's operational parameters are being met. There is a great deal of grey area between preventive maintenance and retro-commissioning, and the evaluation of eligibility would need to be made on a case-by-case basis as part of early retro-commissioning study discussions between IPL,

Heapy, and the customer to ensure that the proposed measures are appropriate for the specific project. We offer the following definition of preventive maintenance measures:

- Measures where the fundamental design or nature of the equipment remains unaltered after implementation.
- Measures where the associated equipment would be damaged if the measure were not implemented, or actions that are recommended by the equipment manufacturer as maintenance.
- Measures where the facility could not operate properly without the measure being implemented, or actions required to allow the facility or equipment to operate as designed.
- Actions that are performed periodically at the facility or on equipment under an established maintenance protocol.
- Measures that return equipment to the facility's required operational parameters. In other words, the measure would not be eligible as a Retro-Commissioning measure if it proposed an operating condition that violated the set operational parameters of the building.

Conclusion 5. The SEM component achieved a high realization rate in its first year, with education facilities generating 5%-14% energy savings and health care facilities saving 2%-4%. With so much overlap in sectors and participants, there is opportunity to generate further savings and collaboration among participants.

SEM achieved savings across all 13 participants, accounting for 23 facilities. Education participants saved a total of 1,204,757 kWh across 17 facilities, for an average of 7% of total baseline usage. Health care facilities saved a total of 1,664,626 kWh across six facilities, for an average of 1% of total baseline usage. The achieved percentage saving differed from sector suggesting the savings potentials differ across sectors.

The largest drivers of the evaluated realization rate resulted from unaccounted for rebated projects and holiday indicators. The team evaluated an overall realization rate of 94%. For IU Health Clinical Labs and Methodist, the team evaluated realization rates below 0%. This is primarily due to the evaluation team accounting for large projects that received rebates from another IPL program that were installed in the midst of the baseline period. The evaluation team estimated lower realization rates for both Ivy Tech facilities, as well as IU Health Gateway and North. For all four of these facilities the main difference in model selection was the inclusion of a holiday indicator.

Recommendations:

- Encourage the energy champions within sectors to work collaboratively. As facilities tend to be similar within sector, the potential areas for improvements are often consistent. Energy champions within sectors can learn from each other's successes.
- All rebated programs installed during the baseline should be accounted for in the final regression model.
- For all facilities, test major holidays when selecting baseline model.

PRESCRIPTIVE REBATES PROGRAM

Through the Prescriptive Rebates program, IPL offers incentives for C&I customers who install energy efficiency measures (primarily high-efficiency lighting such as LEDs). In 2019, the program exceeded its energy savings and demand reduction goals (108% and 120%, respectively).

Program Description

The program implementer (CLEAResult) oversees program management, direct program marketing to customers, and program delivery. CLEAResult relies on trade allies to promote and deliver the program to customers, supplemented by outreach support from IPL and direct program marketing from CLEAResult. IPL delivers a portion of the Prescriptive Rebates program's lighting incentives through local lighting distributors, or Midstream delivery channel. With this delivery channel, lighting distributors offer nonresidential IPL customers point-of-sale incentives for the purchase of energy-efficient lighting products. The Prescriptive Rebates program still achieves a majority of its savings through the traditional, Non-Midstream delivery channel, where participants or contractors apply for rebates for installed energy efficiency measures. Throughout this chapter, the evaluation team distinguishes between the two delivery channels using the labels Midstream and Non-Midstream.

Research Objectives

For the 2019 program year evaluation, the evaluation team addressed several research objectives:

- Determine whether the program is meeting its goals and objectives
- Assess how effectively the program is meeting customer needs
- Identify whether the program marketing, outreach, and communication efforts are effectively reaching targeted customers
- Assess whether program operations are efficient and supportive of customer participation
- Identify whether the program has influenced customers' decisions and behavior to purchase energy-efficient equipment
- Estimate a program NTG value
- Determine program energy savings and demand reduction

Research Approach

To answer the research objectives outlined above, the evaluation team conducted several activities:

- Interviewed IPL and CLEAResult staff
- Surveyed 2019 participants
- Assessed savings reported in Vision extracts (CLEAResult's program tracking database) against project documentation
- Examined whether claimed savings algorithms aligned with the Indiana TRM (v2.2) or other appropriate secondary sources
- Determined any reduction in verified savings using ISRs calculated from on-site EM&V
- Assessed the accuracy of prescriptive savings assumptions in describing the building types and operating schedules of installed equipment through site visits and desk reviews

Program Performance

The 2019 Prescriptive Rebates program achieved 108% of its net energy-savings goal and surpassed its peak demand reduction goal, achieving 120% of planned savings. Table 235 shows the net goal, *ex post* actuals, and percentage of goal, along with budget and expenditures for the Prescriptive Rebates program. The program exceeded its *ex ante* goals and was under budget.

Table 235. 2019 Prescriptive Rebates Program Expenditures, Participation, and Savings

Metric	Net Goal [a]	*Ex Post Net*	Percentage of Goal
Net Energy Savings (kWh)	58,225,852	62,981,714	108%
Net Demand Reduction (kW)	7,709	9,227	120%
Participation (units) [b]	N/A	324,397	N/A
Budget	$8,642,218	$7,400,463	86%

Note: Values rounded for reporting purposes.

[a] Goals per IPL's Settlement in DSM Cause #44945.

[b] Units are defined as a single fixture or installed item (such as a 2x2 LED fixture) or, with some equipment, units are a measure of capacity, such as controlled wattage for lighting controls. This report defines measures as the smallest granular tracking record for a program, which is generally a unit or collection of units installed in a given project and grouped at the measure category level (such as three 2x2 LED fixtures installed at Site A).

Table 236 presents 2019 savings for the Prescriptive Rebates program. *Ex post* gross energy savings and demand reduction aligned well with *ex ante* savings for both delivery channels, though the Non-Midstream delivery channel yielded higher savings compared with *ex ante* savings than the Midstream delivery channel. Similar to previous years, the lower relative savings for the Midstream delivery channel was primarily driven by a lower ISR for Midstream measures.[45] This issue as well as other EM&V findings drove the realization rates, as discussed in the *Ex Post Gross Savings* section.

[45] As in previous years, the Midstream delivery channel ISR is driven largely by stored bulbs, so a portion of the unachieved savings in 2019 will be evaluated as carryover savings in future program evaluations.

Table 236. 2019 Prescriptive Rebates Program Savings Summary

Metric	*Ex Ante* [a]	Audited	Verified	*Ex Post* Gross	*Ex Post* Net
2019 Non-Midstream					
Energy Savings (kWh)	60,529,455	61,076,274	60,858,228	58,157,795	51,760,438
Demand Reduction (kW)	8,178	8,564	8,534	8,452	7,522
2019 Midstream					
Energy Savings (kWh)	10,414,666	10,296,347	9,420,417	9,331,968	8,678,731
Demand Reduction (kW)	1,433	1,415	1,295	1,364	1,268
2016-2018 Midstream Carryover Savings					
Energy Savings (kWh)	N/A	N/A	N/A	2,913,518	2,542,546
Demand Reduction (kW)	N/A	N/A	N/A	502	436
Total Program					
Energy Savings (kWh)	70,944,122	71,372,620	70,278,645	70,403,281	62,981,714
Demand Reduction (kW)	9,611	9,979	9,828	10,317	9,227

Note: Values rounded for reporting purposes.

[a] The 2019 IPL scorecard reports the aggregated savings for the Prescriptive Rebates program Non-Midstream and Midstream delivery channels combined. *Ex ante* savings in this table are sourced from data extracts on VisionDSM to illustrate the savings share of each delivery channel. The team verified that, when combined, the Vision savings match the scorecard.

Table 236 also shows the *ex post* gross and net carryover savings from the 2016, 2017, and 2018 Midstream delivery channel. Historically, some participants keep rebated lamps or fixtures in storage during the first year they receive the incentives. In 2018, for example, the evaluation team calculated the Midstream first-year ISR as 75%, which means that program participants stored an average of 25% of the lighting units they received through the program. Because participants will install a portion of these units in year two (2019), the team followed the installation schedule presented in the UMP ("Chapter 6: Residential Lighting Evaluation").[46] The schedule assumes that 24% of stored bulbs will be installed in year two, which accounts for a portion of the carryover savings the team applied in 2019. The team also included year three carryover from the 2017 program and year four carryover from the 2016 program. (The *Impact Evaluation* section has further discussion of these evaluation adjustments.)

Table 237 presents the *ex post* gross and net energy adjustment factors resulting from the evaluation, with realization rates for energy savings and demand reduction. The Non-Midstream delivery channel measures had a NTG of 93% and the Midstream delivery channel measures had a NTG of 89%. The NTG for the program as a whole, including Midstream carry over savings, was also 89%.

[46] Note that the UMP does not currently outline an installation schedule for midstream C&I programs, so the team used the residential installation schedule as a proxy for Midstream delivery channel lighting carryover savings.

Table 237. 2019 Prescriptive Rebates Program Realization and Net-to-Gross Rates

Metric	Realization Rate [a]	Freeridership	Spillover	NTG
Non-Midstream				
Energy Savings (kWh)	96.1%	11%	0%	89%
Demand Reduction (kW)	103.4%	11%	0%	89%
Midstream				
Energy Savings (kWh)	89.6%	7%	0%	93%
Demand Reduction (kW)	95.2%	7%	0%	93%
2016-2018 Midstream Carryover Savings				
Energy Savings (kWh)	N/A	13%	0%	87%
Demand Reduction (kW)	N/A	13%	0%	87%
Total Program				
Energy Savings (kWh)	99.2%	11%	0%	89%
Demand Reduction (kW)	107.3%	11%	0%	89%

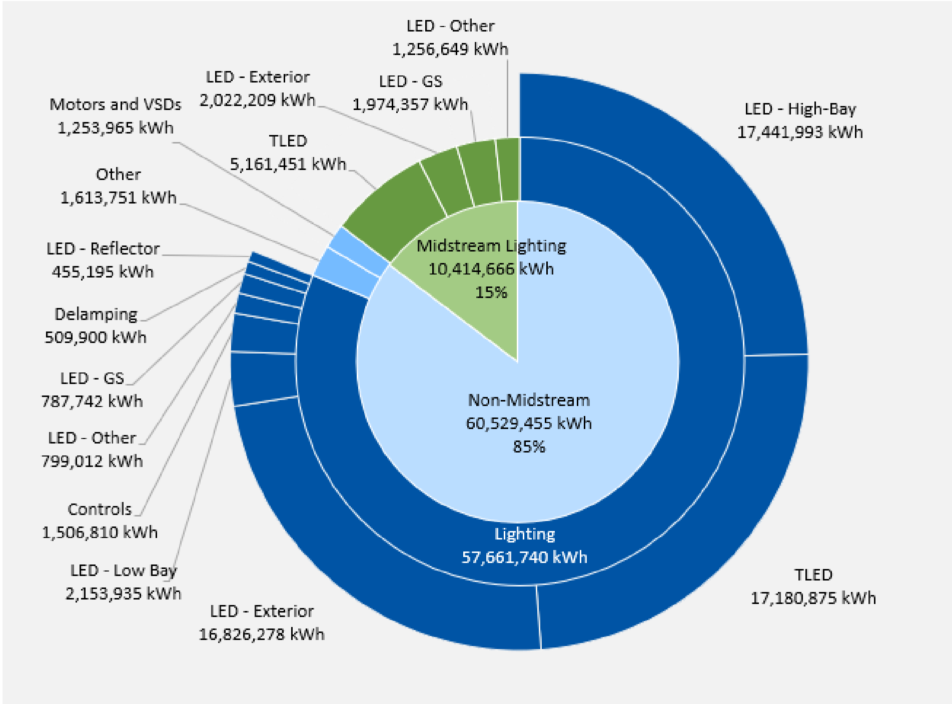
[a] Realization rate is defined as *ex post* gross savings divided by *ex ante* savings.

Impact Evaluation

Because the Midstream and Non-Midstream delivery channels are administered differently, the team evaluated the two populations of measures separately, calculating distinct ISRs and realization rates for each delivery channel. As in 2016 through 2018, the Midstream delivery channel was impacted by a low ISR in 2019, because some large facilities stored bulbs for future installation. Notably, the ISR was considerably higher in 2019 (91.5%) than in previous years, which may indicate that CLEAResult's efforts to minimize the storage of Midstream lighting units were successful.

Figure 97 illustrates the Prescriptive Rebates program population (including Non-Midstream and Midstream delivery channels) by energy savings and measure type. In 2019, the Prescriptive Rebates program accounted for 70.9 million kilowatt-hours in *ex ante* savings. The Non-Midstream delivery channel measures accounted for 85% of total program *ex ante* savings in 2019 (as in 2018), with LED lighting measures encompassing the vast majority of the delivery channel (96.6% of *ex ante* savings).

Figure 97. 2019 Prescriptive Rebates Program *Ex Ante* Savings Distribution by Measure Category



Note: The evaluation team grouped and defined measure categories in this figure based on the "equipment name" field in the tracking database (GS = General Service and TLED = Tubular LED).

The inner circle in Figure 97 represents the program division between the Non-Midstream and Midstream delivery channels. The middle ring further describes the measure categories present in both delivery channels. The outer ring represents savings from Non-Midstream lighting measures.

In contrast to 2018, when general service LEDs accounted for most Midstream measure savings, TLED lamps and fixtures dominated 2019 savings for the Midstream delivery channel, accounting for 50% of claimed savings. Exterior LED lighting also made large gains in 2019, providing 19% of claimed savings. For the Non-Midstream delivery channel, as in 2018, the most common measures in 2019 were larger wattage fixtures, with high bay, exterior, and TLED retrofits accounting for 85% of *ex ante* savings.

Non-lighting measures contributed only 4% of the energy savings in the 2019 Prescriptive Rebates program. This is consistent with previous years, when non-lighting measures represented between 2% and 5% of energy savings. Variable speed drive measures were either HVAC or compressed air applications, while "Other" measures comprised cooling equipment and heat pump upgrades as well as refrigeration, ENERGY STAR kitchen appliances, and incentive adjustments for lighting.

The team used the same approaches to evaluate the Non-Midstream and Midstream delivery channels in 2019. In the previous program cycle (2015 through 2017) for Midstream delivery channel measures, the evaluation team performed a database review of the population during *ex post,* because the team found that the *ex ante* methodology assigned deemed electric energy savings and peak demand reduction for the Midstream delivery channel. In 2018 and 2019, the team confirmed that CLEAResult used the same methodology for Midstream as for Non-Midstream delivery channel measures (based on evaluation recommendations). In 2019, CLEAResult estimated measure savings for both delivery channels using site-specific inputs based on building type and installed fixture wattage, and CLEAResult supplied documentation for each sampled project measure to support the data tracked in the VisionDSM database.

To analyze the impact of the Prescriptive Rebates program in 2019, the team selected a sample of measures and extrapolated findings to the larger population for each deliver channel (Non-Midstream and Midstream). The team assigned each delivery channel a unique ISR and realization rate. Using a PPS sampling approach, the team determined the evaluation sample for each delivery channels. Table 238 shows the unit and measure populations, actual and target measures in the sample, and the sample's share of energy savings for the Prescriptive Rebates program.[47]

Table 238. 2019 Prescriptive Rebates Program Impact Sample Characteristics

Gross Population Count		Site Visit Sample Measure Count		Total Sample Measure Count		Evaluation Sample Share of Program Energy Savings
Unit	Measure	Actual	Target	Actual	Target	
Non-Midstream						
276,378	3,323	11	9	42	42	11%
Midstream						
48,011	775	18	18	44	44	29%
Total [a]						
324,389	4,098	28	27	86	86	14%

[a] This total represents the sum of units for measures claiming non-zero savings in the Vision database, which is slightly different than the scorecard of 324,397 presented in Table 1. Vision DSM *ex ante* energy savings and demand reduction match the scorecard exactly.

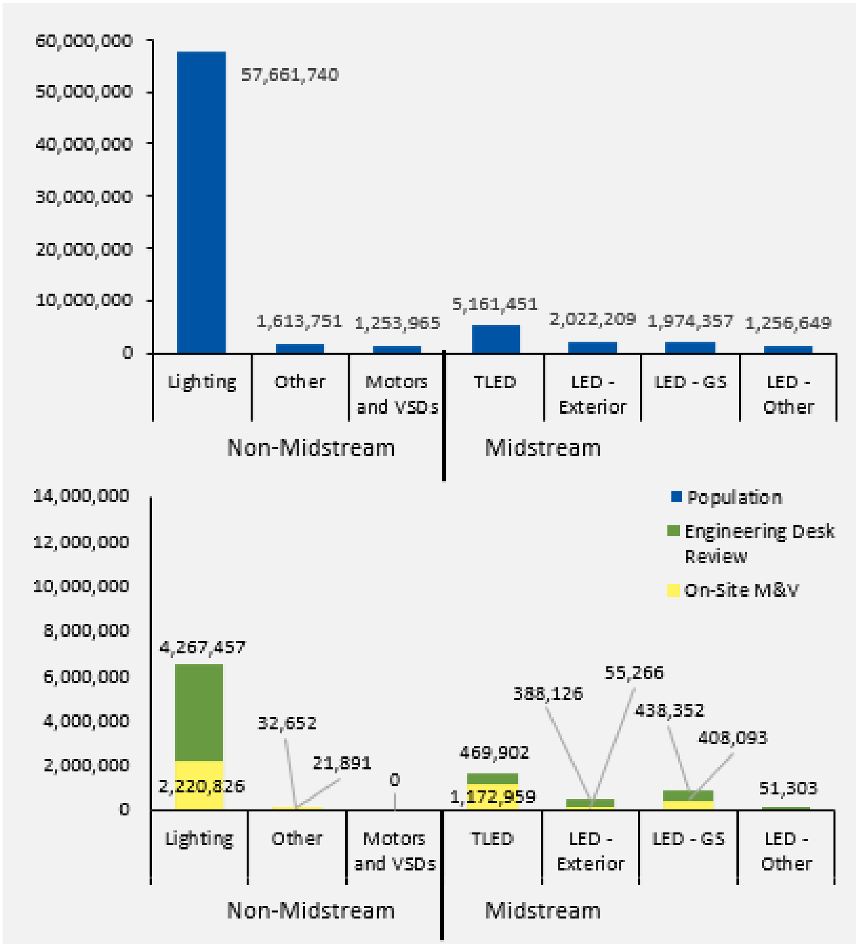
To inform sampling targets for the Non-Midstream delivery channel in 2019, the team used findings from the 2015 through 2018 evaluations. By understanding the savings variability (error ratio) for these measures, the team could more efficiently target the sample. The 2019 sample required only 42 Non-Midstream measures to achieve 90% confidence at ±10% precision for the realization rates. The final sample for the Non-Midstream delivery channel achieved an energy realization rate of 96.1% at 90% confidence with ±8% relative precision.

Because 2018 was the first year to apply the PPS sampling approach for the Midstream delivery channel, the team used a more conservative error ratio to determine the sample size of 62 for that year. For 2019, the evaluation team used a less conservative error ratio, which led to a smaller sample size. The final sample of 44 measures for the 2019 Midstream delivery channel achieved an energy realization rate of 89.6% with ±12% relative precision at 90% confidence.

[47] This report defines units as a single fixture or installed item and defines measures as the smallest granular tracking record for a program, which is generally a unit or collection of units installed at a given project and grouped at the measure category level (such as three 2x4 LED fixtures installed at Site A).

The 2019 evaluation sample for Midstream and Non-Midstream represented 14% of the total Prescriptive Rebates program energy savings. Figure 98 shows the breakdown of on-site EM&V analysis and engineering desk reviews for various measure categories in the sample.

Figure 98. 2019 Prescriptive Rebates Program Population Total *Ex Ante* Distribution by Measure Category Compared with Evaluation Sample

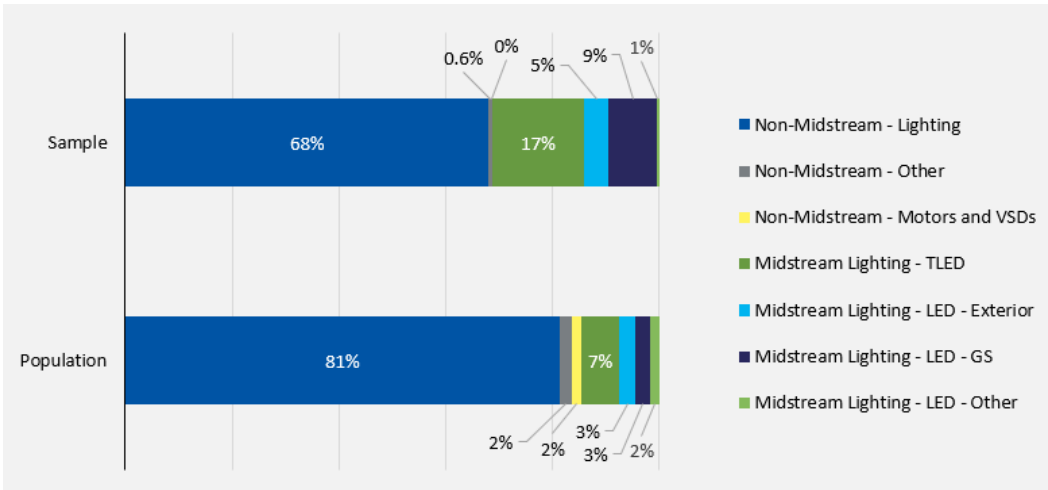


Ex ante energy savings in the sample closely correlated to the distribution of measure types in the total Prescriptive Rebates program population. The team conducted site visits to verify installation of 18 Midstream measures and 11 Non-Midstream measures (including 10 lighting measures) and calculated the ISR for each delivery channel.[48] The team performed an engineering review of on-site measures using on-site EM&V data, supplemented with additional engineering desk reviews of other projects to increase the sample to 44 Midstream and 42 Non-Midstream measures.

48 The evaluation plan includes conducting site visits each year to validate measure ISRs over the three-year evaluation cycle (2018 to 2020), where the ISRs combined over the three years achieve ±10% precision at the 90% confidence level.

Figure 99 shows the 2019 sample and population distribution by measure category using data from the tracking database.

Figure 99. 2019 Prescriptive Rebates Program Sample *Ex Ante* Percentage Distribution by Measure Category Compared with Population



Midstream TLED, exterior, and general service lighting have higher representation in the sample (31%) than in the population (13%) because the sampling design required a larger proportional sample size for Midstream than for Non-Midstream. Additionally, the largest sampling weight for the Midstream delivery channel was for TLED measures.

Audited Savings

Audited savings generally aligned well with *ex ante* savings in 2019. Most adjustments to *ex ante* savings were small and resulted from minor discrepancies in lamp wattage reported in the database versus the project files, such as an efficient lamp wattage of 14.5-watt used in the tracking data and calculations and a value of 14-watt indicated in the project files.

One large adjustment in energy savings resulted from CLEAResult calculating *ex ante* energy savings for a Midstream lighting measure based on the “Healthcare” facility type (6,802 AOH) instead of the “Hotel/Motel” facility type (3,754 AOH) as indicated in the project files. With this same project, another apparent error caused *ex ante* demand reduction to be nearly twice that of the audited value. The evaluation team recalculated savings using CLEAResult’s algorithm and inputs from the project file:

- Fixture count of 52
- Baseline fixture of 102 watts as provided in CLEAResult documentation for the installed fixture type
- Efficient fixture of 33.62 watts as provided in the tracking data
- AOH of 3,754 based on “Hotel/Motel” facility type in Indiana TRM (v2.2) lookup table
- Energy WHF of 0.119091 for all building types from the CLEAResult lookup table
- Demand WHF of 0.2 for all building types from CLEAResult lookup table
- Summer peak coincidence factor of 0.37 based on “Hotel/Motel” facility type in CLEAResult lookup table

The evaluation team's recalculation resulted in 14,938 kWh of savings per year (which is 55% of the project's *ex ante* value) and 1.6 kW of peak demand reduction (which is 48% of the *ex ante* value). This discrepancy and several smaller discrepancies caused small differences in audited savings compared with *ex ante* savings.

Table 239 summarizes the audited and *ex ante* savings for each delivery channel and for the program overall in 2019.

Table 239. Audited Savings Summary by 2019 Prescriptive Rebates Program Delivery Channel

Metric	*Ex Ante* [a]	Audited
2019 Non-Midstream		
Energy Savings (kWh)	60,529,455	61,076,274
Demand Reduction (kW)	8,178	8,564
2019 Midstream		
Energy Savings (kWh)	10,414,666	10,296,347
Demand Reduction (kW)	1,433	1,415
Total Program		
Energy Savings (kWh)	70,944,122	71,372,620
Demand Reduction (kW)	9,610	9,979

[a] The 2019 IPL scorecard reported the aggregated savings for the Prescriptive Rebates program Non-Midstream and Midstream delivery channels combined. *Ex ante* savings in this table are sourced from data extracts on VisionDSM to illustrate the savings share of each delivery channel. The team verified that, when combined, the VisionDSM savings matched the scorecard.

Verified Savings

The evaluation team conducted site visits to verify installation of 42 sampled measures for the 2019 Non-Midstream delivery channel. Table 240 lists the technology and *ex ante* and *ex post* quantities, and provides reasons where the claimed and verified quantities do not match. The team calculated a 99.6% ISR with a relative precision of ±0.4% at 90% confidence. The team applied the 99.6% ISR to the audited savings (61,076,274 kWh and 8,564 kW) to calculate the verified savings (60,858,228 kWh and 8,534 kW) for the 2019 Non-Midstream delivery channel (shown in Table 242 below).

Table 240. 2019 Prescriptive Rebates Program Non-Midstream Lighting In-Service Rate Summary

Site	Technology	*Ex Ante* Quantity	*Ex Post* Quantity	Discrepancy Notes
1	TLED	5,379	5,379	N/A
2	Controls	726	726	N/A
3	LED - Low Bay	628	628	N/A
4	LED - High-Bay	324	304	6 fixtures in storage
5	TLED	230	227	3 fixtures in storage
6	LED - Low Bay	180	180	N/A
7	Controls	148	145	Only 145 fixtures in facility
8	LED - High-Bay	148	145	Only 145 fixtures in facility
9	LED - High-Bay	48	48	N/A
10	LED - High-Bay	32	33	33 fixtures found in facility
Total		**7,843**	**7,815**	**N/A**
ISR		**99.6%**		
Precision at 90% Confidence		**±0.4%**		

The evaluation team performed site visits to verify the installation of 18 sampled measures for the 2019 Midstream delivery channel. Table 241 lists the technology and *ex ante* and *ex post* quantities, and provides reasons where the claimed and verified quantities do not match. The team calculated a 91.5% ISR with a precision of ±8.4% at 90% confidence. The team applied the 91.5% ISR to the audited savings (10,296,347 kWh and 1,415 kW) to calculate the verified savings (9,420,417 kWh and 1,295 kW) for the Midstream delivery channel in 2019 (shown in Table 242 below).

Table 241. 2019 Prescriptive Rebates Program Midstream In-Service Rate Summary

Site	Technology	*Ex Ante* Quantity	*Ex Post* Quantity	Discrepancy Notes
1	TLED	4,300	4,300	N/A
2	TLED	1,212	1,212	N/A
3	TLED	824	47	777 lamps in storage
4	LED - GS	672	672	N/A
5	TLED	572	572	N/A
6	LED - GS	355	355	N/A
7	TLED	290	290	N/A
8	TLED	254	251	3 lamps in storage
9	TLED	164	164	N/A
10	TLED	142	142	N/A
11	TLED	138	138	N/A
12	TLED	94	94	N/A
13	LED - GS	73	73	N/A
14	TLED	47	47	N/A
15	TLED	40	38	2 lamps in storage

Site	Technology	*Ex Ante* Quantity	*Ex Post* Quantity	Discrepancy Notes
16	TLED	37	37	N/A
17	LED - Exterior	19	19	N/A
18	LED - Exterior	18	13	5 fixtures in storage
Total		**9,251**	**8,464**	**N/A**
ISR		**91.5%**		
Precision at 90% Confidence		**±8.4%**		

One quirk of the VisionDSM tracking data complicates the calculation of ISR when lighting control measures, such as occupancy sensors, are involved: the "Number of Units" column provides the number of controlled watts per installed control rather than the number of installed controls. For one measure the evaluation team reviewed, for example, although 726 controls were installed, the tracking data provided a "Number of Units" value of 131.7, which matched the value in the "Watts Controlled" column also included in the tracking data. The evaluation team compensated for this problem to ensure that ISR reflects the percentage of installed equipment.

Table 242 summarizes the verified savings by program delivery channel, displaying the application of each channel's ISR to audited savings.

Table 242. Verified Savings Summary by 2019 Prescriptive Rebates Program Delivery Channel

Metric	Audited	ISR	Verified
2019 Non-Midstream			
Energy Savings (kWh)	61,076,274	99.6%	60,858,228
Demand Reduction (kW)	8,564		8,534
2019 Midstream			
Energy Savings (kWh)	10,296,347	91.5%	9,420,417
Demand Reduction (kW)	1,415		1,295
Total Program			
Energy Savings (kWh)	71,372,620	98.5%	70,278,645
Demand Reduction (kW)	9,979		9,828

Note: Values rounded for reporting purposes.

Ex Post Gross Savings

The evaluation team adjusted *ex ante* measure savings in the *ex post* analysis based on three types of data, described in more detail below:

- Fixture quantity and wattage discrepancies discovered during site visits and discussions with business owners
- AOH metered during site visits and provided by business owners
- Adjustment of WHFs and peak summer coincidence factors consistent with the Indiana TRM (v2.2)

Findings from site visits and engineering reviews contributed to the 0.8% decrease in *ex post* energy savings and the 7.4% increase in demand reduction in 2019 (compared with *ex ante*). Adjustments to AOH had the largest impact on the energy-savings realization rate for the Non-Midstream delivery channel, while the Midstream ISR of 91.5% had a greater effect on energy savings within that delivery channel. For demand reduction realization rates, ISR had the largest effect for the Midstream delivery channel, while changes in coincidence factor for some measures likely had the largest effect for the Non-Midstream delivery channel. The addition of carryover savings for 2016 through 2018 boosted realization rates for the Prescriptive Rebates program as a whole, increasing realization rates for energy saving and demand reduction by 4% and 5%, respectively.

Site visits were essential to evaluating program savings, partly through visual verification of measure installation, which was the basis for the ISRs. Site visits also often led to adjustments in AOH, where actual operating hours determined through on-site interviews and observation were notably different than the AOH assumed by CLEAResult based on facility type.

ISR and adjustments to AOH can have large effects on realization rates, because these adjustments have a proportional effect on measure savings. For example, reducing the AOH for lighting in a facility by 50% reduces estimated savings by 50%. The evaluation team adjusted AOH for eight of 11 Non-Midstream measures based on site visit observations, increasing AOH in some cases and decreasing in other cases. The team adjusted AOH for 14 of the 18 Midstream measures that received site visits. The examples that follow illustrate some of the adjustments made based on site visit observations:

- As shown in Table 240 and Table 241, field staff noted several discrepancies between installed and claimed quantities. In some cases, missing lamps or fixtures were found in storage. In the most striking example (Site 3 in Table 241), of 824 light fixtures purchased for an ongoing lighting project, only 47 were found to be installed, with the remaining 777 still in storage.
- For both sites identified as “24/7 Buildings” (8,760 AOH, 1.0 CF), the evaluation team reduced AOH dramatically based on information gained on site—to 2,600 AOH for one site and 3,754 AOH for the other. For the latter site, a hotel that installed lamps in a combination of hallways and guest rooms, the team also adjusted the energy WHF to a value for electric heating with AC, which is negative and reduced savings considerably; in contrast, CLEAResult assumed the same energy WHF of 0.119091 for all measures, regardless of facility type or heating fuel.
- The team visited five religious buildings, which CLEAResult had assigned AOH based on the “Other” Indiana TRM (v2.2) facility type (4,408 AOH, 0.65 CF). The team changed the AOH for four of these facilities to match usage hours provided by the site contact or where we confirmed that the “Public Assembly” facility type provided more accurate values (2,867 AOH, 0.65 CF). In the fifth facility, only exterior fixtures were installed, and the evaluation team adjusted the AOH to that for exterior fixtures (4,300 AOH, 0.00 CF).

Engineering reviews also led to adjustments in *ex post* gross savings. For example, for nine of the 31 reviewed Non-Midstream measures and seven of the 26 reviewed Midstream measures, the team adjusted AOH based on posted business hours or by choosing a facility type more representative of the facility. Several examples illustrate the type of adjustments often made based on engineering review:

- For 11 “Retail” facilities that received engineering reviews but not site visits, the evaluation team adjusted AOH either up or down based on posted hours plus a margin for cleaning. For one of the sites, a box for exterior fixtures had been checked on the incentive from, but the 304 LED troffers installed would not be appropriate for an external location and were likely indicated as exterior by mistake; the evaluation team calculated savings using interior AOH, coincidence factor, and WHF values, which provided an especially large increase in verified demand reduction versus audited (because exterior lights do not contribute to demand reduction for IPL measures).
- The evaluation team adjusted AOH for four of 13 measures installed in “Other” facilities (4,408 AOH, 0.65 CF). One facility—a small, specialized museum—had posted hours that totaled 1,296 per year, though the team estimated savings based on 1,608 hours to account for any special events. Another facility was a library services building that the evaluation team assumed to have “Office” hours (3,253 AOH, 0.76 CF). Two additional measures at one site received different adjustments: the team determined that all lamps for one measure operated continually in common areas (8,760 AOH, 1.0 CF) and that lamps for the other measure were installed in exterior fixtures (4,300 AOH, 0.0 CF).
- CLEAResult calculated savings for three religious facilities based on values for the “Other” Indiana TRM (v2.2) facility type (4,408 AOH, 0.65 CF). Because churches tend to have much lower occupied hours than average buildings, the evaluation team aligned AOH with the “Assembly” facility type (2,867 AOH, 0.65 CF). (Compared with the Indiana TRM (v2.2), the Illinois TRM (v7) provides much lower lighting AOH values for religious buildings: 2,085 for fixtures and 1,664 for screw-base lamps.)

For Midstream delivery channel measures, where the wattage of the replaced lamp or fixture are often unknown at the time of sale and not reflected in the measure definition, the team also made *ex post* adjustments on a case-by-case basis to align baseline wattage and efficiencies with the UMP and current federal minimum requirements.[49] CLEAResult’s baseline wattage lookup tables appeared to be sourced from a memo prepared by CLEAResult for the 2016 evaluation (Core Engineering and CLEAResult

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[49] UMP; Government Publishing Office. Last modified April 1, 2020. “Electronic Code of Federal Regulations: Energy Conservation Program for Consumer Products.” https://www.ecfr.gov/cgi-bin/text-idx?SID=2fed8aa79758a538d0878801f58a3312&mc=true&node=se10.3.430_132&rgn=div8; Government Publishing Office. Last modified April 1, 2020. “Electronic Code of Federal Regulations: Part 431—Energy Efficiency Program for Certain Commercial and Industrial Equipment.” https://www.ecfr.gov/cgi-bin/text-idx?SID=d4564d0dc7aca6e97a8b4c1dcc774eb0&mc=true&node=pt10.3.431&rgn=div5

2017),[50] which described baseline wattage assumptions from a 2010 U.S. Department of Energy Market Lighting Characterization study. For this evaluation, the team determined baseline wattages for Midstream measures using the lumen equivalence method described in the UMP. This is the best practice for estimating the wattage of replaced equipment to determine program savings and is a more current approach than the 2010 Market Lighting Characterization study.

The lumen equivalence method assumes that customers purchase bulbs with similar lighting characteristics to those already installed and relies on maximum wattage requirements for bulbs, by lumens range, based on EISA 2007. The team used this method to determine baseline bulb wattages based on the lumen output of purchased bulbs (as provided in spec sheets for the installed fixtures or lamps), and sometimes found higher or lower lumens than CLEAResult's assumption.

Midstream Carryover Savings

In 2016, the evaluation team calculated the first-year ISR for the Midstream delivery channel as 79.1%, finding that program participants on average stored 20.9% of lighting units they received through the program. To account for the portion of these bulbs that participants would install in year two (2017), the team followed the installation schedule described in the UMP. This schedule assumes that 24% of stored bulbs will be installed in year two (and in each subsequent year), accounting for the carryover savings in 2017. The evaluation team has used this method to carry over savings from stored bulbs each year since 2016.

In addition to the year four carryover savings from 2016 and year three carryover savings from 2017, the evaluation team also counted year two carryover savings from 2018 in the 2019 *ex post* analysis. Table 243 shows the carryover savings for each year counted in 2019. The team incorporated these carryover savings into the 2019 *ex post* gross and net savings for the Prescriptive Rebates program.

Table 243. 2019 Prescriptive Rebates Program Carryover Savings Summary

Metric	Year Four Carryover Savings (from 2016)	Year Three Carryover Savings (from 2017)	Year Two Carryover Savings (from 2018)	Total Carryover Savings in 2019
***Ex Post* Gross**				
Energy Savings (kWh)	1,449,065	731,311	733,142	2,913,518
Demand Reduction (kW)	257	129	116	502
***Ex Post* Net**				
Energy Savings (kWh)	1,231,705	592,362	718,479	2,542,546
Demand Reduction (kW)	218	104	114	436

[50] Core Engineering and CLEAResult. January 2017. *Savings Methodology for Midstream Commercial Lighting Measures.*

Realization Rates

Table 244 shows the program realization rates and ISRs. The Non-Midstream delivery channel achieved a realization rate of 96.1% for energy savings and 103.4% for demand reduction. The Midstream delivery channel had lower realization rates of 89.6% for energy savings and 95.2% for demand reduction.

Table 244. 2019 Prescriptive Rebates Program Realization Rates

Delivery Channel	Realization Rate (*Ex Post* Gross/*Ex Ante*)		ISR	ISR Precision at 90% Confidence
	Electric Energy (kWh)	Peak Demand (kW)		
Non-Midstream	96.1%	103.4%	99.6%	±0.4%
Midstream	89.6%	95.2%	91.5%	±8.4%

Realization rates by measure type in the sample varied according to on-site and engineering review findings. Table 245 shows the aggregated *ex post* realization rates for each measure group in the sample.

Table 245. 2019 Prescriptive Rebates Program Evaluation Sample Results by Measure Type

Measure Category	Evaluation Sample Measure Count	Evaluation Sample Unit Count	Demand *Ex Post* Realization Rate	Energy *Ex Post* Realization Rate
Non-Midstream				
Lighting - LED - High-Bay	8	1,132	98%	80%
Lighting - TLED	16	12,730	106%	94%
Lighting - LED - Exterior	11	438	N/A	100%
Lighting - LED - Low Bay	3	1,393	113%	115%
Lighting - Controls	2	874	89%	119%
Other - Heating and Cooling Equipment	1	105	106%	103%
Other - Other	1	49	98%	99%
Midstream				
TLED	24	10,609	101%	94%
LED - GS	11	3,130	86%	74%
LED - Exterior	6	298	N/A	95%
LED - Reflector	2	258	64%	99%
LED - Other	1	400	94%	94%

The measure category realization rates in Table 245 do not explicitly describe the performance of these measures. The drivers described earlier in this section were not specific to any measure category, and some findings affected demand reduction differently from energy savings at the measure level. For example, though ISR has a proportional effect on both energy savings and demand reduction, adjustments to AOH impact demand reduction only if the coincidence factor is also changed. With one lighting measure that was incorrectly identified as an exterior measure, the change to interior lighting had minimal effect on AOH but a dramatic effect on demand reduction, which increased from no reduction to 23 kW.

It is also important to note that the realization rates in Table 245 are for the sample and were ***not*** applied to each measure type in the population to determine *ex post* gross savings. Table 245 is presented only to provide more insights about findings within the evaluation sample. To calculate the *ex post* gross impacts, the team applied each sample's energy and demand realization rates to the *ex ante* energy savings and demand reduction of the corresponding delivery channel, as shown in Table 246. The team calculated realization rates based on the sample and applied them to the population's *ex ante* impacts for each delivery channel.

Table 246. 2019 Prescriptive Rebates Program Realization Rates and *Ex Post* Gross Savings

Metric	*Ex Ante*	Realization Rate	*Ex Post* Gross
Non-Midstream			
Electric Energy Savings (kWh)	60,529,455	96.1%	58,157,795
Peak Demand Reduction (kW)	8,178	103.4%	8,452
Midstream			
Electric Energy Savings (kWh)	10,414,666	89.6%	9,331,968
Peak Demand Reduction (kW)	1,433	95.2%	1,364

Note: Values rounded for reporting purposes.

Ex Post Net Savings

The evaluation team calculated freeridership and spillover using the methods described in *Self-Report Net-to-Gross Methodology* and the survey data collected from 2019 participants. As shown in Table 247, we estimated a 90% NTG for the Prescriptive Rebates program.

Table 247. 2019 Prescriptive Rebates Program Net-to-Gross

Delivery Channel	Freeridership	Spillover	NTG	*Ex Post* Gross Population Program Energy Savings (kWh)
Non-Midstream	11% [a]	0%	89%	58,157,795
Midstream	7% [a]	0%	93%	9,331,968
Overall	**10% [b]**	**0%**	**90%**	**67,489,763**

[a] The team weighted Non-Midstream and Midstream freeridership by survey sample *ex post* gross energy savings.

[b] The team weighted overall freeridership by program population *ex post* gross energy savings.

The overall freeridership, spillover, and NTG for the 2019 Prescriptive Rebates program are heavily weighted toward the Non-Midstream delivery channel estimates due to the channel representing 86% of the total *ex post* gross population program kilowatt-hour savings. The overall NTG of 90% for the 2019 Prescriptive Rebates program is consistent with the *ex post* gross population program kilowatt-hour savings-weighted NTG average of 88% (100% - 12% freeridership + 0% participant spillover) for the 2018 Prescriptive Rebates program.

Freeridership

The overall 10% freeridership for the Prescriptive Rebates program is the population savings-weighted average of the delivery channel–specific freeridership estimates based on survey feedback (shown in Table 248). Each delivery channel freeridership estimate is an average of the savings-weighted *intention* and *influence* freeridership scores from respondents. Refer to *Self-Report Net-to-Gross Methodology* for further details on the *intention* and *influence* questions and scoring methodologies.

Table 248. 2019 Prescriptive Rebates Program Freeridership Results

Delivery Channel	Responses (n)	Freeridership	*Ex Post* Gross Population Program Savings (kWh)
Non-Midstream	37	11% [a]	58,157,795
Midstream	29	7% [a]	9,331,968
Overall	**66**	**10% [b]**	**67,489,763**

[a] The team weighted Non-Midstream and Midstream freeridership by survey sample *ex post* gross program kilowatt-hour savings.

[b] The team weighted overall freeridership by program population *ex post* gross energy savings.

The overall freeridership of 10% for the 2019 Prescriptive Rebates program is consistent with the 2018 *ex post* gross population program kilowatt-hour savings weighted freeridership average of 12% for the 2018 Prescriptive Rebates program.

Intention Freeridership

The evaluation team estimated *intention* freeridership scores for all participants based on their responses to the *intention*-focused freeridership questions. The team translated their responses into a matrix value and applied a consistent, rules-based calculation to obtain the final score. As shown in Table 249, the overall *intention* freeridership score for the Prescriptive Rebates program is 16%, similar to the 2018 evaluation result.

Table 249. 2019 Prescriptive Rebates Program *Intention* Freeridership Results

Delivery Channel	Responses (n)	*Intention* Freeridership Score
Non-Midstream	37	17% [a]
Midstream	29	11% [a]
Overall	**66**	**16% [b]**

[a] The team weighted the Non-Midstream and Midstream intention freeridership score by the survey sample *ex post* gross program energy savings.

[b] The team weighted the overall freeridership by the *ex post* gross population program energy savings.

Table 250 shows the unique Non-Midstream delivery channel participant response combinations resulting from the *intention* freeridership questions, along with the *intention* freeridership score assigned to each combination and the number of responses for each combination. An “x” indicates a question that was skipped because of the participant’s response to a previous question. The “Yes,” “Partial,” and “No” values in the table represent whether the respondent’s answer to a given question was indicative of freeridership.

Table 251 shows the unique Midstream delivery channel participant response combinations resulting from the *intention* freeridership questions, along with the *intention* freeridership score assigned to each combination and the number of responses for each combination.

Table 250. 2019 Prescriptive Rebates Program Non-Midstream Delivery Channel Frequency of *Intention* Freeridership Scoring Combinations

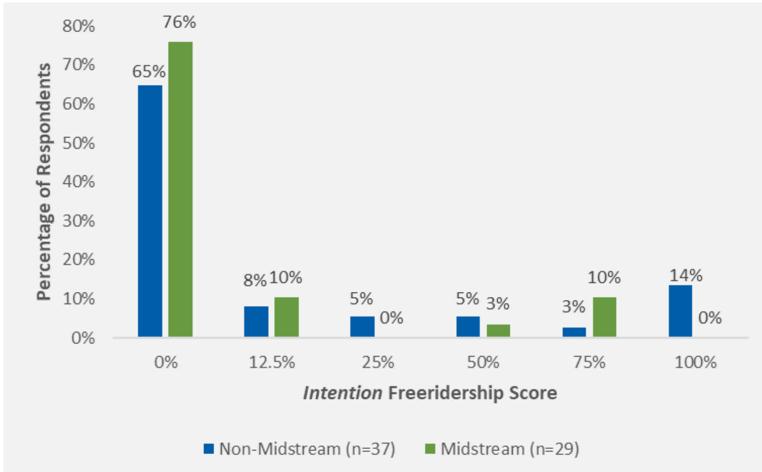
1. Installed same measure without incentive?	2. Already ordered or installed?	3 Already planning to purchase?	4. In capital budget?	[Ask if 1=No] 5. Confirm, would not have installed any measure?	6. Installed same quantity?	7. Installed same efficiency?	8. Installed at the same time?	8. Organization has ROI goal?	[Ask if 8=Yes] 10. Program incentive was key to meeting ROI goal?	Freeridership score	Response frequency
Yes	Yes	x	x	x	x	x	x	x	x	100%	4
Partial	Yes	x	x	x	x	x	x	x	x	100%	1
Yes	No	Yes	Yes	x	Partial	Yes	Yes	Yes	x	75%	1
Yes	No	Yes	No	x	Yes	Yes	Partial	Yes	x	25%	1
Yes	No	Partial	x	x	Yes	Yes	Yes	No	No	25%	1
Yes	No	Partial	x	x	Yes	Yes	No	x	x	0%	1
Yes	No	No	x	x	Yes	Yes	Yes	No	No	12.5%	1
Yes	No	No	x	x	Yes	Yes	Yes	Yes	x	50%	1
Yes	No	No	x	x	Partial	Partial	Yes	Yes	x	12.5%	1
Yes	No	No	x	x	Partial	No	x	x	x	0%	1
Partial	No	Yes	No	x	Partial	Partial	Partial	Yes	x	0%	1
Partial	No	Yes	No	x	No	x	x	x	x	0%	1
Partial	No	Partial	x	x	Yes	Yes	Yes	Yes	x	50%	1
Partial	No	Partial	x	x	Yes	Partial	Partial	Yes	x	12.5%	1
Partial	No	Partial	x	x	Partial	Partial	Partial	Yes	x	0%	1
Partial	No	No	x	x	Yes	Yes	No	x	x	0%	2
Partial	No	No	x	x	Yes	No	x	x	x	0%	1
Partial	No	No	x	x	Partial	Partial	Partial	Yes	x	0%	1
No	x	x	x	Yes	No	x	x	x	x	0%	1
No	x	x	x	Partial	Partial	No	x	x	x	0%	1
No	x	x	x	No	x	x	x	x	x	0%	13

Table 251. 2019 Prescriptive Rebates Program Midstream Delivery Channel Frequency of *Intention* Freeridership Scoring Combinations

1. Installed same measure without incentive?	2 Already planning to purchase?	[Ask if 1=No] 3. Confirm, would not have installed any measure?	4. Installed same quantity?	5. Installed same efficiency?	6. Installed at the same time?	7. Organization has ROI goal?	[Ask if 7=Yes] 8. Program incentive was key to meeting ROI goal?	Freeridership score	Response frequency
Yes	Yes	x	Yes	Yes	Partial	Yes	x	75%	2
Yes	Yes	x	Yes	No	x	x	x	0%	1
Yes	Yes	x	Partial	Yes	Yes	No	Yes	75%	1
Yes	Yes	x	Partial	Yes	Partial	Yes	x	50%	1
Yes	No	x	Partial	Yes	Partial	No	No	0%	1
Yes	No	x	Partial	Yes	Partial	Yes	x	12.5%	1
Yes	No	x	Partial	Partial	Yes	No	No	0%	1
Yes	No	x	Partial	Partial	Partial	Yes	x	0%	1
Partial	Yes	x	Partial	Partial	Partial	Yes	x	12.5%	1
Partial	Partial	x	Partial	Partial	Partial	Yes	x	0%	1
Partial	No	x	Yes	Yes	No	x	x	0%	1
Partial	No	x	Yes	Partial	Partial	Yes	x	0%	1
Partial	No	x	Partial	Yes	Yes	Yes	x	12.5%	1
Partial	No	x	Partial	Partial	Partial	Yes	x	0%	1
No	x	Yes	Partial	No	x	x	x	0%	1
No	x	No	x	x	x	x	x	0%	13

Figure 100 shows the distribution of *intention* freeridership scores by delivery channel.

Figure 100. Distribution of *Intention* Freeridership Scores by 2019 Prescriptive Rebates Program Delivery Channel



Influence Freeridership

The evaluation team assessed *influence* freeridership by asking participants how important various program elements were in their purchase decision. Table 252 shows program elements participants rated for importance, along with a count and average rating for each factor.

Table 252. 2019 Prescriptive Rebates Program *Influence* Freeridership Responses

Influence Rating	Influence Score	The IPL incentive / discount		The information provided by IPL on energy saving opportunities		Recommendation from contractor or vendor		Previous participation in an IPL energy efficiency program	
		Non-Midstream	Midstream	Non-Midstream	Midstream	Non-Midstream	Midstream	Non-Midstream	Midstream
1 - Not at all important	100%	0	0	0	1	1	2	2	2
2	75%	1	2	6	5	4	3	7	2
3	25%	12	7	19	11	13	13	6	8
4 - Very important	0%	23	20	8	8	17	9	6	6
Not applicable	50%	1	0	4	4	2	2	16	11
Average		**3.6**	**3.6**	**3.1**	**3.0**	**3.3**	**3.1**	**2.8**	**3.0**

We determined each respondent's *influence* freeridership rate by using the maximum rating provided for any factor in Table 252. As shown in Table 253, the respondents' maximum *influence* ratings ranged from 1 (*not at all important*) to 4 (*very important*). A maximum score of 1 means the customer ranked all factors from the table as *not at all important*, while a maximum score of 4 means the customer ranked at least one factor as *very important*. Counts refer to the number of "maximum *influence*" responses for each factor/*influence* score response option. The team weighted the average *influence* scores for both delivery channels by *ex post* kilowatt-hour program savings. The overall *intention* freeridership score for the Prescriptive Rebates program is 4% after weighting the delivery channel–specific *influence* freeridership scores by delivery channel *ex post* gross population program kilowatt-hour savings.

Table 253. 2019 Prescriptive Rebates Program *Influence* Freeridership Score

Maximum *Influence* Rating	*Influence* Score	Non-Midstream			Midstream		
		Count	Total Survey Sample *Ex Post* Savings (kWh)	*Influence* Score Savings (kWh)	Count	Total Survey Sample *Ex Post* Savings (kWh)	*Influence* Score Savings (kWh)
1 - Not at all important	100%	0	0	0	0	0	0
2	75%	0	0	0	0	0	0
3	25%	7	204,322	51,080	5	65,407	16,352
4 - Very important	0%	30	1,027,173	0	24	966,245	0
Not applicable	50%	37	1,231,495	51,080	29	1,031,652	16,352
Average Maximum Influence Rating - Simple Average				**Non-Midstream 3.8**			**Midstream 3.8**
Average Influence Score - Weighted by *Ex Post* Savings				**Non-Midstream 4%**			**Midstream 2%**

Final Freeridership

Next, we calculated the mean of the *intention* and *influence* freeridership components to estimate final freeridership for the program delivery channels.

$$Final\ Freeridership = \frac{Intention\ FR\ Score\ + Influence\ FR\ Score}{2}$$

The higher the freeridership score, the more savings are deducted from the gross savings estimates. Table 254 shows the *intention*, *influence*, and final freeridership scores by delivery channel.

Table 254. 2019 Prescriptive Rebates Program Freeridership Score

Delivery Channel	Responses (n)	*Intention* Score	*Influence* Score	Freeridership Score
Non-Midstream	37	17% [a]	4% [a]	11%
Midstream	29	11% [a]	2% [a]	7%
Overall	**66**	**16% [b]**	**4% [b]**	**10%**

[a] The team weighted the Non-Midstream and Midstream *intention* and i*nfluence* freeridership scores by the survey sample *ex post* gross program energy savings.

[b] The team weighted the overall *intention* freeridership by the *ex post* gross population program energy savings.

Spillover

The evaluation team estimated spillover measure savings using specific information about participants determined through the evaluation, and relying on the Indiana TRM (v2.2) as a baseline reference. We estimated the percentage of program spillover by dividing the sum of additional spillover savings (as reported by survey respondents) by the total gross savings achieved by all program respondents. The spillover estimates by delivery channel are shown in Table 255.

Table 255. 2019 Prescriptive Rebates Program Spillover

Delivery Channel	Spillover Savings (kWh)	Participant Program Savings (kWh)	Spillover
Non-Midstream	3,908	1,231,495	0%
Midstream	0	1,031,652	0%

One Prescriptive Rebates program Non-Midstream delivery channel participant rated the overall program as *very important* in their decisions to install additional high-efficiency measures for which they did not receive a rebate from IPL. Table 256 shows the additional spillover measures and the total resulting energy savings. Because it amounts to less than one percent (0.31%), spillover equals zero.

Table 256. 2019 Prescriptive Rebates Program Spillover Measures, Quantity, and Savings

Delivery Channel	Spillover Measures	Quantity	Total Energy Savings (kWh)
Non-Midstream	LEDs	96	3,908
	Total	**96**	**3,908**

Table 257 summarizes the percentage of freeridership, spillover, and NTG by delivery channel and for the Prescriptive Rebates program overall.

Table 257. 2019 Prescriptive Rebates Program Net-to-Gross Results

Delivery Channel	Responses (n)	Freeridership	Spillover	NTG	*Ex Post* Gross Population Program Savings (kWh)
Non-Midstream	37	11% [a]	0%	89%	58,157,795
Midstream	29	7% [a]	0%	93%	9,331,968
Overall	**66**	**10% [b]**	**0%**	**90%**	**67,489,763**

[a] The team weighted the Non-Midstream and Midstream freeridership scores by the survey sample *ex post* gross program energy savings.

[b] The team weighted the overall freeridership by the *ex post* gross population program energy savings.

Evaluated Net Savings Adjustments

Table 258 shows the energy savings, realization rate, and NTG for the Prescriptive Rebates program.

Table 258. 2019 Prescriptive Rebates Program *Ex Post* Net Savings

Program Category	*Ex Post* Gross Energy Savings and Demand Reduction		NTG		*Ex Post* Net Energy Savings and Demand Reduction	
	kWh	kW	kWh	kW	kWh	kW
Prescriptive Non-Midstream Program	58,157,795	8,452	89%	89%	51,760,438	7,522
Midstream Program	9,331,968	1,364	93%	93%	8,678,731	1,268
Subtotal	**67,489,763**	**9,816**	**90%**	**90%**	**60,439,168**	**8,790**
2016-2018 Midstream Carryover Savings	2,913,518	502	87%	87%	2,542,546	436
Program Total	**70,403,281**	**10,317**	**89%**	**89%**	**62,981,714**	**9,227**

Process Evaluation

This section describes process findings for the Prescriptive Rebates program from the evaluation team's database review, participant surveys, and stakeholder interviews.

Program Delivery

As in 2018, the program exceeded its 2019 *ex ante* energy-savings and demand reduction goals while staying under the program budget. The program achieved this success in 2019 despite decreasing its outreach and marketing efforts. CLEAResult indicated that because the Prescriptive Rebate program has historically exceeded its savings and demand goals, it shifted emphasis to engaging customers to participate in the Custom Incentives program, and therefore staff were less focused on outreach for the Prescriptive Rebates program in 2019 than in previous years.

The program design was similar to 2018. IPL offered prescriptive or custom incentives to customers who implemented eligible energy-saving measures. IPL offered rebates for dozens of prescriptive measures, such as efficient lighting, heating and cooling, refrigeration, pumps and drives, and commercial kitchen equipment. A subset of the Prescriptive Rebates program lighting rebates are delivered by distributors through a Midstream delivery channel, where the distributor deducts the incentive amount from the product price and IPL reimburses the distributor.

In 2019, the Midstream delivery channel measures accounted for 15% of the total Prescriptive Rebates program's *ex ante* kilowatt-hour savings (the same as in 2018) and 15% of the 2019 *ex ante* demand reduction (compared with 17% in 2018). Midstream delivery channel measures used 14% of the total 2019 Prescriptive Rebates program incentives budget, compared with 10% in 2018.

Program Application Process

Non-Midstream delivery channel customers can complete their applications via email or an online application portal that is available for Prescriptive Rebates, Custom Incentives, and SBDI program incentives. The online application portal can serve as a useful tool that allows customers to verify that their equipment meets the program requirements and to track their application status. However, the IPL program manager and CLEAResult reported that most customers completed program applications via email rather than the online application portal. In response to a recommendation from the 2018 evaluation for CLEAResult to flag areas where customers or contractors typically encounter issues with the application form or process, CLEAResult held a training in 2019 for its energy advisors and call center staff to discuss how to answer common customer questions. CLEAResult did not track a change in application errors but anecdotally assessed that the training helped to reduce the number of application errors and increased the efficiency of processing applications. CLEAResult intends to offer staff training on the applications on an as-needed basis. As explained in Table 260, CLEAResult did not make changes to the application in 2019.

Midstream delivery channel distributors apply for reimbursement via email and do not have access to an application portal; CLEAResult said the Midstream delivery channel application process works smoothly.

Program Marketing and Outreach

CLEAResult thought targeted emails were the most effective marketing strategy in 2019. While CLEAResult has traditionally relied on trade allies to market the Non-Midstream incentives to customers, CLEAResult also worked with IPL in 2019 to develop a strategic list of customers, including past program participants, to send direct marketing emails for the Prescriptive Rebates program. CLEAResult sent a program kick-off email in April to 1,758 customers to explain program changes and opportunities for savings, and CLEAResult sent an email later in the year to 491 customers encouraging project completion and application submissions. These customers emails had an average open rate of 25%. CLEAResult also sent an email to trade allies encouraging project completion and application submissions, with an email open rate of 27%.

Participation distributors to market the Midstream delivery channel to contractors. CLEAResult solicited distributor feedback in 2019 to identify participation barriers with the Midstream delivery channel and how to overcome those barriers. CLEAResult learned that the sales limit set by IPL for each distributor hindered some of them, who worried they would exceed their sales quotas if they marketed the program to customers. As a result of this finding, CLEAResult revised the sales quota for each distributor and reported that this change led to an uptick in program participation levels. However, the evaluation team found that Midstream 2019 savings fell slightly compared to 2018.

Program Key Performance Indicators

In addition to its energy savings and participation goals, CLEAResult tracked key performance indicators related to program delivery, shown in Table 259. IPL revised one of CLEAResult's key performance indicators from 2018 to 2019: the target time period to complete rebate applications increased from 15 business days to 20 business days. The increase in this target time period stemmed from CLEAResult adding a requirement that measure installation must be validated prior to the payment being made. CLEAResult achieved all goals, except to increase the trade ally network by 5% annually (no growth achieved). CLEAResult indicated that due to the increased emphasis on marketing and outreach for the Custom Incentive program, staff were less focused on trade ally outreach for the Prescriptive Rebates program in 2019 than in previous years.

Table 259. 2019 Prescriptive Rebates Program Service-Level Key Performance Indicators

Service Level	Key Performance Indicator	2019 Result
QA/QC Site Verification	100% site verification for self-installed projects with rebate payments ≥$1,000, all projects with rebate payments ≥$20,000, and 5% of random selection for all other projects	Reached goal
Trade Ally Network	Increase number of participating trade allies by 5% annually (from 204 participating trade allies in 2018)	Did not reach goal (achieved 198 participating trade allies)
Incomplete Notice	Send an incomplete notice within five business days of receiving application	Reached goal
Rebate Payment	Issue 100% of rebate payments within 20 business days of receiving application	Reached goal

Source: December 2019 CLEAResult scorecard and program tracking data.

Changes from 2018 Design

IPL made a few changes to the Prescriptive Rebates program's incentive offerings in 2019, primarily to align with market conditions and baseline replacements:

- Discontinued incentives for traffic signals and T5 parking garage fixtures replacing high-intensity discharge (HID) fixtures
- Introduced incentives for Non-Midstream delivery channel lighting measures:
  - LEDs replacing T8 high bay/low bay
  - LED 4-foot tubes replacing T5HO
  - Channel signage
  - Networked lighting controls
- Introduced incentives for Midstream delivery channel lighting measures:
  - T5 and T5HO 4-foot tube replacements
  - 1x4 troffers and retrofit kits
  - HID to LED high bay/low bay retrofit kits or mogul screw base
  - HID to LED exterior retrofit kits or mogul screw base
- Updated efficiency requirements for high-efficiency pumps
- Decreased lighting incentive amounts:
  - High bay LED replacing 251-watt to 400-watt HID incentive declined from $190 to $150
  - High bay LED replacing >400-watt HID incentive declined from $250 to $200
  - 4-foot 10 lamp T5HO replacing 1,000-watt HID incentive declined from $213 to $210
  - 4-foot 12 lamp T5HO replacing 1,000-watt HID incentive declined from $179 to $175
  - 1x4 troffers and retrofit kits incentive declined from $15 to $12
  - 2x4 troffers incentive declined from $50 to $35

CLEAResult worked to streamline the Prescriptive Rebates program project process in 2019 by training its energy advisors to be the main points of contact at all stages of the project, rather than handing customers off to CLEAResult engineers midway through a project. Each program trade ally is assigned an energy advisor, who pursues project leads, verifies that customers qualify for the program, and assists customers or contractors with their applications if necessary.

The IPL program manager and CLEAResult mentioned two program changes for future program years:

- In 2020, IPL will add a bonus prescriptive incentive for certain measures if the customer had previously participated in an SBDI audit.
- CLEAResult is working to identify new opportunities for energy savings as savings opportunities for lighting measures decline.

An additional effort CLEAResult initiated in 2018 began to bear fruit in 2019: to reduce the number of lamps customers were purchasing and storing through the program, IPL and CLEAResult implemented language around storage in the customer agreement and called participating customers to confirm all measures were installed. When customers reported they'd stored some measures, CLEAResult would periodically call these customers back to check on status of stored measures. This effort reduced the percentage of lamps in storage and generated a more immediate energy savings benefit.

Follow-Up on 2018 Evaluation Recommendations

The evaluation team discussed program status with IPL and CLEAResult to follow up on the recommendations made during the 2018 evaluation; the status of each is shown in Table 260.

Table 260. Prescriptive Rebates Program 2018 Recommendation Status

2018 Recommendation	2019 Follow Up
Flag areas where participants or contractors typically encounter issues with the application form or process. For areas of issues found in customer-submitted applications, revise the application instructions. For issues found in contractor-submitted applications, provide support through contractor training.	***Partially Completed***. CLEAResult and IPL did not change the application forms. IPL said the Prescriptive Rebates program application collects the right level of information needed for program evaluation without being too burdensome for customers. CLEAResult instead trained energy advisors and its call center staff on all application types and how to answer common customer and contractor questions about the applications.
In the tracking database, capture information about heating and cooling systems. The Indiana TRM (v2.2) classifies interactive effects for five HVAC types: AC with Gas Heat, Heat Pump, AC with Electric Heat, Electric Heat Only, and Gas Heat Only/Exterior. On program applications, prompt participants or contractors to record HVAC type prior to rebate processing. Alternatively, consider a more conservative estimate for WHF that accounts for heating fuel distribution in the commercial building population.	***Rejected/Not Completed.*** IPL does not intend to add HVAC type to the tracking database due to challenges in verifying that the customer reports the correct HVAC system type or that the installation specialist recorded the correct HVAC system type. IPL had not yet considered, but is willing to consider, a more conservative estimate for WHF that accounts for heating fuel distribution for the commercial building population.
Where possible, use the Indiana TRM (v2.2) building descriptors for AOH and coincidence factor lookups that best describe the space-specific location within a building where lighting measures are installed. Use business operating hours to better inform which building type look-up is appropriate (for example, a small dentist's office will have hours of use closer to an "Office" (3,253) than to a "Healthcare" facility (6,802).	***Partially Completed.*** CLEAResult used the Indiana TRM (v2.2) values but maps some of its own descriptors to these values instead of always using the TRM descriptors. Building types assigned to each facility sometimes appeared to be chosen to best represent actual business hours, but often they map literally to the closest broad category of the facility—such as "retail" for a hair salon or "healthcare" for a medical office. In both examples, the literal mapping provides a much higher AOH value than supported by typical office hours.
Use the Indiana TRM (v2.2) "Assembly" building descriptor to determine AOH and coincidence factor for religious buildings to avoid overstating energy savings.	***Not Completed.*** IPL will consider this recommendation for 2020.
Align lighting and HVAC algorithms to reflect the proper baseline efficacy and efficiency standards based on current federal regulations (also refer to the UMP). This effects general-service screw-base and fluorescent tube fixtures (TLEDs).	***Not Completed***. Some, but not all, values match the EISA lookup table values.

2018 Recommendation	2019 Follow Up
Move new construction lighting measures to the Custom Incentives program to allow for more robust engineering calculations for determining savings. Alternatively, incorporate a prescriptive algorithm designed for the lighting power density reduction methodology.	***Completed.*** CLEAResult reported that new construction lighting measures are mostly offered through the Custom Incentives program, with just some measures being offered through the Prescriptive Rebates program. The evaluation team found that 2019 saw a large increase in whole-building new construction projects allocated to the Custom program.

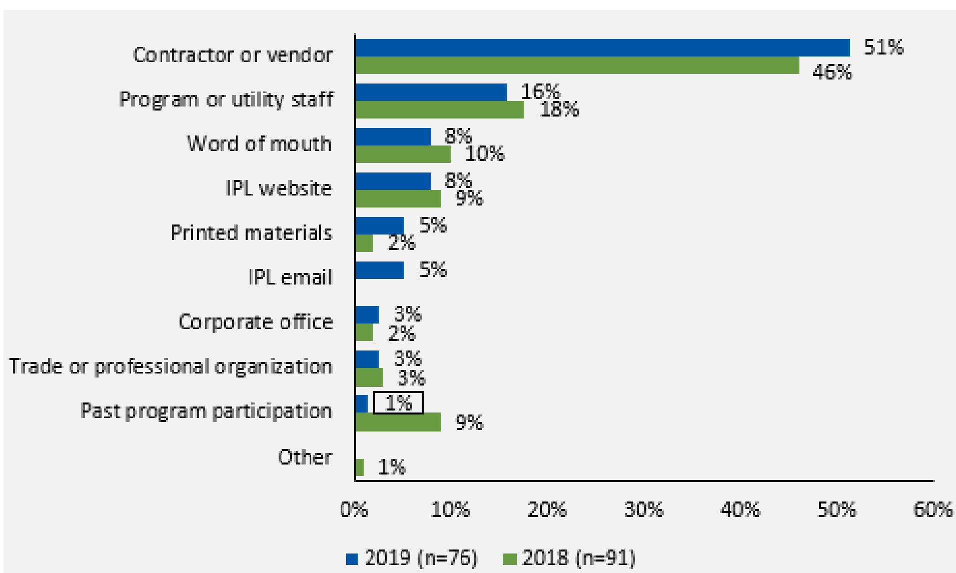
Participant Feedback

In January 2020, after removing duplicate emails, the evaluation team sent survey invitations to 759 businesses that participated in the Prescriptive Rebates program through either the Non-Midstream (n=517) or Midstream (n=242) delivery channel. After accounting for bounced emails, there were 632 reachable businesses (423 Non-Midstream and 209 Midstream contacts). Email was sufficient to achieve 40 Non-Midstream delivery channel participants (a 9% response rate). In total, the evaluation team received responses from 36 Midstream delivery channel participants (a 17% response rate).

Energy Efficiency Awareness and Marketing

In 2019, respondents most commonly heard about the Prescriptive Rebates program through their contractor or vendor (51%). As shown in Figure 101, this was also the most common source of awareness in 2018. Other sources of awareness in 2019 included program or utility staff (16%) and word of mouth (8%). Despite CLEAResult's email outreach to customers about the program, just 5% of customers learned about the program from email. IPL email was not an answer choice in the 2018 survey.

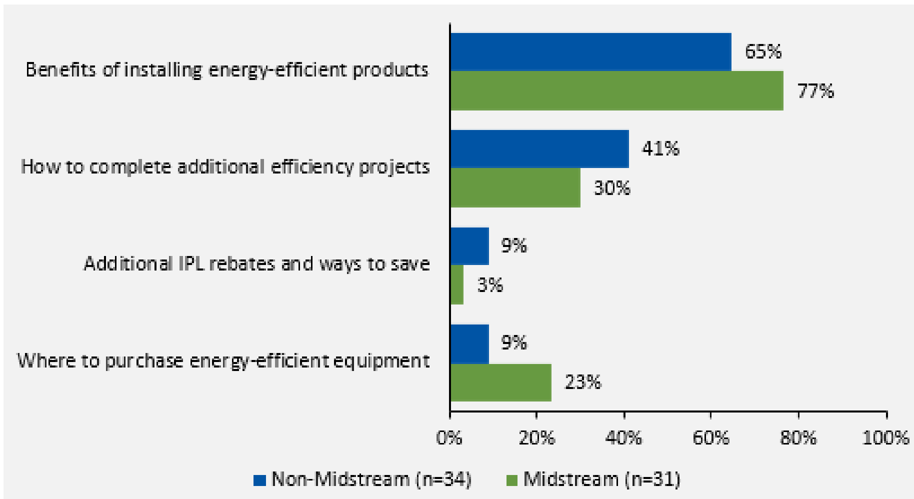
Figure 101. 2019 Prescriptive Rebates Program Source of Awareness



Source: 2018 and 2019 Participant Survey Question B1. "How did you first learn about IPL's Prescriptive Rebates program?" The response with a boxed rating significantly differed from the previous period results at the 95 percent level (p<0.05).

Most 2019 respondents (89%, n=75) said they received enough information about the Prescriptive Rebates program. As shown in Figure 102, respondents most commonly said the most helpful program information they received was about the benefits of installing energy-efficient equipment (65% Non-Midstream and 77% Midstream). Differences in responses between delivery channels were not statistically significant.

Figure 102. Most Helpful Information Provided about 2019 Prescriptive Rebates Program

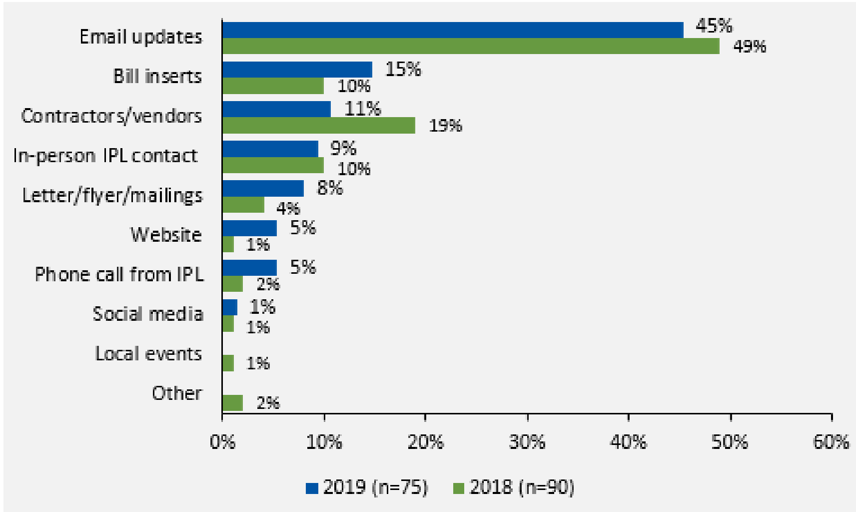


Source: 2019 Participant Survey Question B7. "What was the most helpful information you received about the program?" Multiple response allowed.

However, 13% of respondents (four Midstream and six Non-Midstream) said they did not receive enough information about the program. When asked what information they would have found helpful, these 10 respondents most commonly suggested information on other IPL rebates (nine of 10), followed by how to complete additional efficiency projects (two respondents).

When asked the best ways that IPL could keep organizations informed about energy-saving opportunities, 45% preferred email updates. As shown in Figure 103, this was also the most common requested form of outreach in the 2018 evaluation. In addition, 15% preferred IPL bill inserts and 11% preferred to hear from contractors or vendors (down from 19% in 2018, which is notable but not significant).

Figure 103. 2019 Respondents' Preferred Means of Staying Informed about IPL Energy-Saving Opportunities

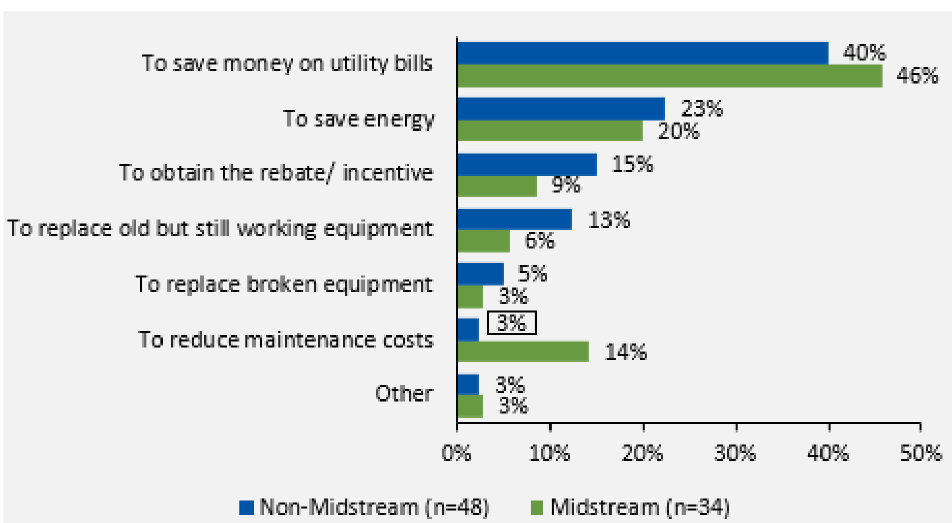


Source: 2018 and 2019 Participant Survey Question B4. "In your opinion, what is the best way for IPL to keep companies like yours informed about opportunities to save energy and money?"

Participation Drivers

The most common driver of participation across delivery channels in 2019 was saving money on utility bills (41%), followed by saving energy (21%) and obtaining the incentive (8%). Figure 104 shows the 2019 participation motivations for each delivery channel. Significantly more Midstream (14%) than Non-Midstream customers wanted to reduce their maintenance costs (3%). While more Non-Midstream than Midstream delivery channel customers wanted to replaced old but still working equipment, the difference was not statistically significant.

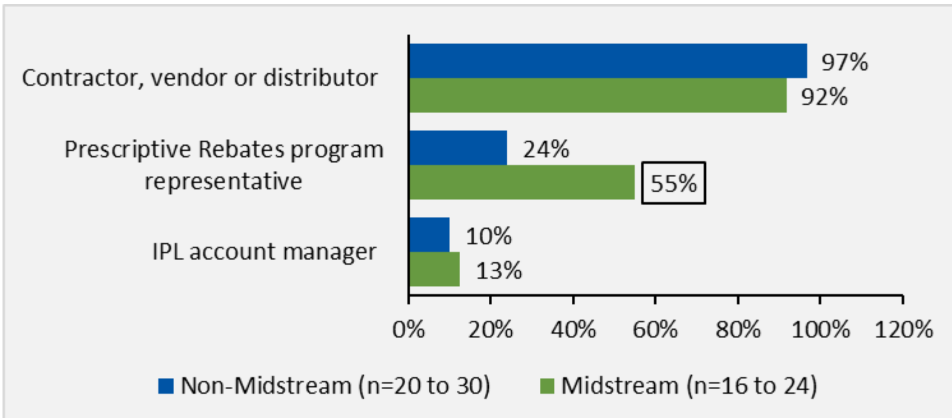
Figure 104. 2019 Prescriptive Rebates Program Participation Drivers by Delivery Channel



Source: 2019 Participant Survey Question C1. "What factor was most important in your decision to make energy-saving improvements through this program?" The response with a boxed rating significantly differed from the previous period results at the 95 percent level (p<0.05).

Prescriptive Rebates program respondents identified contractors, vendors, and distributors as the most common person to help them plan or initiate their energy efficiency project (Figure 105). Also, more respondents said they worked with a Prescriptive Rebates program representative than with an IPL account manager. These findings are similar to 2018 results, when 90% were helped by a contractor, vendor, or distributor while 50% were helped by a program representative and 14% were assisted by an IPL account manager.

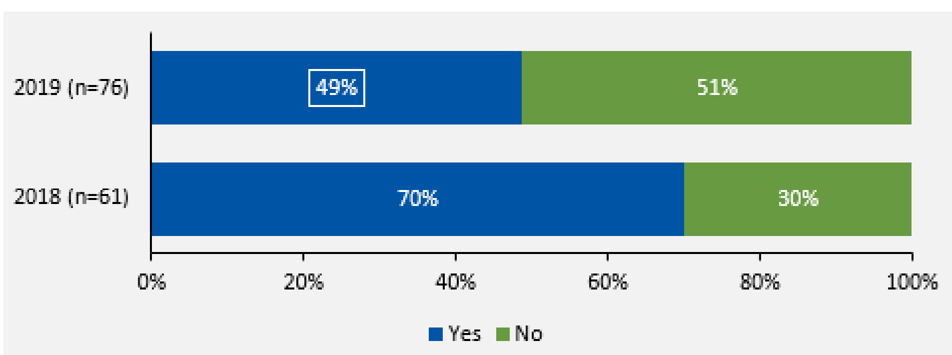
Figure 105. Sources of 2019 Prescriptive Rebates Program Project Initiation



Source: 2019 Participant Survey Question B5. “Who, if anyone, was involved in helping you plan or initiate your energy efficiency project?” Multiple responses allowed. The response with a boxed rating significantly differed from the previous period results at the 95 percent level (p<0.05).

Just over half (53%) of respondents said they were considering implementing other energy-efficient upgrades within the next year, which is a significantly lower percentage compared with 2018 (70%; Figure 106). Responses did not vary significantly between Non-Midstream and Midstream customers.

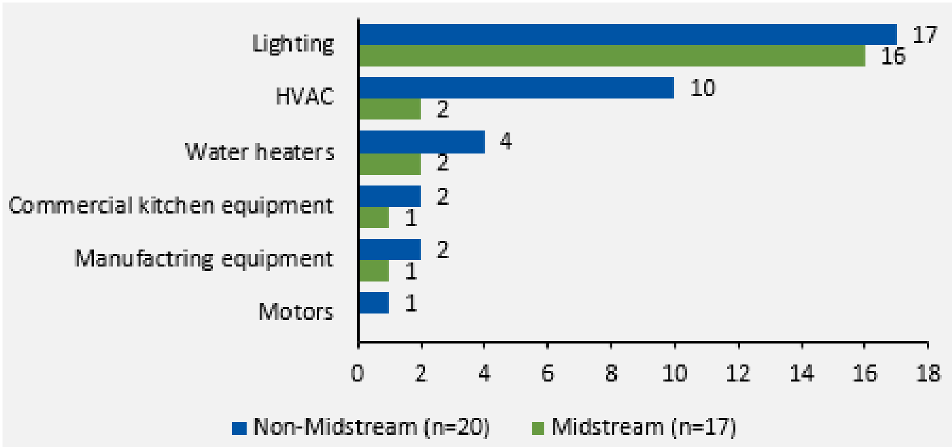
Figure 106. 2019 Prescriptive Rebates Program Respondents Considering Additional Upgrades



Source: 2018 and 2019 Participant Survey Question B2. “Besides the [MEASURE] rebate you received from the program for energy-efficient technology, are you considering implementing other energy-efficient building upgrades in the next year?” The response with a boxed rating significantly differed from the previous period results at the 95 percent level (p<0.05).

Of the 37 respondents considering upgrades within the next year, 89% were interested in lighting and 32% were interested in HVAC. Others were considering new water heaters (16%), kitchen equipment (8%), or manufacturing equipment (8%). Figure 107 shows how interest in equipment type varies by delivery channel, with Non-Midstream respondents showing more interest in HVAC upgrades than Midstream respondents.

Figure 107. Future Upgrades Considered by 2019 Prescriptive Rebates Program Respondents

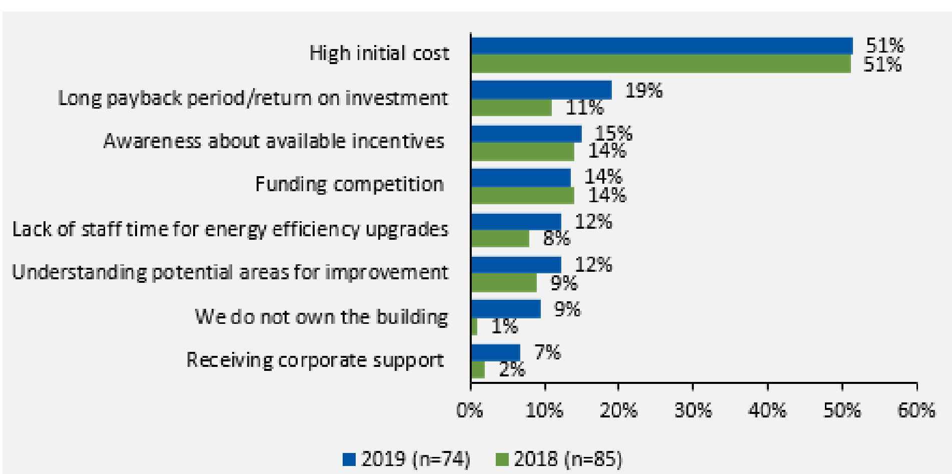


Source: 2019 Participant Survey Question B3. "What other equipment types or technologies are you considering?

Participation Barriers

Businesses faced many challenges with improving the energy efficiency of their facilities. As shown in Figure 108, high initial project costs was the biggest barrier for 2019 respondents (51%), which was also the most common barrier in 2018. Other common challenges included long payback period or return on investment (19%), lack of awareness of available incentives (15%), and funding competition with other facility improvements (14%). Fourteen percent of respondents said their facilities do not face challenges or barriers. No 2019 responses were significantly different from 2018 responses.

Figure 108. 2019 Prescriptive Rebates Program Participants' Challenges to Becoming More Energy Efficient



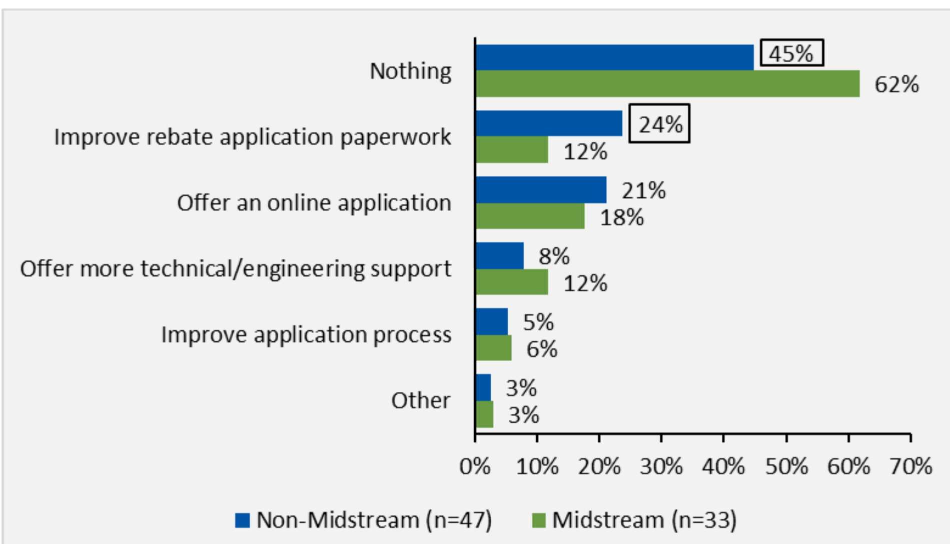
Source: 2018 and 2019 Participant Survey Question D1. "What are the most significant challenges at your facility in becoming more energy efficient?" Multiple responses allowed.

When asked, 14% of respondents (n=71) said they experienced a specific challenge with participating in the Prescriptive Rebates program (with some respondents reporting more than one challenge):

- Completing the application process (three respondents)
- Understanding the application process (three respondents)
- Knowing who to contact with questions (three respondent)
- Working with their contractor (two respondents)
- Understanding equipment eligibility (two respondents)
- Finding the time to complete projects (one respondent)

These respondents were also asked what IPL could do, other than increase incentives, to help companies overcome challenges with program participating. As shown in Figure 109, 45% of Non-Midstream respondents and 62% of Midstream respondents did not provide a suggestion (this was a statistically significant difference). Significantly more Non-Midstream respondents suggested improving rebate application paperwork (24%, compared with 12% of Midstream respondents). The results did not vary significantly from 2018. Each of the respondents who suggested improving the application paperwork completed lighting projects through the program and received their rebate application via mail. Only 18% of Non-Midstream respondents reported that they received their rebates as an instant discount from their contractor on their project invoice, and none of these customers suggested that the improvements for the rebate application paperwork.

Figure 109. 2019 Prescriptive Rebates Program Responses of Non-Incentive Ways for IPL to Help

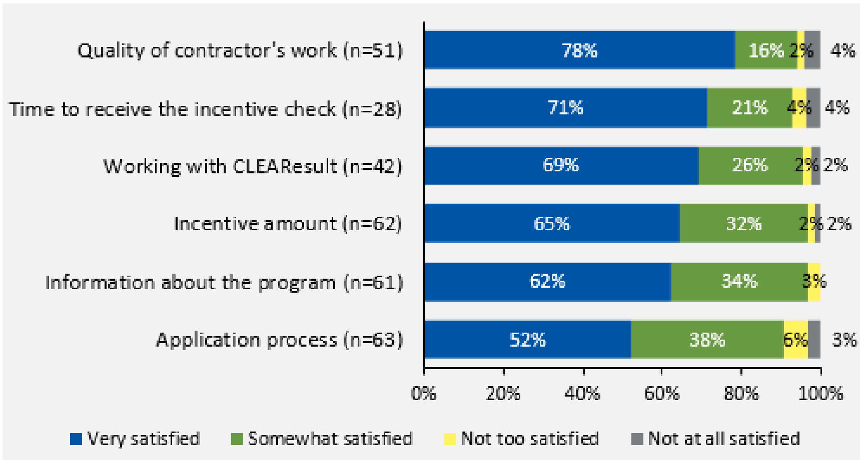


Source: 2019 Participant Survey Question D4. "Besides increased incentives, what could IPL have done to help your company overcome the challenges you faced on this project?" Multiple response allowed. Responses with boxed ratings significantly differed from the comparison ratings at the 95 percent level (p<0.05).

Satisfaction with Program Processes

Survey respondents rated their satisfaction with different program components. As shown in Figure 110, respondents gave high satisfaction ratings overall, with 90% to 97% being *very satisfied* or *somewhat* *satisfied* with all program components. 2019 respondents were most satisfied with the quality of the contractors' work (78% *very satisfied* and 16% *somewhat satisfied*, compared with 87% and 13% in 2018, respectively) and were least satisfied with the program application process (52% *very satisfied* and 38% *somewhat satisfied*, compared with 54% and 38% in 2018, respectively). The 2019 satisfaction ratings for each program component were statistically consistent with the 2018 satisfaction ratings.

Figure 110. Customer Satisfaction with 2019 Prescriptive Rebates Program Components

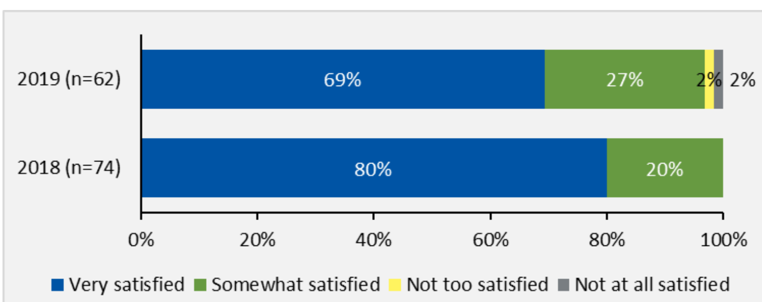


Source: 2019 Participant Survey Question H1. "Please rate your level of satisfaction with each of these components…" The evaluation team omitted participants who responded "not applicable."

Overall Satisfaction and Benefits of Program Participation

Participants expressed high levels of satisfaction with the program overall, with 97% being either *very satisfied* or *somewhat satisfied*, as shown in Figure 111. The percentage of *very satisfied* respondents decreased from 80% in 2018 to 69% in 2019, but this change was not statistically significant. There was no notable difference in overall satisfaction between the 2019 Midstream (73% *very satisfied*) and Non-Midstream (67% *very satisfied*) respondent groups. The two participants who were *not too satisfied* or *not at all satisfied* explained they provided that rating due to issues with their contractor: one felt that contractors only promote the program to benefit themselves, and another was charged $10 per bulb by his contractor after being initially told that the contractor would install the bulbs for free.

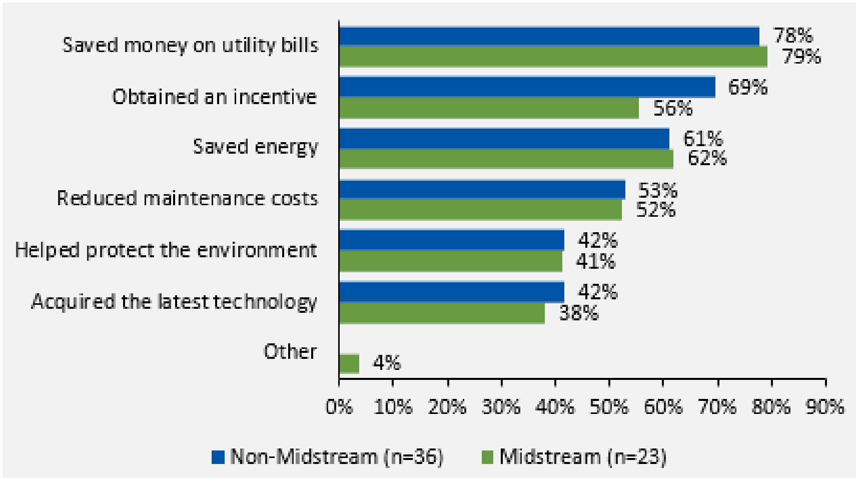
Figure 111. Overall 2018 and 2019 Prescriptive Rebates Program Satisfaction



Source: 2018 and 2019 Participant Survey Question H1.7 "How satisfied are you with the program overall? Would you say you are…"

Participants most commonly said their organization benefited from the program by saving money on their utility bills (78%), obtaining the program incentive (69%), and saving energy (61%; Figure 112).

Figure 112. Benefits of 2019 Prescriptive Rebates Program Participation by Participation Group

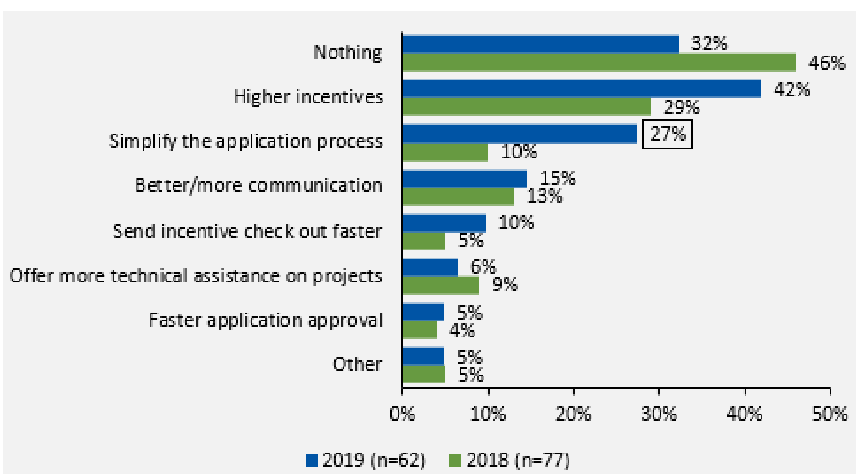


Source: 2019 Participant Survey Question H3. "How has your company benefitted from participating in IPL's energy efficiency program?" Multiple responses allowed. Responses with boxed ratings significantly differed from the previous period results at the 95 percent level (p<0.05).

Suggestions for Improvement

When asked how to improve the Prescriptive Rebates program, 68% of respondents provided a suggestion. As shown in Figure 113, respondents most commonly suggested higher incentives (42%), followed by simplifying the application process (27%) and providing better or more communication (11%).

Figure 113. 2019 Prescriptive Rebates Program Respondents' Suggestions for Improving Overall Prescriptive Rebates Program Experience



Source: 2019 Participant Survey Question H4. "Is there anything IPL could have done to improve your overall experience with the program?" Multiple responses allowed. The response with a boxed rating significantly differed from the previous period results at the 95 percent level (p<0.05).

When asked, six respondents gave suggestions for how to improve the application process or paperwork (multiple responses allowed): provide an online application portal (four respondents), simplify the application or provide better training on how to complete it (two respondents), and provide realistic estimates for the time required to complete the application (one respondent). One respondent who suggested simplifying the application specified that the HVAC portion of the application needs simplification.[51]

When asked, five respondents had suggestions for how IPL could improve communication (one suggestion per respondent):

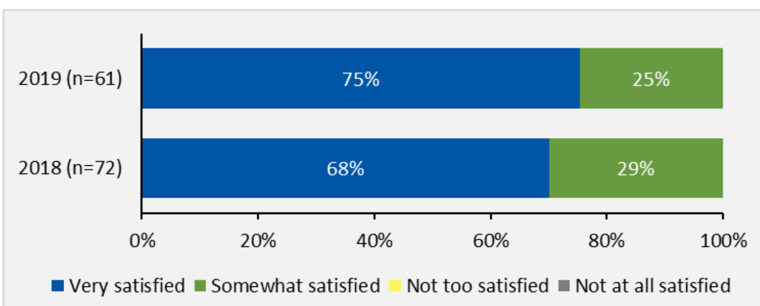
- Be more proactive in providing updates and returning calls (three respondents)
- Involve the vendors in communication efforts (one respondent)
- Expand methods of outreach to email (one respondent)

The team asked respondents who suggested sending out incentive checks faster about an acceptable timeline. Four of six considered two weeks to be reasonable, while one said four weeks is acceptable and one said one week is acceptable.

Satisfaction with IPL

Most Prescriptive Rebates program participants were satisfied with IPL as their business' energy provider, with 100% rating themselves as *very satisfied* or *somewhat satisfied* (Figure 114).

Figure 114. 2019 Prescriptive Rebates Program Respondent Satisfaction with IPL as an Energy Provider



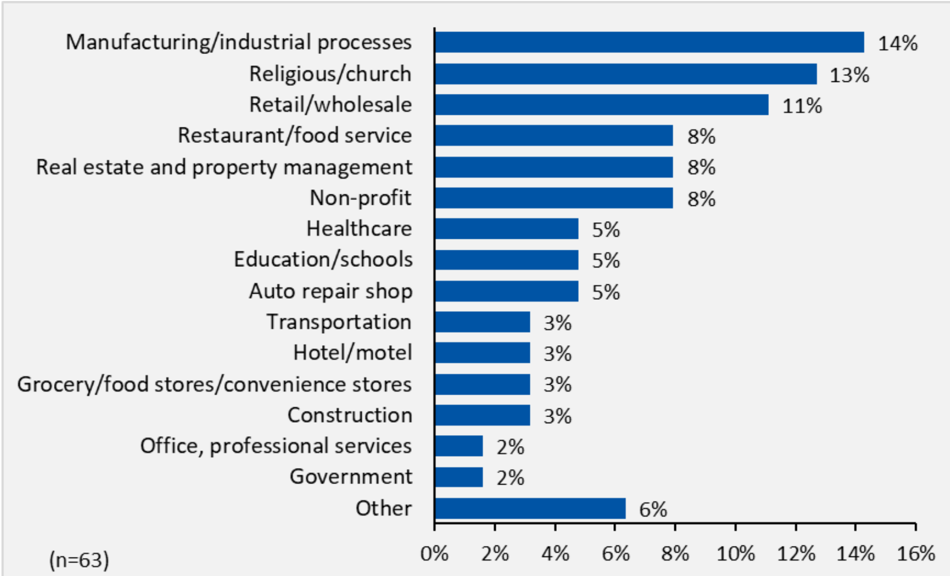
Source: 2018 and 2019 Participant Survey Question H1.8. "How satisfied are you with IPL overall as a provider of energy service to your business?"

Participant Firmographics

The evaluation team asked survey respondents about various aspects of their business and the facility in which they operate. As shown in Figure 115, respondents work in a variety of industries, the most common being manufacturing or industrial processes (16%), religious facilities (13%), real estate and property management (9%), non-profits (9%), and schools (9%).

51 Business customers and their contractors can submit applications online through the Prescriptive Rebates program website: https://www.iplpower.com/Ways_to_Save/Business/Rebates/Prescriptive_Rebates/.

Figure 115. 2019 Prescriptive Rebates Program Respondents by Business Sector

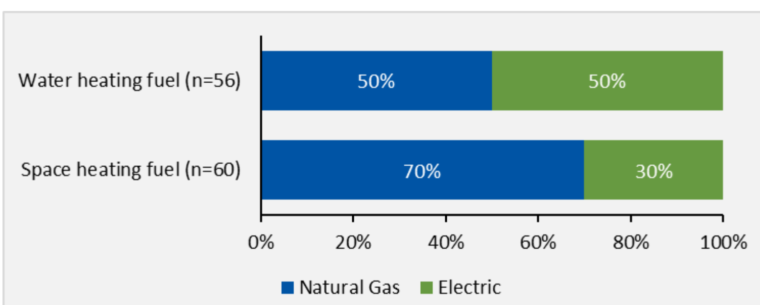


Source: 2019 Participant Survey Question H1. "What industry is your company in?"

The majority of respondents owned their facility (73%, n=60) and 27% leased their facility. Prescriptive Rebates program respondents also reported their approximate facility square footage. Sixty percent of facilities were 50,000 square feet or less: 33% are 10,000 square feet or less and 27% were between 10,001 and 50,000 square feet. Fourteen percent (n=63) were in a facility over 100,000 square feet, with an additional 14% in a facility between 50,001 and 100,000 square feet.

As shown in Figure 116, most facilities use natural gas for general facility heating (70%). For water heating, fuel type is split between natural gas (50%) and electric (50%).

Figure 116. 2019 Prescriptive Rebates Program Respondents' Main Fuel Type for Space and Water Heating



Source: 2019 Participant Survey Questions H3 and H4. "What is the main fuel type used for heating the facility?" and "What is the main fuel type used for water heating at the facility?"

Conclusions and Recommendations

Conclusion 1. Customer satisfaction with the program remains high and the program operated smoothly, in part due to enhancements in CLEAResult operations. Opportunity exists to further improve customer satisfaction and application processing efficiency by training contractors to complete rebate applications as a service to their customers.

Survey respondents reported high overall program satisfaction ratings, with 96% saying they were *very* or *somewhat satisfied*, and the program met its energy savings and demand reduction goals along with its KPIs for rebate payment processing times and notice of incomplete rebate applications.

However, improving the incentive application process or paperwork remains a common suggestion despite CLEAResult's efforts to train its staff on how to address customers' application questions. When asked to rate their satisfaction with various program aspects, customers were least satisfied with application process (9% were *not too satisfied* or *not at all satisfied*). When asked what IPL could have done to overcome project challenges, customers most commonly suggested that IPL improve the application paperwork (27%) or improve the application process (5%).

Training contractors to handle the rebate application paperwork for customers may improve customer experience with the program. Only 18% of Non-Midstream respondents reported that they received their rebates as an instant discount from their contractor on their project invoice, and none of these customers suggested that the improvements for the rebate application paperwork.

Recommendations:

- Assess contractor opinion of the application process in future program evaluations.
- Consider encouraging contractors to handle the rebate application process for Non-Midstream measures by completing the rebate application on behalf of the customer. Explain to contractors that this practice increase customer satisfaction.

Conclusion 2. Site visits revealed that claimed lighting AOH was incorrectly estimated in many cases.

For eight of 11 Non-Midstream measures that received site visits, the lighting schedules were much different than assumed based on facility type. There were also large discrepancies in 14 of 18 Midstream measures visited. Similarly, the team adjusted AOH for nine of 31 Non-Midstream measures and seven of 26 Midstream measures that received engineering review only, based on available information about site hours or on engineering judgement. In some cases, some installed measures or units operate 24 hours a day while others operate fewer hours, which contributed to errors in savings estimates that were determined assuming one value for all measures at a site.

Recommendations:

- For Non-Midstream measures, where contractors have the ability to determine AOH, consider requiring an AOH input for each measure installed at each site. This will support more accurate savings estimates for the Non-Midstream measures in general and will allow for separate, more accurate savings estimates for lighting that operates on different schedules within a facility.
- Use the Indiana TRM (v2.2) "Public Assembly" and "Assembly" facility types to assign AOH, coincidence factor, and WHF values for religious buildings, to avoid overstated energy savings.

Conclusion 3. Some claimed baseline assumptions do not currently align with federal minimum efficiencies.

CLEAResult's baseline wattage lookup tables seemed to be sourced from the Core Engineering and CLEAResult 2017 report, prepared for the 2016 evaluation, that outlined baseline wattage assumptions based on the 2010 DOE *Market Lighting Characterization* study. As this source continues to grow outdated, a better practice for estimating the wattage of replaced equipment is the lumen equivalence method outlined in the UMP ("Chapter 6: Residential Lighting Evaluation"). Additionally, although the HVAC equipment algorithm for AC measures references the Indiana TRM (v2.2) for baseline assumptions, that source is now outdated, as new federal guidelines went into place in 2018.

Recommendations:

- Align lighting and HVAC algorithms to reflect the proper baseline efficacy/efficiency standards based on current federal regulations.[52] Refer also to the UMP ("Chapter 6: Residential Lighting Evaluation"). Lighting measures affected include general-service screw-base and fluorescent tube fixtures (TLEDs).
- To support assignment of baseline values through the lumen equivalence method, consider providing a lookup table with lumens and wattage values for each fixture and lamp in the *qualified products list*.
- For lighting measures in the Non-Midstream delivery channel, consider collecting the actual wattage of the removed lamps or fixtures for each measure and providing this information in the tracking data. This would allow calculation of first-year savings based on the replaced wattage for early replacement measures.

Conclusion 4. Measure tracking data provided inadequate support for calculating savings from lighting control measures.

VisionDSM extracts for the Prescriptive program populate the Number of Units field with the controlled watts for each lighting control, not the number of installed lighting controls. A separate field—Watts

[52] Note that new linear fluorescent efficiency standards went into effect on January 26, 2018. ("Electronic Code of Federal Regulations for Consumer Products" and "Electronic Code of Federal Regulations for Certain Commercial and Industrial Equipment").

Controlled—provides the same information. No field in the data provides the number of units installed, and the provided unit savings values appear to be per controlled watt, not per installed unit. This makes calculation of savings impossible without the benefit of additional documentation and complicates calculation and application of ISR, because the Number of Units field is used differently for lighting controls than for other measures.

Recommendation:

- For lighting controls measures, provide the number of installed controls in the Number of Units field. Values in the gross kilowatt per-unit and gross kilowatt-hour per-unit fields should provide savings per installed lighting control, not per controlled watt per installed control.

SMALL BUSINESS DIRECT INSTALL PROGRAM

IPL has offered the SBDI program since 2015. The program includes an on-site audit of energy efficiency opportunities along with no-cost energy-saving measures to drive energy savings and bill reductions for small businesses. In 2019, the program did not meet its energy-savings and demand reduction goals, meeting 70% and 88% of its targets, respectively.

Program Description

IPL offers this program to reach an underserved segment of the nonresidential market by providing immediate energy savings and by identifying other electric-saving opportunities for small business customers. The program implementer (CLEAResult) oversees program management and delivery, recruits customers, and administers program offerings directly to customers, with outreach support from IPL.

Research Objectives

The evaluation team addressed several research objectives:

- Determine whether the 2019 program met its goals and objectives
- Assess how effectively the program met customers' needs
- Identify whether the program marketing, outreach, and communication efforts effectively reach targeted customers
- Assess whether the program operations are efficient and supportive of customer participation
- Identify whether the program influences customers' decisions and behavior
- Calculate program spillover and freeridership and estimate net program savings

Research Approach

To answer the research objectives outlined above, the evaluation team conducted several activities:

- Reviewed program materials
- Interviewed IPL and CLEAResult staff
- Surveyed 2019 participants
- Assessed savings reported in VisionDSM extracts against project documentation
- Examined whether claimed savings algorithms aligned with the Indiana TRM (v2.2) or other appropriate secondary sources
- Assessed the accuracy of *ex ante* savings assumptions and operating schedule of installed equipment through site visits and desk reviews
- Performed on-site EM&V activities

Program Performance

IPL sought to achieve 4,517,083 kWh in net energy savings and 683 kW in net demand reduction. As shown in Table 261, the program spent 97% of its budget in 2019, achieving 70% of its net energy-savings goal and 88% of its demand reduction goal. Savings achieved in 2019 were 3,166,673, compared with 3,091,457 kWh *ex post* net in 2018.

Table 261. 2019 SBDI Program Expenditures, Participation, and Savings

Metric	Net Goal [a]	*Ex Post* Net	Percentage of Goal
Energy Savings (kWh)	4,517,083	3,166,673	70%
Demand Reduction (kW)	683	598	88%
Participation [b]	N/A	491	N/A
Budget	$1,166,393	$1,127,383	97%

Note: Values rounded for reporting purposes.

[a] Goals per IPL's Settlement in DSM Cause #44945.

[b] Participation is defined as the number of distinct sites served in 2019. Multiple projects and measures may be associated with a single site.

As shown in Table 262, audited and verified gross savings in 2019 aligned well with *ex ante* estimates. Based largely on discrepancies in reported lamp wattage, audited savings experienced a general increase compared to *ex ante* savings, and the team's review of supporting records and calculations uncovered higher savings than reported in the tracking database for some project measures. Due to adjustments in AOH, application of the ISR, and other 2019 EM&V findings, however, overall *ex post* savings were less than *ex ante* savings. *Ex post* gross savings represented a realization rate of 75% for energy savings and 98% for demand reduction.

Table 262. 2019 SBDI Program Savings Summary

Metric	*Ex Ante*	Audited	Verified	*Ex Post* Gross	*Ex Post* Net
Energy Savings (kWh)	4,826,489	4,854,133	4,663,136	3,598,491	3,166,673
Demand Reduction (kW)	693	722	694	679	598

A freeridership rate of 13% drove the reduction in evaluated savings from *ex post* gross and net. Table 263 also lists *ex post* gross and net energy adjustment factors applied by the evaluation team, along with separate realization rates for kilowatts and kilowatt-hours.

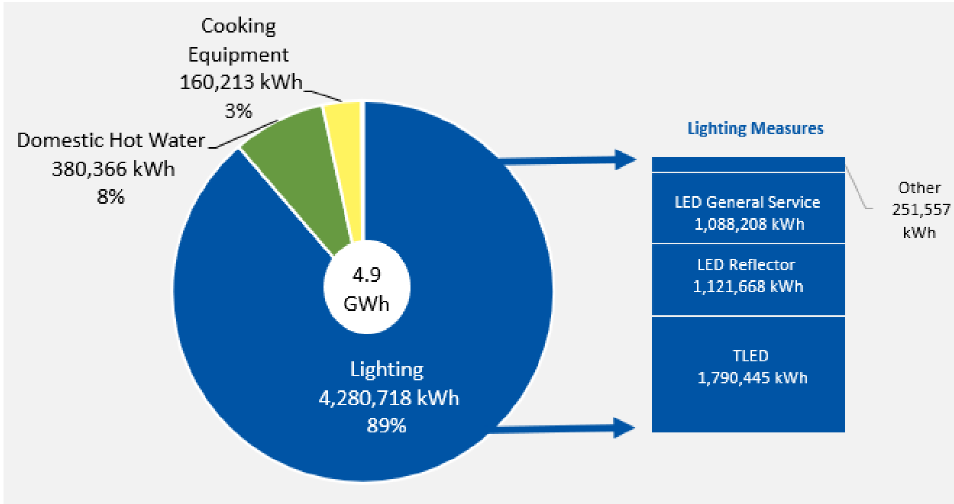
Table 263. 2019 SBDI Program Realization Rate and Net-to-Gross

Realization Rate		Freeridership	Spillover	NTG
Energy Savings (kWh)	Demand Reduction (kW)			
75%	98%	13%	1%	88%

Impact Evaluation

The evaluation team assessed total program savings through a series of steps. In 2019, SBDI projects accounted for 4.83 million kilowatt-hours in *ex ante* savings. Figure 117 illustrates the SBDI project population by energy savings and measure types, as labeled in the tracking database.

Figure 117. 2019 SBDI Program *Ex Ante* Savings Distribution by Measure Category



LED lighting measures accounted for 89% of *ex ante* population energy savings (similar to 88% in 2018). In terms of *ex ante* kilowatt-hour savings, TLED retrofits represented the largest-saving lighting measure, with the remaining savings primarily attributable to LED general service and reflector-style screw-base fixtures. The 2019 distribution of lighting measures tracked fairly closely with 2018 results, with a few minor differences:

- TLED's share of savings fell slightly, from 46% in 2018 to 42% in 2019
- The percentage of LED reflector lamps installed decreased, from 33% in 2018 to 26% in 2019
- Though still well below their 60% share in 2017, LED general service lamps gained share, increasing from 20% in 2018 to 26% in 2019

For the 2019 SBDI program, the remaining *ex ante* savings derived primarily from direct install measures for electrically heated hot water conservation. DHW measures mostly included pre-rinse salon sprayers (82% of the category *ex ante* savings). Faucet aerators, showerheads, and water heater pipe insulation completed the rest of the DHW category (with 15%, 2%, and 1% of *ex ante* kilowatt-hour savings, respectively). Cooking equipment consisted entirely of pre-rinse spray valves for dishwashing sinks.

The evaluation team selected a representative sample of measures for the impact evaluation and extrapolated the findings from these measures to the larger program population. As with the 2018 evaluation, the team used a PPS sampling approach. Table 264 shows the sample characteristics used for the 2019 SBDI impact evaluation. Project measures represent each unique energy efficiency upgrade performed within the population (n=1,361). Units represent the quantity of each measure (such as the number of light fixtures, capacity of heating equipment in MBh, or feet of pipe insulation). Of 1,361 project measures installed through the SBDI program, the evaluation team completed an engineering review or an on-site EM&V analysis of 67 project measures, surpassing the 90% confidence at ±10% precision target for the energy-savings realization rate. The 2019 *ex post* gross energy savings achieved ±5.8% precision at 90% confidence.

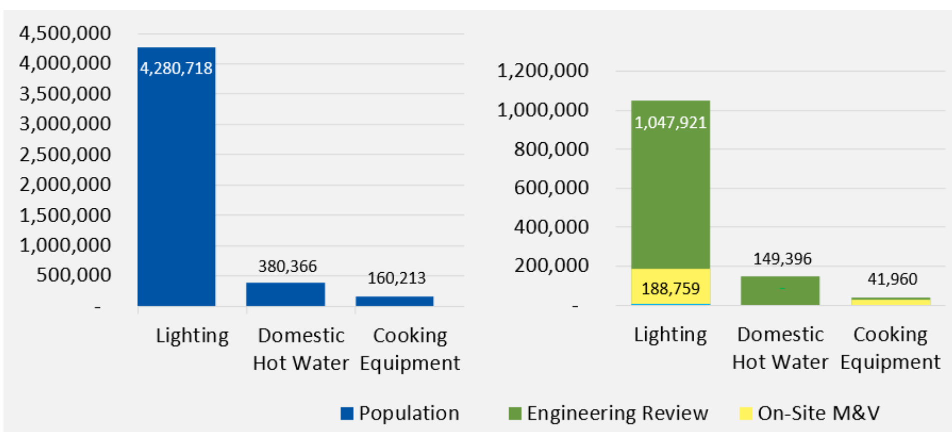
Table 264. 2019 SBDI Program Impact Evaluation Sample Characteristics

Gross Population Count		Site Visit Sample Measure Count		Total Sample Measure Count		Evaluation Sample Energy-Savings Share of Program
Unit	Measure	Actual	Target	Actual	Target	
31,274	1,361	21	19	67	66	12%

The evaluation team used the 2015 through 2018 evaluation findings to inform 2019's sampling targets. Our understanding of the savings variability (error ratio) of historical SBDI performance since 2015 allowed the team to more efficiently target the 2019 sample. The actual sample surpassed the target, better aligning the sample's measure distribution with the population.

Unlike the Custom Incentives and Prescriptive Rebates programs, where a small number of measures produce a large portion of program savings, the SBDI program tends to achieve the majority of its savings from small-savings measures. Therefore, the percentage of SBDI savings represented in the evaluation sample tends to be smaller than the percentage for other C&I programs (in this case, 12% of program savings). However, given the SBDI program has historically exhibited smaller variations in realization rates, the sample realization rate and ISR both achieved the ±10% target. Figure 118 shows detail of the projects represented in the on-site EM&V analysis and engineering desk reviews.

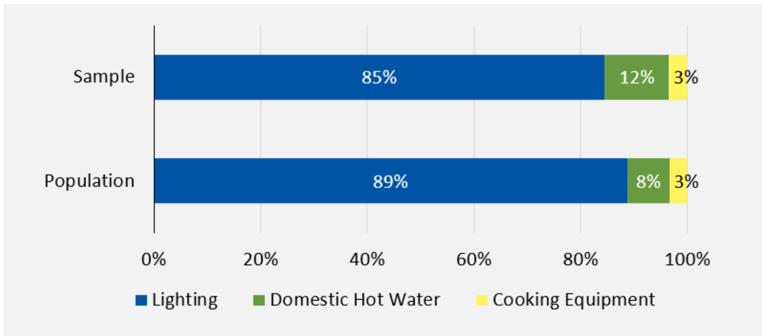
Figure 118. 2019 SBDI Program Sample Total *Ex Ante* Distribution by Measure Category Compared to Population



The measure with the largest savings across all projects represented 1.1% of total 2019 program savings (an LED measure with *ex ante* savings of 52,111 kWh). While the evaluated sample represented a relatively small portion of overall savings, the PPS sampling approach ensured that the distribution of *ex ante* energy savings in the sample closely correlated to the distribution of measure types in the total program population.

For 2019, the evaluation team reviewed 21 measures at 17 sites in the sample to calculate the program ISR. The three-year evaluation cycle includes conducting site visits each year in cycle to validate measure ISRs at 90% confidence and ±10% precision over the three years. The team performed an engineering review using on-site EM&V data for each site visit measure and supplemented additional engineering desk reviews to increase the evaluation sample to 67 project measures. Figure 119 shows the sample distribution by measure category, using data from the tracking database, compared with the 2019 population distribution.

Figure 119. 2019 SBDI Program Sample *Ex Ante* Percentage Distribution by Measure Compared to Population



The DHW measures had somewhat higher representation in the sample than in the population due to the PPS sample's weighting. On average, salon sprayers saved about three times the kilowatt-hours per project measure than lighting measures, which increased their probability of selection relative to lighting measures.

Audited and Verified Savings

Audited savings generally aligned well with *ex ante* savings in 2019. For 14 of 67 sampled measures, CLEAResult used slightly higher values for efficient lamp wattage than values provided in program documentation. These discrepancies created slightly higher audited energy savings and demand reduction than the *ex ante* values.

For a few other measures, the evaluation team could not duplicate demand reduction *ex ante* values using the equations and values provided in program documentation. The three occupancy sensor measures the evaluation team reviewed had the most notable discrepancies. The following details outline this issue for the measure with the largest number of sensors (n=45), but the apparent discrepancy in methodology is identical for each of the three measures.

- Measure name: Occupancy Sensors (0-watt to 499-watt controlled)
- Claimed annual energy savings (from tracking database): 12,286 kWh
- Claimed peak demand reduction (from tracking database): 0.6075 kW
- Claimed install quantity (from tracking database and project documentation): 45
- Claimed building type (from tracking database): Office (medium/large)
- Claimed savings algorithms in Indiana TRM (v2.2), referenced in the "SBDI Algorithms" worksheet for this measure:

$$\Delta kWh = kW_{controlled} * Hours * (1 + WHF_e) \times ESF$$

$$\Delta kW = kW_{controlled} * (1 + WHF_d) \times CF$$

Where:

$kW_{controlled}$	=	Total lighting load connected to the control in kilowatts (= actual, or assumed to be 0.25 per unit for SBDI occupancy sensor measures)
Hours	=	Total lighting operating hours before lighting controls are installed (= actual, or from lighting lookup table based on facility type)
WHF_e	=	Energy waste heat factor (= 0.119091 used by CLEAResult for all building types in Indiana, assumed to have AC with natural gas heat)
ESF	=	Energy savings factor; the percentage of operating hours reduced due to installing occupancy lighting controls (= 0.30 used by CLEAResult for SBDI occupancy sensor measures)
WHF_d	=	Demand waste heat factor (= 0.2 used by CLEAResult for all building types in Indiana, assumed to have AC with natural gas heat)
CF	=	Summer peak coincidence factor (= 0.15 used by CLEAResult for SBDI occupancy sensor measures)

Using the same calculations and values, the evaluation team calculated audited energy savings that matched the claimed savings (12,286 kWh), but yielded demand reduction more than three times higher than the claimed value of 0.6075 kW:

$$\Delta kW = 45 * 0.25 * (1 + 0.2) * 0.15 = 2.025\ kW$$

The evaluation team concluded that CLEAResult may have incorrectly applied the energy savings factor to the demand reduction equation.

Small differences in calculated values are normal in typical evaluations due to rounding errors, differences in assumed values where no Indiana TRM (v2.2) guidance is available, or differences in look-up values (referencing an incorrect building type for the operating hours). Larger discrepancies relative to claimed savings (such as the one outlined above) were not common but can contribute to a notable overstatement or understatement of claimed savings.

The evaluation team performed site visits to verify the installation of 21 sampled measures for the 2019 population. Table 265 outlines findings from each measure and provides notes where claimed and verified quantities differed. In 2019, the team calculated a 96.1% ISR with a precision of ±3.9% at 90% confidence.

Table 265. 2019 SBDI Program In-Service Rate Calculation Summary

Measure	Technology	Quantity		Site Notes
		Ex Ante	*Ex Post*	
1	LED	32	33	--
2	LED	52	52	--
3	LED	50	50	--
4	LED	50	50	--
5	High-Efficient Cooking Equipment	1	1	--
6	High-Efficient Cooking Equipment	2	2	--
7	LED	85	87	The team found TLEDs installed in 18 two-lamp troffers, 12 four-lamp troffers, and three single-lamp troffers (for a total of 87)
8	Lighting Controls/Sensors	45	45	--
9	Lighting Controls/Sensors	33	33	--
10	LED	128	128	--
11	LED	72	46	The team identified 38 TLED lamps (and possibly eight more)
12	LED	94	91	The team was unable to locate three lamps
13	LED	100	100	--
14	LED	91	91	--
15	LED	25	25	--
16	LED	15	8	The team found eight installed lamps and four in storage
17	LED	7	7	--
18	LED	72	72	--
19	LED	72	64	The team found eight lamps in storage
20	LED	14	14	--
21	LED	2	2	--
Total		**1,042**	**1,001**	--
ISR				**96.1%**
Precision at 90% Confidence				**±3.9%**

The evaluation team applied the ISR to 2019's audited savings (4,854,133 kWh and 722 kW) to calculate verified savings for this program year (4,663,136 kWh and 694 kW).

Ex Post Gross Savings

The evaluation team adjusted *ex ante* measure savings in the *ex post* analysis based on several factors:

- Fixture quantity and wattage discrepancies discovered during site visits or discussions with business owners
- AOH determined during site visits or provided by business owners
- AOH estimated by assigning hours based on a more representative facility type
- Adjustment of WHFs and peak summer coincidence factor consistent with the Indiana TRM (v2.2)

In 2019, the site visits and engineering review findings were both key factors in reduced *ex post* savings, especially energy savings (with a 25.4% reduction in realization rate). The biggest factor in this reduction was a downward adjustment in AOH for the majority of sites, including sites with many measures that received only engineering review. For both demand reduction and energy savings, the ISR also led to reduced realization rates (as uninstalled units cannot contribute to savings).

Adjustments to AOH typically have the largest effect on lighting savings, having a proportional effect on measure savings. For example, reducing AOH for lighting in a facility by 50% reduces estimated savings by 50%. Reductions in lamp count also have a proportional effect. Many findings from site visits contributed to reduced *ex post* savings, often through large reductions on AOH:

- The evaluation team identified a much lower AOH for three of four sites with claimed 24/7 lighting operations (8,760 AOH, 1.0 CF). In one case, most lamps were exterior but installed in fixtures with light-sensor controls; the remaining lamps were installed in an office space (3,253 AOH, 0.76 CF). At a second site, all lamps were installed in an office space (3,253 AOH, 0.76 CF). At the third site, the efficient lamps were installed in common areas of a retirement home and were not used 24 hours per day; for this project, the evaluation team used AOH for the “Other” facility type (4,408 AOH, 0.65 CF) outlined in the Indiana TRM (v2.2).
- In the retirement home mentioned above, the field technician and site contact could locate only 38 of the claimed 72 TLEDs. The site contact said some fixtures had not been updated to LED lamps due to incompatible ballasts. The evaluation team added eight lamps to the count, for a total of 46, because we could not identify between six and eight lamps used in one recessed area of the ceiling.
- Three “Retail” facility type sites (4,984 AOH, 0.84 CF)—two hair salons and one dental office—operated for many fewer hours per year than claimed. The evaluation team assigned AOHs of 2,912, 3,253, and 3,380 to these three sites and a coincidence factor that aligned with either the “Retail” (0.84) or “Office” (0.76) facility type.
- The team visited two churches where the claimed AOH aligned with the “Other” Indiana TRM (v2.2) facility type (4,408 AOH, 0.65 CF). The team changed the AOH for both facilities to match usage hours provided by the site contacts for the relevant areas—2,986 for one site and 1,000 for the other. Additionally, at the latter site, the field technician and site contact could locate only eight installed lamps and four in storage of the reported 15.
- For an auto body shop with claimed hours that aligned with the “Other” facility type (4,408 AOH, 0.65 CF), the evaluation team lowered the AOH to 2,857 based on the site interview. Two sampled measures for this site were lamps installed in the garage and office spaces. The evaluation team applied different WHFs to lamps in each location, because the garage is not cooled.
- An office site aligned with the “Office” facility type (3,253 AOH, 0.76 CF) was found to operate 2,340 hours per year, based on the site interview. In addition, eight of the claimed 72 lamps were in storage (so did not contribute to savings).

- For a grocery aligned with the “Food Sales” facility type (5,544 AOH, 0.92 CF), the evaluation team decreased AOH to 3,484 based on information about hours of use gathered on the site. Also, the field technician could not locate three of the 94 claimed lamps.
- Three interior lighting measures were installed in locations that used an electric resistance heating system, creating a large WHF penalty for the electric savings.
- The evaluation team increased the AOH for lighting installed in one site—a full-service restaurant—based on the site interview. Instead of using the Indiana TRM (v2.2) values assigned to the “Food Service” facility type (3,357 AOH, 0.83 CF), the evaluation team based *ex post* savings calculations on actual annual facility hours of 4,928.
- At one facility, where two pre-rinse spray values were installed, a natural gas–fired boiler with an indirect tank provided all hot water for the site, eliminating any possibility for electric energy savings through the installed measure, which received no *ex post* savings. At a second site, the spray valve was rated at a lower gpm that assumed for *ex ante* savings, which increased the energy realization rate for that site to 136%.

The evaluation team also adjusted facility type, AOH, or both for numerous measures that received engineering reviews:

- Sixteen of the 46 sampled measures that received engineering reviews but not site visits were installed in churches or other religious facilities, and all but one claimed savings aligned with the “Other” Indiana TRM (v2.2) facility type (4,408 AOH, 0.65 CF). Because churches tend to have much lower occupied hours than average buildings, the evaluation team aligned AOH with the “Assembly” facility type (2,867 AOH, 0.65 CF). (Compared with the Indiana TRM (v2.2), the Illinois TRM (v7) provides much lower lighting AOH values for religious buildings: 2,085 for fixtures and 1,664 for screw-base lamps.)
- For seven sites identified as “Retail” facilities (4,984 AOH, 0.84 CF), the evaluation team reduced AOH based on posted hours or, in the case of one religious building, the “Assembly” facility type (2,867 AOH, 0.65 CF). The six other sites were a hair salon, three barbershops, a restaurant, and a tailor’s shop, with *ex post* AOH values ranging from 2,600 to 3,253 and coincidence factor values of either 0.76 or 0.84.
- For two sites identified as 24/7 buildings (8,760 AOH, 1.0 CF), the evaluation team assigned different facility types“Healthcare” (6,802 AOH, 0.78 CF) for one and “Office” (3,253 AOH, 0.76 CF) for the other.
- For a dental office assigned to the “Healthcare” facility type (6,802 AOH, 0.78 CF), the team assigned “Office” values (3,253 AOH, 0.76 CF), which aligned reasonably well with the posted hours of business.
- For a small medical office assigned to the “Office” facility type (3,253 AOH, 0.76 CF), the team reduced hours to 2,340 based on posted office hours (plus one hour per day).

Additional small variations between *ex ante* and *ex post* resulted from CLEAResult assuming the same energy WHF for all building types (0.119091), while the evaluation team used the Indiana TRM (v2.2)

WHF lookup table for Indianapolis by each building type (where the WHF varies between 0.096 and 0.155 for AC with natural gas heat).

Table 266 lists program realization rates and verification adjustments for the evaluation sample. The table also shows the 2019 ISR of 96.1%, as well as the gross energy savings and demand reduction program realization rates of 74.6% and 98.0%, respectively.

Table 266. 2019 SBDI Program Realization Rates

ISR	ISR Precision at 90% Confidence	Realization Rate	
		Electric Energy (kWh)	Peak Demand (kW)
96.1%	±3.9%	74.6%	98.0%

Realization rates by measure types in the sample varied with respect to on-site and engineering review findings. Table 267 shows aggregated *ex post* realization rates for each type of measure in the sample.

- The ***lighting*** measure type accounts for most of the reduction in total *ex post* realization rates, with an energy realization rate of 70%; adjustments to AOH accounted for much of this decrease in *ex post* lighting savings (relative to claimed savings).
- For ***cooking equipment*** (pre-rinse spray valves), on-site findings drove *ex post* savings discrepancies: two spray valves that were found to have no energy savings represented approximately 25% of the sample's *ex ante* savings for this measure type, This caused *ex post* savings to decrease considerably when the team adjusted these measures to zero savings. A realization rate of 136% for a site with the same *ex ante* savings partially offset the reduction from the units installed with natural gas water heating.

Table 267. 2019 SBDI Program Evaluation Sample Results by Measure Type

Measure Type	Evaluation Sample Measure Count	Evaluation Sample Unit Count	Energy Savings *Ex Post* Realization Rate	Demand Reduction *Ex Post* Realization Rate
Cooking Equipment	6	7	87%	N/A
Domestic Hot Water	6	39	100%	N/A
Lighting	55	2,893	70%	98%

Notably, the evaluation team did not apply the realization rates in Table 267 to each measure type in the population to determine *ex post* gross savings, which would rely on realization rates calculated using relatively small sample sizes and could therefore lead to inaccurate results. Instead, the team calculated *ex post* gross savings by applying the realization rate for the sample as a whole to the population *ex ante* energy savings and demand reduction. Table 268 provides an outline of findings within the evaluation sample.

Table 268. 2019 SBDI Program Application Prescriptive Realization Rates

Metric	Population *Ex Ante*	Realization Rate (From Evaluation Sample)	Population *Ex Post* Gross
Electric Energy Savings (kWh)	4,826,489	74.6%	3,598,491
Peak Demand Reduction (kW)	693	98.0%	679

Note: Values rounded for reporting purposes.

Ex Post Net Savings

The evaluation team calculated freeridership and spillover using the survey data collected from 2019 participants. Table 269 shows an estimated NTG of 88% for the 2019 SBDI program.

Table 269. 2019 SBDI Program Net-to-Gross Results

Measure Type	n [a]	Freeridership	Spillover	NTG	*Ex Post* Gross Population Savings (kWh)
LED Screw Base	24	15% [b]	1%	86%	1,704,718
LED Tube Replacement	32	9% [b]	1%	92%	1,299,309
DHW/Other	31	14% [b]	1%	87%	594,465
Overall	**87**	**13% [c]**	**1% [c]**	**88% [c]**	**3,598,491**

Note: Values rounded for reporting purposes.

[a] The evaluation team asked 47 customers who installed more than one measure type the freeridership battery of questions for a maximum of three measures, resulting in 87 unique responses.

[b] The team weighted measure freeridership by the survey sample *ex post* gross program kilowatt-hour savings.

[c] The team weighted overall freeridership by the *ex post* gross program population kilowatt-hour savings.

Freeridership

To determine freeridership, the evaluation team asked 47 participants (representing 87 measure installations) whether they would have installed equipment to the same level of efficiency, at the same time, and in the same amount in the absence of the program. Based on survey feedback, the evaluation team calculated overall freeridership for the program of 13% (Table 270).

Table 270. 2019 SBDI Program Freeridership Results

Measure Type	N	Freeridership	*Ex Post* Gross Savings (kWh)
LED Screw Base	24	15% [a]	1,704,718
LED Tube Replacement	32	9% [a]	1,299,309
DHW/Other	31	14% [a]	594,465
Overall	**87**	**13% [b]**	**3,598,491**

Note: Values rounded for reporting purposes.

[a] The team weighted measure freeridership by the survey sample *ex post* gross program kilowatt-hour savings.

[b] The team weighted overall freeridership by the *ex post* gross program population kilowatt-hour savings.

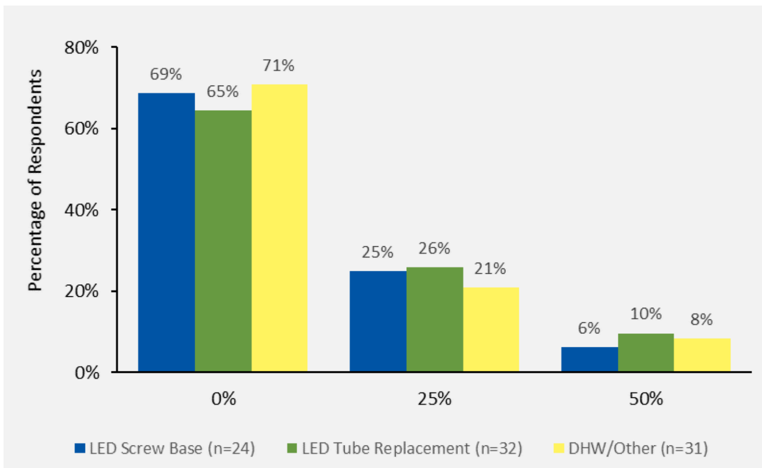
As in prior evaluations, the evaluation team estimated measure-level freeridership for each participant based on the response to the following question: “If the Small Business Direct Install program did not exist, in terms of timing, when would you most likely have purchased [MEASURE]s similar to those provided through the program?” The intention and influence freeridership components used in the Custom Incentives and Prescriptive Rebates program freeridership analysis do not apply well to a direct install program like SBDI, where customers are not purchasing or installing anything themselves. Table 271 shows the response options to the freeridership question, the freeridership score associated with each response, and the frequency of responses for each measure type.

Table 271. 2019 SBDI Program Freeridership Responses and Scoring

Response	Freeridership Score	Frequency of Responses		
		LED Screw Base	LED Tube Replacement	DWH/Other
At the same time	100%	2	3	2
Later, but within a year	50%	8	8	5
Not within a year	0%	10	10	3
Never	0%	12	10	14
Total	**N/A**	**32**	**31**	**24**

Figure 120 shows the distribution of assigned freeridership scores by program measure type.

Figure 120. 2019 SBDI Program Distribution of Freeridership Scores by Measure Type



Spillover

As detailed in the *Appendix B*, the evaluation team estimated spillover measure savings using specific information about participants determined through the evaluation, and relying on the Indiana TRM (V2.2) as a baseline reference. We estimated the percentage of program spillover by dividing the sum of additional spillover savings (as reported by survey respondents) by the total gross savings achieved by all program respondents. The SBDI program had a 1% spillover estimate, rounded to the nearest whole percent, as shown in Table 255.

Table 272. 2019 SBDI Program Spillover

Spillover Savings (kWh)	Participant Program Savings (kWh)	Spillover
1,689	294,804	1%

Two SBDI program participants said that overall the program was very important in their decisions to install additional LEDs for which they did not receive a rebate from IPL. Table 273 shows this additional spillover measures and the total resulting energy savings.

Table 273. 2019 SBDI Program Spillover Measures, Quantity, and Savings

Spillover Measures	Quantity	Total Energy Savings (kWh)
LEDs	29	1,689
Total	**29**	**1,689**

Evaluated Net Savings Adjustments

Table 274 presents the savings, realization rates, and NTG for the SBDI program. The total program NTG was 88%.

Table 274. 2019 SBDI Program *Ex Post* Net Savings

Savings Type	*Ex Post* Gross	NTG	*Ex Post* Net
Energy Savings (kWh)	3,598,491	88%	3,166,673
Demand Reduction (kW)	679	88%	598

Note: Values rounded for reporting purposes.

Process Evaluation

In 2019, the evaluation team conducted stakeholder interviews and participant phone surveys as part of the process evaluation activities.

Program Delivery

Through the SBDI program, IPL offers a free facility energy audit and free direct install measures to business customers who have no more than 200 kW of peak demand. CLEAResult performs the audits and installs program-eligible measures, listed in Table 275. The program measures did not change from 2018 to 2019.

Table 275. 2019 SBDI Program Measure Offering

Measure	
LED Lamp: A line, PAR38, BR30, linear LED replacing fluorescent T8 lamp	LED Exit Sign
Occupancy Sensor	Programmable Thermostat (electric heat)
Faucet Aerator	Low-Flow Showerhead
Salon Sprayer	Pre-Rinse Spray Valve
Water Heater Pipe Insulation	Water Heater Setback

CLEAResult divides its staff into dedicated recruitment and installation roles. The outreach team performs recruitment and manages customer relationships until the installation team becomes involved, performing installations and property energy assessments. Outreach staff schedule an on-site audit and an installation specialist visits the site to conduct the audit and perform the direct installations. CLEAResult subcontracts occupancy sensor installations to a trade ally, who schedules and performs these installations separately from CLEAResult's audit and installation.

During the walk-through audit, the installation specialist identifies energy-savings opportunities beyond the direct installations made that day. To reach as many customers as possible, CLEAResult caps the number of measures—primarily capping linear LEDs at 100—that can be implemented at one site through the program. The installation specialist recommends applicable measures and incentives offered through IPL's Prescriptive Rebates and Custom Incentives programs. After the audit, the customer receives an audit report with recommendations for further energy-efficient upgrades. Program staff provide contact information so the customers can reach out to pursue additional opportunities. When customers express an interest in pursuing other opportunities, staff refer them to a program specialist, who contacts the customer to help initiate the project.

Program Marketing and Outreach

CLEAResult's outreach team recruits eligible customers through direct mail and door-to-door canvassing, the program website, and limited telephone campaigns. CLEAResult sends letters to one geographic area every two weeks, following up face-to-face or over the phone. CLEAResult uses sector-specific language in its letters along with online case studies to persuade organizations to invest time in the direct install process.

Follow-Up on 2018 Evaluation Recommendations

Through stakeholder interviews and program database review, the evaluation team assessed the status of actions taken from recommendations we made during the 2018 evaluation, outlined in Table 276.

Table 276. SBDI Program 2018 Recommendation Status

2018 Evaluation Recommendation	2019 Follow Up
Formalize a consistent process of following up with all SBDI participants, including helping small businesses identify a path forward and resolve any issues encountered during the direct install process. The vast majority of customer follow up could be automated through CLEAResult's SalesForce DSM Tracker platform, allowing CLEAResult to focus its direct outreach efforts on customers who use the maximum measure limits or are motivated to pursue additional projects through the Prescriptive Rebates or Custom Incentives program.	***Completed.*** Since direct conversation between customers and program staff is the most effective form of communication, CLEAResult followed up on about additional opportunities with 20 to 30 customers and found that most of these customers lacked the capital to invest in energy efficiency projects supported through the Prescriptive Rebates and Custom Incentives programs. CLEAResult discontinued the effort based on the feedback from those customers.
Collect contact information for each building owner (or property manager) as part of the walk-through audit. Then automate the follow up with these individuals through CLEAResult's SalesForce DSM Tracker platform. This activity will encourage future participation for buildings that receive direct installation services, and could encourage participation in other properties under the same management.	***Partially Completed.*** CLEAResult collects the building owner or property manager's contact information but does not follow up with each customer.
In the tracking database, capture information about heating and cooling systems. The Indiana TRM (v2.2) classifies interactive effects for five HVAC types: AC with Gas Heat, Heat Pump, AC with Electric Heat, Electric Heat Only, and Gas Heat Only/Exterior. On program applications, prompt participants or contractors to record HVAC type prior to rebate processing. Alternatively, consider a more conservative estimate for WHF that accounts for heating fuel distribution in the commercial building population.	***Rejected/Not Completed.*** IPL does not intend to add HVAC type to the tracking database due to challenges in verifying that the customer reports the correct HVAC system type or that the installation specialist recorded the correct HVAC system type. IPL had not yet considered, but is willing to consider, a more conservative estimate for WHF that accounts for heating fuel distribution for the commercial building population.

2018 Evaluation Recommendation	2019 Follow Up
Assign the proper Indiana TRM (v2.2) WHFs to interior lighting measures and include building types on program applications to effectively use the WHF look-up table.	***Partially Completed.*** Building type is already included in the 2019 tracking data.
Use the Indiana TRM (v2.2) building descriptors for AOH and coincidence factor lookups that best identify space-specific locations within a building where lighting measures are installed. Use the business operating hours to better inform which building type look-ups are appropriate (for example, a small dentist's office will have hours of use closer to an "Office" [3,253 AOH] than to a "Healthcare" facility type [6,802 AOH]).	***Completed.*** CLEAResult used the Indiana TRM (v2.2) values.
Use the Indiana TRM (v2.2) "Assembly" facility type to determine AOH and coincidence factor for religious buildings, thus avoiding overstated energy savings.	***Not Completed.*** CLEAResult will consider this recommendation for 2020.

Changes to Future Program Design

The IPL program manager and CLEAResult mentioned two future program changes.

- In 2020, IPL will add a bonus Prescriptive Rebates program incentive for certain measures for customer who previously had an SBDI audit. IPL will make this change due to the low conversion rate of just 13 customers from the 2017, 2018, and 2019 SBDI program to the Custom Incentives (seven customers) or Prescriptive Rebates (six customers) program after receiving their audit.
- CLEAResult is working to identify new opportunities for energy savings in future years as savings opportunities for lighting measures decline.

Participant Feedback

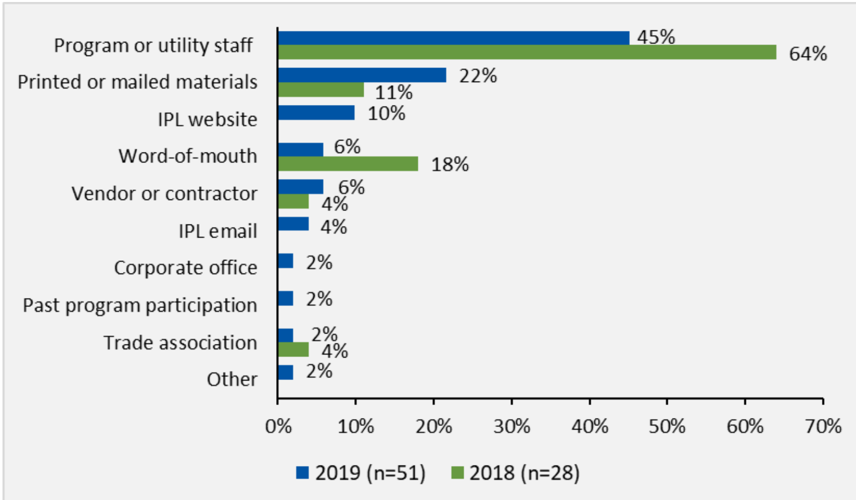
In February 2020, the evaluation team surveyed 55 SBDI program participants from 2019 to assess their program experiences, including participation drivers, barriers, and satisfaction with the SBDI program and its components. While the team did not achieve the original target of reaching 70 participants, the phone survey achieved a 15% response rate, compared to an 11% response rate to the 2018 online survey. The evaluation team tested for statistical significance across years, but due to the small 2018 and 2019 sample sizes, variations across program years may be overstated.

Participant Awareness and Participation Process

In 2019, 45% of SBDI survey respondents learned about the program through program or utility staff outreach (Figure 121). Other common program awareness sources in 2019 were from printed or mailed materials (22%) and the IPL website (10%).

While the percentage of small business customers who learned about the program from printed or mailed materials increased from 11% in 2018 to 22% in 2019, awareness from program or utility staff fell from 64% in 2018 to 45% in 2019; both differences are notable but not significant.

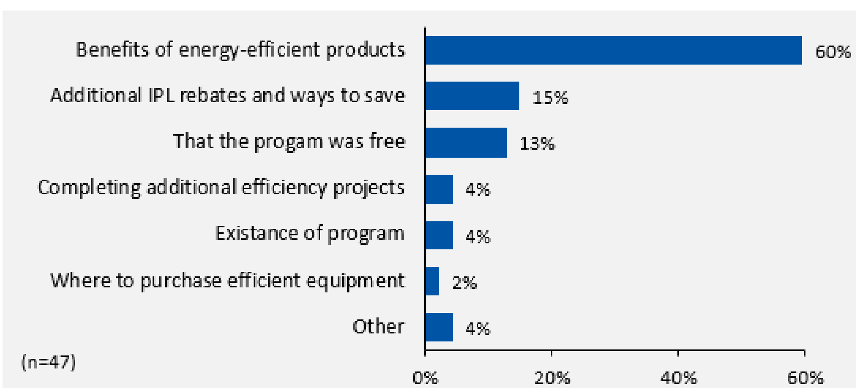
Figure 121. Source of 2018 and 2019 SBDI Program Awareness



Source: 2018 Participant Survey Question B1 and 2019 Participant Survey Question D1. "How did you first hear about the SBDI program?" Responses with boxed ratings significantly differed from the previous period results at the 95 percent level ($p<0.05$).

When asked, 95% of 2019 respondents (n=55) said they received sufficient information to participate in the program, a slight increase from 84% in 2018 (though not statistically significant). When asked for the most helpful information they received, 60% of SBDI respondents indicated the benefits of installing energy-efficient products (Figure 122), while 15% said information on additional IPL rebates was most helpful and 13% said knowing the program was free was most helpful.

Figure 122. Most Helpful Information Received about 2019 SBDI Program



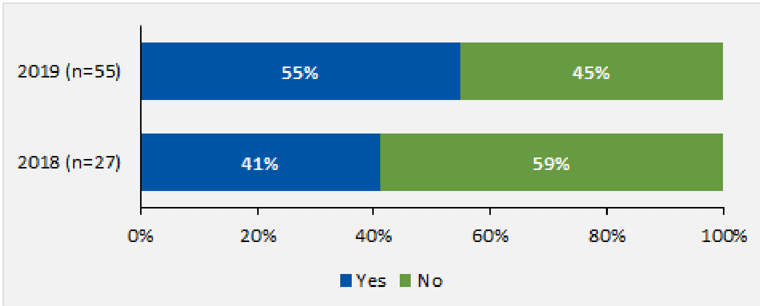
Source: 2018 Participant Survey Question D6 and 2019 Participant Survey Question D6. "What was the most helpful information you received about participating in the program?"

Of those who indicated that insufficient information had been provided, three respondents suggested information that would be helpful to their decision-making processes (one response each):

- Details on how to complete additional efficiency projects
- The fact that the program exists
- Details on qualifying company industries and sizes

As shown in Figure 123, 55% of SBDI participants reported being aware that IPL offers other energy efficiency rebates beyond free direct install measures, an increase from 41% in 2018 (though not statistically significant).

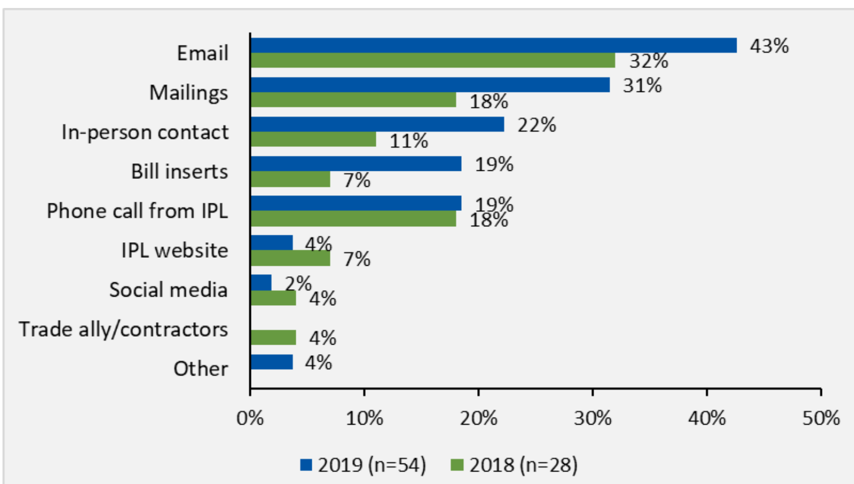
Figure 123. 2018 and 2019 SBDI Program Respondent Awareness of Other IPL Rebate Programs



Source: 2018 Participant Survey Question C9 and 2019 Participant Survey Question E9. "Are you aware that IPL offers rebates for energy-efficient products, beyond the free direct install services you received?"

When asked how IPL can best inform them of opportunities like the SBDI program, 43% of survey respondents suggested email, followed by mailings (31%) and in-person contact from an IPL representative (22%; Figure 124). No differences between 2018 and 2019 responses were statistically significant.

Figure 124. 2018 and 2019 SBDI Program Respondents Preferred Means of Staying Informed about IPL Energy-Saving Opportunities

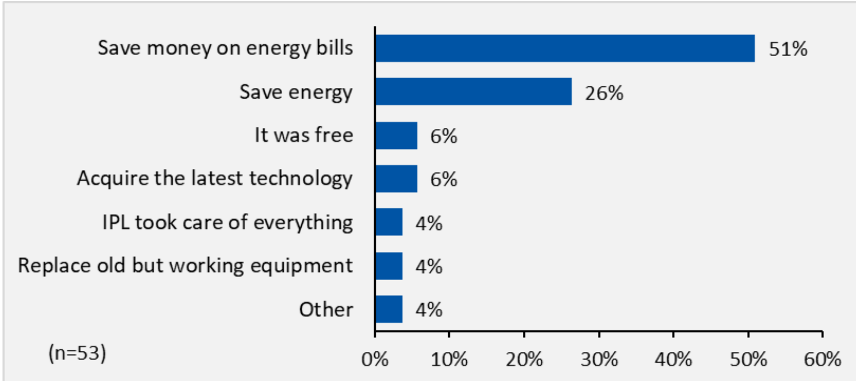


Source: 2018 Participant Survey Question B4 and 2019 Participant Survey Question D4. "In your opinion, what is the best way for IPL to keep companies like yours informed about opportunities to save energy and money?" Multiple response allowed in 2019 but not 2018.

Participation Drivers

SBDI respondents said the most important reasons for participating in IPL's SBDI program included saving money on utility bills (51%), followed by saving energy (26%; Figure 125).

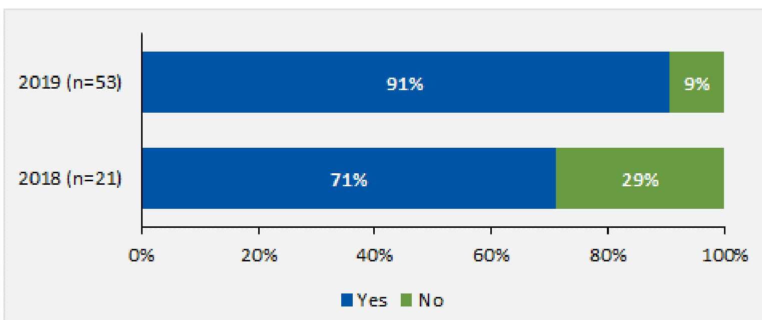
Figure 125. 2019 SBDI Program Participation Drivers



Source: 2019 Participant Survey Question E1. "What factor was most important in your decision to make energy-saving improvements through this program?"

As shown in Figure 126, most 2019 respondents (91%) received everything they expected during their direct installation; this represents a large (though not statistically significant) increase from 71% in 2018. When asked, all respondents (100%) said they still plan to complete the upgrades they had not received (n=5). (The program has a limited number of measures available to each participant, in order to reach as many customers as possible; these participants had likely reached that threshold.)

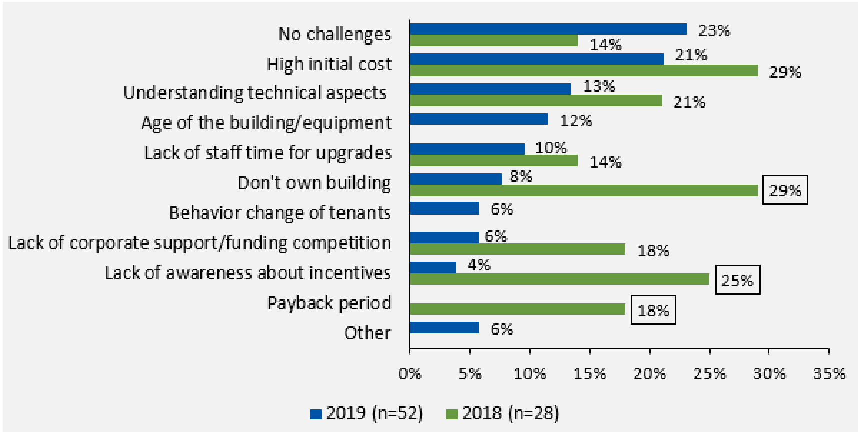
Figure 126. Receipt of Expected 2018 and 2019 SBDI Program Upgrades



Source: 2018 Participant Survey Question C2 and 2019 Participant Survey Question E2. "Did your company receive all of the efficient upgrades you expected by participating in this program?"

When asked what challenges they face to becoming more energy efficient, small business participants most commonly identified the high initial cost of upgrades (21%). As shown in Figure 127, other challenges SBDI respondents identified included a lack of knowledge about opportunities to improve energy efficiency in their facility (13%) and the age of the building (12%). Compared to 2018 results, in 2019 respondents were statistically less likely to cite not owning the building (29% in 2018 and 8% in 2019), lacking awareness of available incentives (25% in 2018 and 4% in 2019), and a long payback period (18% in 2018 and 0% in 2019) as challenges to becoming more energy efficient. Twenty-three percent of 2019 respondents could not identify a challenge or barrier compared to 14% in 2018. Differences in responses between program years may stem from different levels of participation by sector (see Figure 131).

Figure 127. 2018 and 2019 SBDI Program Respondent Challenges in Becoming More Energy Efficient



Source: 2018 Participant Survey Question C5 and 2019 Participant Survey Question E5. "What are the most significant challenges at your facility in becoming more energy efficient?" Multiple response allowed. Responses with boxed ratings significantly differed from the previous period results at the 95 percent level ($p<0.05$).

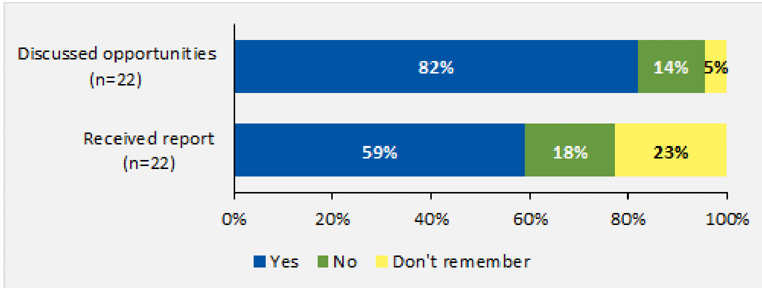
When asked if they had experienced any challenges in participating in the SBDI program specifically, the majority of respondents (93%, n=55) said they had not faced any challenges in participating; those who did experience a challenge (n=4) reported several concerns (one response each):

- Difficulty in communicating with program staff
- Challenges in understanding the report provided
- Difficulty convincing tenants of the benefit
- Concerns about the quality of lighting installed

When asked about their impressions of the energy audit process, 40% of 2019 respondents (n=55) recalled the auditor looking for other energy-saving opportunities while on the property, compared to 36% in 2018 (n=28); 44% of 2019 respondents said the auditor had not looked for such opportunities, while 16% did not remember.

As shown in Figure 128, of those who recalled program staff looking for other energy-saving opportunities, 82% reported discussing those opportunities with program staff (similar to 80% in 2018; n=10), while only 59% reported receiving an energy assessment report (similar to 60% in 2018).

Figure 128. 2019 SBDI Program Energy-Saving Opportunities from the Auditor

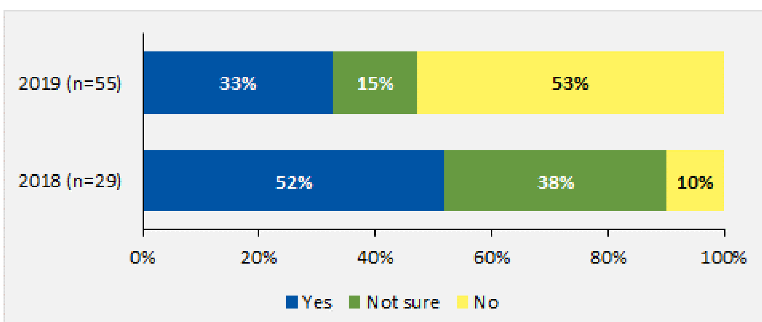


Source: 2019 Participant Survey Questions E11 and E12. "Did you discuss these opportunities?" and "Did you receive an Energy Assessment Report?"

When asked, only 4% of 2019 respondents (n=53) confirmed that program staff contacted them after the direct install process regarding other energy efficiency opportunities, compared to 15% in 2018 (n=27), though this difference was not statistically significant. In 2019, 96% of respondents said they had not been contacted.

As shown in Figure 129, 33% of SBDI respondents are considering other energy efficiency updates for their facilities within the next year, down from 52% in 2018 (notable but not statistically significant). In 2019, 15% said they might complete an energy efficiency project, while 53% said they have no plan to implement other energy-efficient upgrades within one year.

Figure 129. 2018 and 2019 SBDI Program Respondents Intention of Implementing Other Energy Efficiency Upgrades



Source: 2018 and 2019 Participant Survey Question D2. "Besides the items you received through the IPL program, are you considering implementing other energy-efficient building upgrades in the next year?"

Those who were considering other energy-efficient upgrades mentioned multiple types of measures (n=17, with several reporting multiple upgrades):

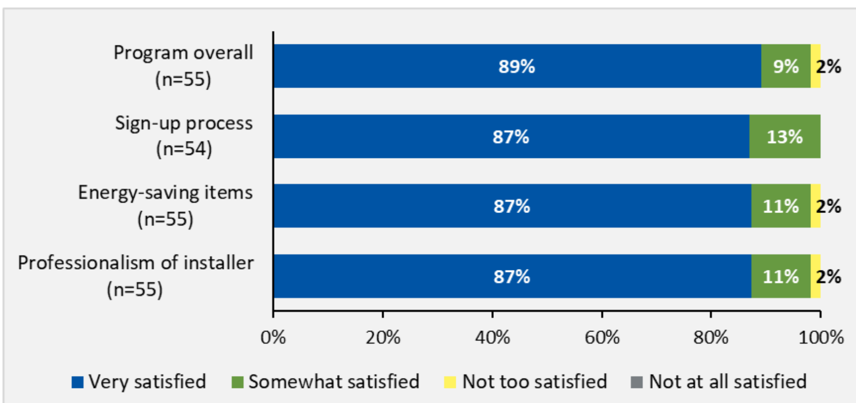
- Lighting upgrades (15 respondents)
- More occupancy sensors (two respondents)
- Windows and doors (two respondents)
- HVAC upgrades (two respondents)
- Solar installations (one respondent)

Just 13 customers who participated in the SBDI program during 2017, 2018, or 2019 also participated in the Custom Incentives or Prescriptive Rebates program after completing the SBDI program. CLEAResult does not follow up with most customers after the direct install process based on the perception that most small businesses cannot afford to participate in IPL's Custom Incentives or Prescriptive Rebates program.

Satisfaction with Program Processes

For individual program aspects, 2019 SBDI respondents were most satisfied with the sign-up process, with all respondents being either *somewhat satisfied* or *very satisfied* (compared to 75% in 2018; n=24). Respondents were equally satisfied with the energy-saving items installed and with the professionalism of the installers (87% *very satisfied*). As shown in Figure 130, 89% of respondents were *very satisfied* with their overall program experience. This represents an increase (though not statistically significant) over 2018 results, when 71% (n=24) were *very satisfied* with energy-saving items, 75% were *very satisfied* with the sign-up process, 79% were *very satisfied* with the professionalism of the installer, and 83% were *very satisfied* with the program overall.

Figure 130. 2019 SBDI Program Participant Satisfaction



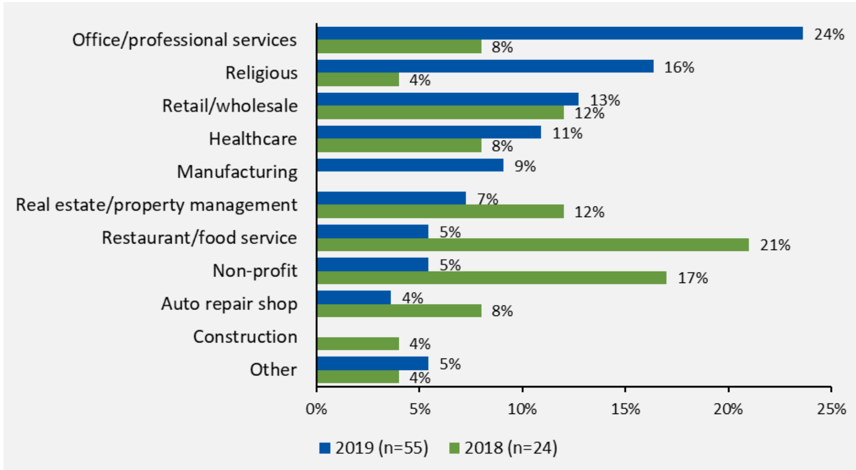
Source: 2019 Participant Survey Question H1. "Please rate your level of satisfaction with…"

When asked for suggestions to improve the program to increase satisfaction levels, 76% of respondents (n=55) offered no recommendations. Of those providing comments (n=13, with one respondent offering more than one suggestion), eight requested providing more or different equipment options, five suggested better or more communication with IPL or program staff throughout the process, and one requested more information specifically on natural gas furnaces.

Participant Firmographics

In 2019, SBDI respondents most commonly worked in office or professional services (24%) or the religious sector (16%). Other common industries included retail or wholesale (13%), healthcare (11%), and manufacturing (9%). As shown in Figure 131, the level of sector participation varied between 2019 and 2018.

Figure 131. 2018 and 2019 SBDI Program Respondents by Business Sector

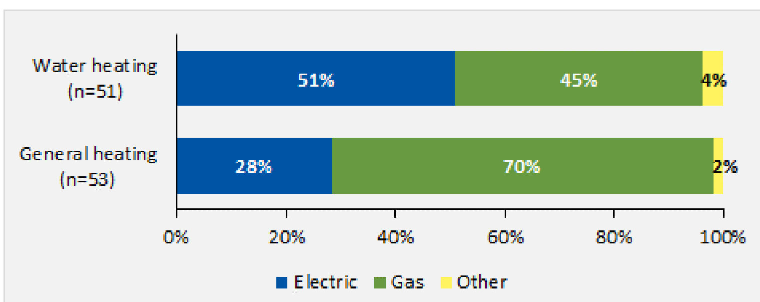


Source: 2018 Participant Survey Question G1 and 2019 Participant Survey Question I1.
"What industry is your organization in?"

Surveyed businesses were most commonly in facilities of 5,000 square feet or less (69%, n=54), with an additional 11% in facilities between 5,001 and 10,000 square feet. Forty-four percent (n=55) of respondents owned the properties receiving upgrades while the remaining leased their facilities.

As shown in Figure 132, 45% of facilities use natural gas for water heating, while 70% use natural gas for general (space) heating.

Figure 132. 2019 SBDI Program Respondents Main Fuel Used for Space and Water Heating



Source: Participant Survey Questions I4 and I5. "What is the main fuel type used for general heating at your facility?" and "What is the main fuel type used for water heating at your facility?"

Conclusions and Recommendations

Conclusion 1. Despite customer interest in pursuing additional energy efficiency projects and high satisfaction with the SBDI program, few businesses participate in the Custom Incentives or Prescriptive Rebates program after completing the SBDI program. While some SBDI participants may face barriers of high upfront cost or leasing their buildings, others may need additional program support or information to pursue additional projects through IPL's other programs.

Customer satisfaction with the SBDI program is high: 98% were satisfied with the program overall, and 93% did not face any challenges with the program. IPL can capitalize on these positive customer interactions by providing additional resources and education to enable customers to continue their energy-efficiency journey.

While not an explicit objective of the program, one avenue to build on SBDI participation is to direct customers to the Custom Incentives or Prescriptive Rebates program. Just 13 customers who participated in the SBDI program during 2017, 2018, or 2019 also participated in the Custom Incentives or Prescriptive Rebates program after completing the SBDI program. CLEAResult does not follow up with most customers after the direct install process based on the feedback from several customers that most small businesses cannot afford the upfront investment of additional opportunities, even with the support of IPL's Custom Incentives or Prescriptive Rebates program; however, one-third of SBDI survey respondents have a planned energy-efficient upgrade within the next year. Most of those respondents were planning lighting projects, which could make them a good fit for the Prescriptive Rebates program.

Just 21% of survey respondents said high costs were a barrier to installing energy-efficient products, and just 8% of respondents said that not owning their building was a barrier to completing energy efficiency projects (56% of respondents lease their space). IPL's bonus incentive for Prescriptive Rebates program participants who have also completed an SBDI project may help generate customer interest in and awareness of other IPL programs.

Solidifying the value of the follow up recommendations in the assessment report is one tool to reinforce additional energy efficiency opportunities. Just over half (59%) of survey respondents recalled receiving an assessment report with recommendations for further energy-efficient upgrades from the SBDI installation specialist, and just 4% recalled program staff contacting them after the direct install process regarding energy efficiency opportunities in their building.

Recommendations:

- Formalize a process for providing written recommendations to each customer during the SBDI assessment by using a checklist of common energy-savings opportunities. Email the written recommendations to each customer within one week of the direct install process so the recommendations remain top-of-mind. In the email, include information about IPL's Prescriptive

Rebates program bonus incentive for SBDI participants and a link to IPL's webpage for commercial customers.

- Prioritize SBDI participants to receive follow-up marketing either on general energy-efficiency resources or materials for the Custom and Prescriptive program for the next two program years after the complete the SBDI process. Some customers may not be ready to make additional upgrades the same year that they complete SBDI, but they can start to plan to achieve deeper energy savings through future energy efficiency upgrades.

Conclusion 2. Discrepancies between the AOH used for claimed savings and the AOH used for *ex post* savings was the primary factor in reduced energy realization rates.

For 16 of the 19 sampled lighting measures that received site visits, the evaluation team identified discrepancies between the lighting AOH used for claimed savings and actual hours determined through site interviews and observation. Similarly, the team adjusted AOH for 29 of 36 lighting measures that received engineering review only, based on publicly available information about site hours or on engineering judgement. These adjustments included 16 measures installed in churches or other religious or worship facilities, where the AOH was roughly 50% greater than the Indiana TRM (v2.2) conservative "Public Assembly" value of 2,867 hours. Hours for the remaining sites were typically at odds with posted hours of business, even after including additional hours for cleaning and other tasks. These AOH adjustments, which reduced operating hours for all but three of the adjusted measures, had a profound effect on *ex post* savings and was the biggest factor in the reduced energy-savings realization rate of 75%.

Recommendations:

- Use the Indiana TRM (v2.2) building descriptors for AOH and coincidence factor lookups that best identify specific locations within a building where lighting measures were installed, based on actual business operating hours and information provided by the site contact. CLEAResult does assign AOH values based on Indiana TRM (v2.2) building descriptors. However, while in most cases these assigned descriptors make sense superficially, often they do not accurately reflect actual AOH. For example, barbershops and hair salons, which are typically open no more than 3,000 hours a year, are often assigned the "Retail" facility type with 4,984 AOH. Similarly, small medical offices and dental offices may be assigned values for "Healthcare" (6,802), "Retail" (4,984), or "Other" (4,408) facility type, but list much shorter business hours.
- Use the Indiana TRM (v2.2) "Public Assembly" and "Assembly" facility types to assign AOH, coincidence factor, and WHF values for religious buildings, to avoid overstated energy savings. SBDI measures in facilities designated as religious/worship in the program tracking data accounted for 23% of SBDI *ex ante* energy savings, so this adjustment alone would have a strong positive effect on program realization rates.
- Do not assign a facility type of "24/7 Building" unless it is known that the installed lighting will operate 24 hours a day.

COST-EFFECTIVENESS

This chapter details the cost-effectiveness analysis results for measures installed through IPL's portfolio of electric programs (implemented in 2019). To determine cost-effectiveness, the evaluation team conducted several procedures, discussed below and in the Research Activities section of this report. The evaluation team evaluated cost-effectiveness for each electric program implemented within IPL's service area. Throughout the EM&V process, the team collected information on the costs and impacts associated with each program, including indirect costs, for our cost-effectiveness analysis for each customer class segment, by program.

Numerous approaches adhere to the Evaluation Framework and *Standard Practice Manual*, two of which can be most relevant for studies of IPL programs:

- Evaluating the *ex ante* cost-effectiveness of proposed programs
- Evaluating the *ex post* cost-effectiveness of existing energy efficiency programs

The *ex ante* approach uses projected measure impacts, while the *ex post* approach uses actual load impact results from EM&V and actual program costs. For this cost-effectiveness analysis, the evaluation team used the *ex post* approach.

This report's benefit/cost assessments include IPL's program implementation costs (administrative, marketing, EM&V, and overhead costs). The results provide perspective on the cost-effectiveness of IPL's DSM portfolio performance, including oversight and management costs.

A form of economic analysis, cost-effectiveness compares an investment's relative costs and benefits. In the energy efficiency industry, this indicates the energy supply's relative performance (or the economic attractiveness of energy efficiency investments or practices) compared to the costs for energy produced and delivered in the absence of such investments (but without considering the value or costs of non-energy benefits or non-included externalities). Typical cost-effectiveness formulas provide an economic comparison of costs and benefits.

This report provides benefit/cost test results for each program and for the full portfolio. Though not necessarily used to recover costs, IPL can use the information from these tests to make informed decisions about adjusting or continuing with a program, and ultimately to improve the performance of the overall energy efficiency portfolio. For example, IPL may use these evaluation results to true-up previous estimates used in its cost-recovery mechanism.

The evaluation team based the analysis results on primary Evaluation Framework tests conducted at the program and portfolio levels, employing the benefits' net present values versus costs for all tests. The team used the EUL of installed measures and the utility's cost of capital, as though program funds were acquired via a utility loan from capital supply markets at a rate similar to those borrowed to construct a new generation plant.

The *Standard Practice Manual* identifies five cost-effectiveness tests typically used to evaluate energy efficiency programs:

- The participant cost test (PCT)
- The utility cost test (UCT; sometimes called the program administrator cost test)
- The ratepayer impact measure (RIM) test
- The total resource cost (TRC) test
- The societal cost test (SCT)

For this EM&V analysis, the evaluation team did not use the SCT, as estimates of environmental and other non-energy costs and benefits[53] were not readily available and remained highly uncertain. However, the TRC test result provided the closest proxy to the SCT.

The cost-effectiveness tests also allow for examining measures from multiple perspectives:

- The TRC compares a program's total costs and benefits for the whole population of customers. These costs include total costs to the utility and incremental participation costs for customers, while the benefits include tax incentives and avoided supply costs. The TRC benefit/cost ratio is based on the present value of program benefits (primarily the avoided cost of capacity, generation, and T&D) relative to the total cost of program implementation and operation as well as incremental customer costs.
- The UCT measures a program's net costs as a resource option based on costs incurred by the program administrator. Though the UCT offers the same benefits as the TRC (namely, energy savings and demand reduction values), the more narrowly defined costs do not include customer costs.
- The PCT assesses cost-effectiveness from participating customers' perspectives by calculating each customer's quantifiable benefits and costs for participating in the program. As many customers do not base their participation decisions entirely on quantifiable variables, this test does not necessarily provide a complete measure of all the benefits and costs perceived by a participant.
- The RIM measures a program's effect on consumer rates due to resulting changes in utility revenues and operating costs. The test indicates the direction and magnitude of expected impacts on rates.

[53] Such costs and benefits can include the value of power plant emissions displaced (or avoided) by the programs' direct energy impacts, the direct and indirect effects of the flow of dollars on Indiana's economy, and economic benefits from increased equipment life, improved productivity, lowered waste generation, increased sales, reduced personnel injuries and illnesses, reduced repair and maintenance expenses, and increased property values.

The following test formulas use terminology from DSMore:

$$TRC = \frac{Avoided\ Costs + Tax\ Saved}{Utility\ Costs\ Net\ of\ Incentives + Participant\ Incremental\ Costs}$$

$$UCT = \frac{Avoided\ Costs}{Utility\ Costs}$$

$$PCT = \frac{Lost\ Revenue + Incentives + Tax\ Savings}{Participant\ Incremental\ Costs}$$

$$RIM = \frac{Avoided\ Costs}{Utility\ Costs + Lost\ Revenue}$$

$$RIM\ (Net\ Fuel) = \frac{Avoided\ Costs}{Utility\ Costs + Lost\ Revenue\ Net\ of\ Fuel}$$

Inputs to Cost-Effectiveness Analysis

This section outlines the specific input data required by DSMore to evaluate energy efficiency measures or programs.

Hourly Prices and Energy Savings

Best-practice, cost-effectiveness modeling begins with hourly prices and hourly energy savings from the specific measures installed and technologies conducted, and correlates both of these to weather. This allows the model to capture and apply appropriate values to low-probability, high-consequence weather events, capturing a more accurate view of the efficiency measure’s value compared to other supply options. To complete the analysis, DSMore requires several inputs, as summarized in the *Program-Related Inputs* section.

The hourly price analysis used for this study derived from an analysis of historical hourly price data, matched with hourly weather to measure the price-to-weather covariance. The analysis measures the overall variation and portion attributable to weather, arriving at a normal weather price distribution. Price variation can result from several uncertain variables, including weather. Using over 30 years of weather data, regressed from two years of actual price data, DSMore measures the full range of possible outcomes, reported as Minimum, Todays (expected), and Maximum test ratios.

Program-Related Inputs

The user adds many details into DSMore: program participation rates, incentives paid, measure load savings, measure life, implementation costs, administrative costs, and incremental costs to participants. These inputs derived from EM&V activities that the evaluation team supplied to Integral Analytics for cost-effectiveness analysis. The evaluation team applied measured kilowatt-hour savings to appropriate hours for each customer, based on load curves for the customer group most likely to install the measure. For example, the team used commercial load curves for commercial measures (and often used various commercial load curves, depending on the measure type and size installed).

The evaluation team calculated electric savings by hour, based on that hour's market value for the measure EUL and given the assumed escalation rates. This avoided cost served as the present cost, with savings valued to today's dollars.

Effective Useful Life

The evaluation team counted and valued energy savings from each type of installed energy efficiency program measure over that measure's full EUL. In addition, the team incorporated energy savings into the cost-effectiveness analysis for technologies with a remaining useful life. In such situations, energy savings reflect a higher impact for the remaining useful life, then slowly decrease to a level consistent with the current baseline EUL.

Spillover

Spillover arises from participants' energy savings that result from program activities, but that have not been captured through the program's tracking of energy savings. This can happen in two ways:

- A customer, due to the program's influence, buys multiple units of a qualifying piece of efficient equipment but obtains a rebate for only one unit.
- A program participant obtains a rebate in one location, then replicates the program-induced purchasing decision in another building but does not apply for a rebate for the second purchase.

In both cases, the program influenced the customer to the extent that their short-term, program-induced actions spilled into other efficient purchases or behaviors not rebated or tracked by a program.

For this evaluation, the team identified and included spillover savings in the benefit/cost assessment as short-term actions taken between the participation period and the evaluation effort. As a result, the included spillover represents a fraction of the total spillover that may have been achieved; it does not include longer-term spillover from actions taken due to the program, which is spread over many years and reflects a program changing the way markets operate.

Freeridership

Freeriders are program participants who would have installed the same energy-efficient equipment in the program's absence. All programs include freeriders, who are often early adopters of a technology and have many differing motivations to participate beyond the program incentive. Program designs, however, can use two methods to minimize freeriders:

- Make incentive levels sufficiently high enough to entice those who would not otherwise have participated due to financial concerns.
- Eliminate measures known to produce high freeridership rates (such as residential ENERGY STAR refrigerators; even though they pass the benefit/cost analysis, the market already experiences high adoption rates for these units).

Utility Inputs

Regarding utility information, DSMore requires utility rates, escalation rates, avoided costs, and discount rates for the utility, society, and participants, all of which were supplied by IPL for this report, in addition to loss ratios.

Avoided Costs

The evaluation team developed each measure's valuation using a bottom-up approach that estimated an hourly avoided cost using forward-looking, incremental cost elements for that hour. The resulting hourly, avoided electricity costs vary by hour of day, day of week, and time of year. Weather-dependent results require a normal weather outcome and a distribution of weather-related variation in outcomes.

Electric avoided costs, by cost component, include three factors:

- **Generation Costs**: Variable by hour, the annual forecast of avoided generation costs is allocated according to an hourly price shape, obtained from historical, participant-specific data that reflects the actual competitive market environment and expected weather variations. IPL provided average annual prices.
- **Capacity Costs**: Associated with generation or capacity markets, these reflect the cost of acquiring the additional capacity. IPL provided these cost estimates.
- **T&D Costs**: Variable by hour, non-peak hours produce zero avoided T&D capacity costs, reflecting that T&D capacity investments serve peak hours. IPL provided these cost estimates.

Net Present Value

The evaluation team calculated an energy efficiency measure's cost-effectiveness based on the net present value of costs and benefits valued in each test, discounted over the EUL for each type of installed measure. The team used a 6.68% discount rate for the present value calculations.

Results

DSMore provides insight regarding energy efficiency programs' cost-effectiveness, per the UCT, TRC, RIM, and PCT, reporting results at the program level, summed to the customer class and portfolio levels. This section is divided into two sets of results.

- The first subsection presents the costs and benefits aligned with the evaluated program savings as reported.
- Based on an agreement with the Office of Utility Consumer Councilor in 2019, IPL agreed to remove benefits associated with the general service lighting from the cost-effectiveness analysis for the Community Based Lighting and Lighting and Appliance programs. The second subsection presents results in accordance with that agreement.

Results Based on Evaluated Savings

Table 277 summarizes cost-effectiveness results for the electric portfolio based on the full evaluated savings, costs, and benefits.

Table 277. Electric Portfolio Cost-Effectiveness Results

Program	Cost-Effectiveness Test			
	UCT	TRC	RIM	PCT
Residential				
Demand Response	1.49	2.34	1.41	N/A
Appliance Recycling	1.22	1.63	0.48	N/A
Community Based Lighting	10.00	10.00	0.86	N/A
Income Qualified Weatherization	1.25	1.25	0.50	N/A
Lighting and Appliance	6.13	4.86	0.82	8.37
Multifamily Direct Install	3.77	3.77	0.68	N/A
Peer Comparison	1.79	1.79	0.54	N/A
School Kit	4.32	4.32	0.72	N/A
Whole Home	1.21	1.18	0.52	12.86
Total Residential	**2.96**	**3.00**	**0.73**	**14.21**
Commercial and Industrial				
Demand Response	1.13	1.49	1.12	N/A
Custom Incentives	3.69	2.17	0.76	3.75
Prescriptive Rebates	7883	3.33	0.94	3.73
Small Business Direct Install	2.52	2.52	0.79	N/A
Total Commercial and Industrial	**5.87**	**2.94**	**0.89**	**3.85**
Total 2019 Electric Portfolio	**4.21**	**2.96**	**0.82**	**5.68**

The evaluation team based these tests on an evaluation of actual program costs, load impacts and utility avoided cost benefits. Individually, all residential programs passed the UCT and TRC cost-effectiveness tests. Only the Demand Response program passed the RIM test. When compared to program year 2018 results, all programs except residential Demand Response improved. Much of the gain can be attributed to improved participation and increased operational efficiency, as well as changes in both program benefits and costs. Program avoided benefits significantly improved compared to last year while the per-unit cost generally increased. However, the increase in program benefits more than offset the increase in per-unit costs. The overall residential portfolio passed the UCT, TRC, and PCT cost-effectiveness tests. Overall, the residential program UCT and TRC results improved compared to program year 2018 results.

All the commercial and industrial programs passed the UCT, TRC, and PCT. The total commercial and industrial portfolio also passed the UCT, TRC, and PCT, but did not pass the RIM test. Cost-effectiveness results for individual commercial and industrial programs were consistent with 2018 results, except for Demand Response. The Demand Response program increased from 0.46 to 1.13 for the UCT due to the increase in utility avoided cost benefits realized in program year 2019.

The 2019 total portfolio of electric programs proved cost-effective for the UCT, TRC, and PCT. Table 278, Table 279, Table 280, and Table 281 show estimates of the present value benefits and costs as well as the net present value of program benefits for each of the four tests—UCT, TRC, RIM, and PCT—respectively. The tables provide values for each electric program, customer segment, and the total portfolio of programs. The net present values represent the difference between the present value of benefits and the present value of costs, including indirect costs (as applicable).

Table 278. Net Present Value of Program Benefits: Utility Cost Test

Program	Total Benefits	Total Costs	Present Value of Net Benefits
	UCT		
Residential			
Demand Response	$4,077,073	$2,737,880	$1,339,192
Appliance Recycling	$854,845	$700,596	$154,250
Community Based Lighting	$8,631,753	$863,312	$7,768,441
Income Qualified Weatherization	$2,771,912	$2,222,312	$549,600
Lighting and Appliance	$20,807,288	$3,391,945	$17,415,342
Multifamily Direct Install	$5,701,750	$1,510,688	$4,191,062
Peer Comparison	$2,521,531	$1,406,654	$1,114,877
School Kit	$2,763,494	$639,066	$2,124,428
Whole Home	$3,314,322	$2,737,254	$577,068
Indirect Portfolio Costs	-	$1,085,523	-
Total Residential	**$ 51,179,110**	**$17,295,230**	**$ 33,883,880**
Commercial and Industrial			
Demand Response	$56,248	$49,843	$6,406
Custom Incentives	$15,733,868	$4,267,134	$11,466,734
Prescriptive Rebates	$58,298,667	$7,400,463	$50,898,203
Small Business Direct Install	$2,846,391	$1,127,383	$1,719,007
Indirect Portfolio Costs	-	$256,475	-
Total Commercial and Industrial	**$76,935,174**	**$13,101,298**	**$63,833,876**
Total 2019 Electric Portfolio	**$128,114,284**	**$30,396,529**	**$97,717,756**

Table 279. Net Present Value of Program Benefits: Total Resource Cost Test

Program	Total Benefits	Total Costs	Present Value of Net Benefits
	TRC		
Residential			
Demand Response	$4,077,073	$1,743,655	$2,333,417
Appliance Recycling	$854,845	$524,086	$330,760
Community Based Lighting	$8,631,753	$863,312	$7,768,441
Income Qualified Weatherization	$2,771,912	$2,222,312	$549,600
Lighting and Appliance	$20,807,288	$4,280,821	$16,526,467
Multifamily Direct Install	$5,701,750	$1,510,688	$4,191,062
Peer Comparison	$2,521,531	$1,406,654	$1,114,877
School Kit	$2,763,494	$639,066	$2,124,428
Whole Home	$3,314,322	$2,808,879	$505,443
Indirect Portfolio Costs	-	1,085,523	-
Total Residential	**$51,179,110**	**$17,084,995**	**$34,094,115**
Commercial and Industrial			
Demand Response	$56,248	$37,863	$18,386
Custom Incentives	$15,733,868	$7,246,108	$8,487,760
Prescriptive Rebates	$58,298,667	$17,511,898	$40,786,769
Small Business Direct Install	$2,846,391	$1,127,383	$1,719,007
Indirect Portfolio Costs	-	$256,475	-
Total Commercial and Industrial	**$76,935,174**	**$26,179,727**	**$50,755,447**
Total 2019 Electric Portfolio	**$128,114,284**	**$43,264,723**	**$84,849,562**

Table 280. Net Present Value of Program Benefits: Ratepayer Impact Measure Test

Program	Total Benefits	Total Costs	Present Value of Net Benefits
	RIM		
Residential			
Demand Response	$4,077,073	$2,884,232	$1,192,840
Appliance Recycling	$854,845	$1,786,522	$(931,677)
Community Based Lighting	$8,631,753	$9,982,960	$(1,351,207)
Income Qualified Weatherization	$2,771,912	$5,556,307	$(2,784,395)
Lighting and Appliance	$20,807,288	$25,508,876	$(4,701,588)
Multifamily Direct Install	$5,701,750	$8,438,449	$(2,736,699)
Peer Comparison	$2,521,531	$4,689,529	$(2,167,998)
School Kit	$2,763,494	$3,817,350	$(1,053,857)
Whole Home	$3,314,322	$6,314,285	$(2,999,963)
Indirect Portfolio Costs	-	$1,085,523	-
Total Residential	**$51,179,110**	**$69,732,889**	**$(18,553,779)**
Commercial and Industrial			
Demand Response	$56,248	$50,059	$6,189
Custom Incentives	$15,733,868	$20,733,251	$(4,999,383)
Prescriptive Rebates	$58,298,667	$62,069,466	$(3,770,799)
Small Business Direct Install	$2,846,391	$3,601,588	$(755,198)
Indirect Portfolio Costs	-	$256,475	-
Total Commercial and Industrial	**$76,935,174**	**$86,710,839**	**$(9,775,664)**
Total 2019 Electric Portfolio	**$128,114,284**	**$156,443,728.15**	**$(28,329,444)**

Table 281. Net Present Value of Program Benefits: Participant Cost Test

Program	Total Benefits	Total Costs	Present Value of Net Benefits
	PCT		
Residential			
Demand Response	$1,140,577	$-	$1,140,577
Appliance Recycling	$2,184,607	$-	$2,184,607
Community Based Lighting	$9,119,577	$-	$9,119,577
Income Qualified Weatherization	$3,333,995	$-	$3,333,995
Lighting and Appliance	$41,539,478	$4,963,941	$36,575,537
Multifamily Direct Install	$7,273,645	$-	$7,273,645
Peer Comparison	$2,951,823	$-	$2,951,823
School Kit	$3,501,730	$-	$3,501,730
Whole Home	$4,759,395	$369,975	$4,389,420
Total Residential	**$75,804,807**	**$5,333,916**	**$70,470,890**
Commercial and Industrial			
Demand Response	$12,196	$-	$12,196
Custom Incentives	$25,803,266	$6,887,616	$18,915,650
Prescriptive Rebates	$67,033,352	$17,991,473	$40,449,298
Small Business Direct Install	$2,811,597	$-	$2,811,597
Total Commercial and Industrial	**$95,660,411**	**$24,879,089**	**$70,781,322**
Total 2019 Electric Portfolio	**$171,465,217**	**$30,213,005**	**$141,252,212**

Results Without General Service Lighting Benefits

Table 282 summarizes cost-effectiveness results for the electric portfolio based on the removal of any benefits associated with general service lighting in the Community Based Lighting and Lighting and Appliance programs, which also applies to carryover savings from prior years. This analysis was completed in accordance with a compromise agreement between IPL and its Oversight Board.

Table 282. Electric Portfolio Cost-Effectiveness Results

Program	Cost-Effectiveness Test			
	UCT	TRC	RIM	PCT
Residential				
Demand Response	1.49	2.34	1.41	N/A
Appliance Recycling	1.22	1.63	0.48	N/A
Community Based Lighting	0.00	0.00	0.00	N/A
Income Qualified Weatherization	1.25	1.25	0.50	N/A
Lighting and Appliance	1.67	2.78	0.60	11.72
Multifamily Direct Install	3.77	3.77	0.68	N/A
Peer Comparison	1.60	1.60	0.52	N/A
School Kit	4.32	4.32	0.72	N/A
Whole Home	1.21	1.18	0.52	12.86
Total Residential	**1.58**	**1.85**	**0.61**	**23.91**
Commercial and Industrial				
Demand Response	1.13	1.49	1.12	N/A
Custom Incentives	3.69	2.17	0.76	3.75
Prescriptive Rebates	7.88	3.33	0.94	3.73
Small Business Direct Install	2.52	2.52	0.79	N/A
Total Commercial and Industrial	**5.87**	**2.94**	**0.89**	**3.85**
Total 2019 Electric Portfolio	**3.43**	**2.54**	**0.79**	**5.13**

All residential programs passed the UCT and TRC cost-effectiveness tests. Note that the UCT, TRC, and RIM test scores are now zero for the Community Based Lighting program and lower for the Lighting and Appliance program with the removal of the benefits for general service lighting measures. The significant drop in test scores for the Lighting and Appliance program occurs because almost 75% of the measures were eliminated by excluding the general service lighting measures

The 2019 total portfolio of electric programs still proved cost-effective for the UCT, TRC, and PCT.

Table 283, Table 284, Table 285, and Table 286 show estimates of the present value benefits and costs as well as the net present value of program benefits for each of the four tests—UCT, TRC, RIM, and PCT—respectively. The tables provide values for each electric program, customer segment, and the total portfolio of programs. The net present values represent the difference between the present value of benefits and the present value of costs, including indirect costs (as applicable).

Table 283. Net Present Value of Program Benefits: Utility Cost Test

Program	Total Benefits	Total Costs	Present Value of Net Benefits
	UCT		
Residential			
Demand Response	$4,077,073	$2,737,880	$1,339,192
Appliance Recycling	$854,845	$700,596	$154,250
Community Based Lighting	$0	$ 863,312	$ (863,312)
Income Qualified Weatherization	$2,771,912	$2,222,312	$549,600
Lighting and Appliance	$5,659,458	$3,391,945	$2,267,513
Multifamily Direct Install	$5,701,750	$1,510,688	$4,191,062
Peer Comparison	$2,256,766	$1,406,654	$850,112
School Kit	$2,763,494	$639,066	$2,124,428
Whole Home	$3,314,322	$2,737,254	$577,068
Indirect Portfolio Costs		$1,085,523	
Total Residential	**$27,399,619**	**$17,295,230**	**$10,104,389**
Commercial and Industrial			
Demand Response	$56,248	$49,843	$6,406
Custom Incentives	$15,733,868	$4,267,134	$11,466,734
Prescriptive Rebates	$58,298,667	$ 7,400,463	$50,898,203
Small Business Direct Install	$2,846,391	$1,127,383	$1,719,007
Indirect Portfolio Costs		$256,475	
Total Commercial and Industrial	**$76,935,174**	**$13,101,298**	**$63,833,876**
Total 2019 Electric Portfolio	**$104,334,793**	**$30,396,529**	**$73,938,264**

Table 284. Net Present Value of Program Benefits: Total Resource Cost Test

Program	Total Benefits	Total Costs	Present Value of Net Benefits
	TRC		
Residential			
Demand Response	$ 4,077,073	$1,743,655	$2,333,417
Appliance Recycling	$854,845	$524,086	$330,760
Community Based Lighting	$0	$863,312	$(863,312)
Income Qualified Weatherization	$2,771,912	$2,222,312	$ 49,600
Lighting and Appliance	$5,659,458	$2,036,498	$3,622,960
Multifamily Direct Install	$5,701,750	$1,510,688	$4,191,062
Peer Comparison	$2,256,766	$1,406,654	$850,112
School Kit	$2,763,494	$ 639,066	$2,124,428
Whole Home	$ 3,314,322	$2,808,879	$505,443
Indirect Portfolio Costs		$1,085,523	
Total Residential	**$27,399,619**	**$14,840,673**	**$12,558,946**
Commercial and Industrial			
Demand Response	$56,248	$37,863	$18,386
Custom Incentives	$15,733,868	$7,246,108	$8,487,760
Prescriptive Rebates	$58,298,667	$17,511,898	$40,786,769
Small Business Direct Install	$2,846,391	$1,127,383	$1,719,007
Indirect Portfolio Costs		$256,475	
Total Commercial and Industrial	**$76,935,174**	**$26,179,727**	**$50,755,447**
Total 2019 Electric Portfolio	**$104,334,793**	**$ 1,020,400**	**$ 63,314,393**

Table 285. Net Present Value of Program Benefits: Ratepayer Impact Measure Test

Program	Total Benefits	Total Costs	Present Value of Net Benefits
	RIM		
Residential			
Demand Response	$4,077,073	$2,884,232	$1,192,840
Appliance Recycling	$854,845	$1,786,522	$ (931,677)
Community Based Lighting	$0	$863,312	$(863,312)
Income Qualified Weatherization	$2,771,912	$5,556,307	$(2,784,395)
Lighting and Appliance	$5,659,458	$9,504,831	$ (3,845,373)
Multifamily Direct Install	$5,701,750	$8,438,449	$(2,736,699)
Peer Comparison	$2,256,766	$4,358,477	$(2,101,711)
School Kit	$2,763,494	$3,817,350	$(1,053,857)
Whole Home	$3,314,322	$6,314,285	$(2,999,963)
Indirect Portfolio Costs		$1,085,523	
Total Residential	**$27,399,619**	**$44,609,288**	**$(17,209,669)**
Commercial and Industrial			
Demand Response	$56,248	$50,059	$6,189
Custom Incentives	$15,733,868	$20,733,251	$(4,999,383)
Prescriptive Rebates	$58,298,667	$62,069,466	$(3,770,799)
Small Business Direct Install	$2,846,391	$3,601,588	$(755,198)
Indirect Portfolio Costs		$256,475	
Total Commercial and Industrial	**$76,935,174**	**$86,710,839**	**$(9,775,664)**
Total 2019 Electric Portfolio	**$104,334,793**	**131,320,126.80**	**$(26,985,334)**

Table 286. Net Present Value of Program Benefits: Participant Cost Test

Program	Total Benefits	Total Costs	Present Value of Net Benefits
	PCT		
Residential			
Demand Response	$1,140,577	$0	$1,140,577
Appliance Recycling	$2,184,607	$0	$2,184,607
Community Based Lighting	$0	$0	$0
Income Qualified Weatherization	$3,333,995	$0	$3,333,995
Lighting and Appliance	$15,674,136	$1,336,969	$14,337,167
Multifamily Direct Install	$ 7,273,645	$0	$7,273,645
Peer Comparison	$ 2,951,823	$0	$2,951,823
School Kit	$3,501,730	$0	$3,501,730
Whole Home	$4,759,395	$369,975	$4,389,420
Total Residential	**$40,819,908**	**$1,706,944**	**$39,112,963**
Commercial and Industrial			
Demand Response	$12,196	$0	$12,196
Custom Incentives	$25,803,266	$6,887,616	$18,915,650
Prescriptive Rebates	$67,033,352	$17,991,473	$49,041,879
Small Business Direct Install	$2,811,597	$0	$2,811,597
Total Commercial and Industrial	**$95,660,411**	**$24,879,089**	**$70,781,322**
Total 2019 Electric Portfolio	**$136,480,318**	**$26,586,033**	**$109,894,285**

Conclusions

This cost-effectiveness analysis indicates that IPL’s total electric energy efficiency portfolio operates very cost-effectively. Based on the UCT test results, the 2019 electric portfolio generates over $97 million in net benefits on a present value basis. Based on the TRC test results, the portfolio generates almost $85 million in net benefits. These program results indicate that the portfolio is very successful at providing financial value to IPL and its customers.

With removal of general service lighting measures from the residential portfolio, the cost-effectiveness analysis indicates that IPL’s electric energy efficiency portfolio still operates very cost-effectively. Under this scenario, based on the UCT test results, the 2019 electric portfolio generates almost $74 million in net benefits on a present value basis. Based on the TRC test results, the portfolio generates over $63 million in net benefits.

Appendix A. Evaluation, Measurement, and Verification Definitions

Table A-1. Evaluation, Measurement, and Verification Definitions

Category	Definition	Purpose	Method
Audited Quantity and Savings	An intermediate step in determining savings. This is the project tracking data savings values, which are checked and adjusted (if needed) for alignment with the less granular *ex ante* data.	Allows for checking the accuracy of tracking system; program savings are based on adjusted program-tracking data.	To calculate this value, review the program tracking databases and a sample of hardcopy program applications to verify consistency with data recorded in program tracking databases.
Ex Ante Savings	Reported savings values in IPL's scorecard.	Claimed savings values after utility reconciliation with implementer tracking data.	As reported.
Ex Post Gross Savings	Evaluator's savings calculations, adjusted from verified values, considering best available information from all primary and secondary sources. These methods may differ from program-specified data and methods and inform updates to same.	Engineer's best estimate of savings, using provided project data and secondary sources.	Typical methods include engineering analysis, building simulation modeling, billing analysis, metering analysis, or other accepted methods. May include changes to baseline assumptions to adjust for weather, occupancy levels, production levels, and other factors.
Ex Post Net Savings	*Ex post* gross savings multiplied by NTG,	This informs program design improvements, planning future programs, cost-effectiveness analysis, and calculations of lost revenues.	This is determined by adjusting the *ex post* gross savings estimates to account for circumstances such as savings-weighted freeridership and spillover effects.
Goal	Target for claimed savings by utility.	Goal setting.	As reported.
Verified Savings	A calculation that further adjusts the audited savings.	Confirm program reach and persistence of installed and are operating measures. Where custom measures are installed, review engineering assumptions for a statistically representative sample of projects. This step may be adjusted to address several types of issues: • Measures rebated but never installed • Measures not meeting program qualifications • Measures installed but later removed • Measures improperly installed	• Check *ex ante* deemed savings estimates and calculations to ensure that the implementer or utility applied the pre-agreed-upon values correctly • Adjust program tracking data to correct any errors or omissions identified above, using the Indiana TRM (V2.2) or other program-specified data and methods (such as best available estimate without benefit of hindsight and in conformance with program methods) • Recalculate program savings based on the adjusted program tracking data • Apply an installation or in-service rate

Appendix B. Self-Report Net-to-Gross Methodology

This appendix describes the team's methodologies to evaluate NTG for the Prescriptive Rebates, Custom Incentives, Retro-Commissioning, the Whole Home programs' rebated HVAC measures, as well as the Lighting and Appliance program appliance and IPL Marketplace measures. NTG estimates serve a critical role in DSM program impact evaluations, allowing utilities to determine gross energy savings influenced by and attributable to DSM programs, free from other influences.

NTG can be divided into two components: freeridership and spillover. Freeriders are customers who would have purchased a measure without the program's influence. Spillover is the amount of additional savings customers obtained by investing in energy-efficient measures or activities due to their program participation. Various methods can be used to estimate program freeridership and spillover. In 2019, the evaluation team used self-reports, procured through participant surveys.

Survey Design

For the 2019 Custom Incentives and Prescriptive Rebates programs' survey design, the evaluation team continued to employ a modification of past freeridership measurements first implemented in 2016. The team's IPL freeridership research prior to 2016 relied on customers' self-reported intentions to purchase a measure in the absence of program incentives, where survey questions addressed the incentive's effect on the efficiency, quantity, and timing of purchases. This portion of freeridership measurement has not changed since 2016. Persistent conjecture in the industry, however, indicates that intention based self-reports may be subject to biases, yielding inflated freeridership values.[54] To address this and to triangulate approaches to the estimate (a desirable measurement principle), the team integrated a second set of survey questions in 2016 (used again in 2017, 2018, and 2019) to measure the program's perceived *influence* on respondents' purchasing decisions.

[54] Some identified biases could lead to underestimated freeridership rates (per literature, the net biasing effect remains unknown). See: Peters, J. and M. McRae. 2008. "Freeridership Measurement Is Out of Sync with Program Logic…or, We've Got the Structure Built, but What's Its Foundation." Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings, Washington, DC.;
Ridge, R., P. Willems, J. Fagan, and K. Randazzo. 2009. "The Origins of the Misunderstood and Occasionally Maligned Self-Report Approach to Estimating Net-to-Gross Ratio." Paper presented at Energy Program Evaluation Conference, Portland, Oregon.; and
Keating, K. 2009. "Freeridership Borscht: Don't Salt the Soup." Paper presented at International Energy Program Evaluation Conference, Portland, Oregon.
www.aceee.org/files/proceedings/2008/data/papers/5_491.pdf

By savings weighting the previously used *intention* methodology with an *influence* methodology, the evaluation team produced a program freeridership score.[55] The team calculated the arithmetic mean of *intention* and *influence* freeridership components to estimate final program freeridership:

$$\text{Final Freeridership} = \frac{\mathit{Intention}\ \text{FR Score} + \mathit{Influence}\ \text{FR Score}}{2}$$

Through spillover questions, the evaluation team determined whether program participants installed other energy-saving measures after participating in the program. The team considered savings that participants received from additional measures as spillover, provided they met two conditions:

- The program significantly influenced the customer's decision to purchase additional measures
- The customer did not receive additional incentives for those measures

If the participant installed one or more measures, additional questions addressed the quantity they installed and the program's influence on their purchasing decisions (*very important*, *somewhat important*, or *not at all important*). The team combined freeridership and spillover questions in the same survey, asking both questions of randomly selected program participants, for the Prescriptive Rebates program, Custom Incentives program, Whole Home program–rebated HVAC measures, Lighting and Appliance program appliance rebate measures, and IPL Marketplace measures.

Intention Freeridership Methodology

The evaluation team estimated *intention* freeridership scores for all participants, based on their responses to *intention*-focused freeridership questions. As part of past IPL evaluations, the team developed a transparent, straightforward matrix approach to assign a single score to each participant based on survey responses.

Direct questions (such as "Would you have installed measure X without the program incentive?") tend to result in exaggerated "yes" responses. Participants often provide answers that they believe surveyors seek, so a question becomes the equivalent of asking: "Would you have done the right thing on your own?" Effectively avoiding such bias involves asking a question in several different ways, then checking for consistent responses.

Determining *intention* freeridership estimates from a series of questions (rather than using a single question) helped the team understand the program's influence on the participant (whether the program affected their decision's timing and, if so, by how many months/years; whether the program affected the efficiency of equipment installed and, if so, by how much; and whether the program affected the quantity of technology installed and, if so, by how much). The team also used multiple questions to check the consistency of each participant's responses.

Not all questions were weighted equally. For example, if the respondent would not have installed measures at the same efficiency level in the program's absence, they automatically became a 0% *intention* freerider. If a residential respondent would not have installed the measures within one year in

[55] *Intention* and *influence* freeridership scores both have a maximum of 100%.

the program's absence, they automatically became a 0% *intention* freerider. If a nonresidential respondent would not have installed the measures within two years in the program's absence, they automatically became a 0% *intention* freerider as well. Other questions included in the *intention* freeridership analysis were assigned partial weights for responses indicative of a non-freerider.

The *intention* freeridership survey questions addressed several core freeridership dimensions:

- Would participants have installed measures without the program?
- Were participants planning to order or install the measures before learning about the program?
- Would participants have installed the measures at the same efficiency levels without the program incentive?
- Would participants have installed the same quantity of measures without the program?
- In the program's absence, would participants have installed the measures at a different time?
- Were the measure purchases included in the organization's most recent capital budget? (Prescriptive Rebates and Custom Incentives programs only)
- Was the program incentive key to meeting a minimum acceptable return on investment or hurdle rate when selecting the energy efficiency project? (Prescriptive Rebates and Custom Incentives programs only)

The survey design included several skip patterns, allowing interviewers to confirm answers previously provided by respondents by asking the same question in a different format.

After assigning an *intention* freeridership score to every survey respondent, the evaluation team calculated a savings-weighted average *intention* freerider score for the program category (weighting respondents' *intention* freerider scores by the estimated savings of installed equipment):

$$Savings\ Weighted\ Intention\ Freeridership =$$

Intention Freeridership Scoring

The following tables illustrated how the team translated program participant survey responses into "yes," "no," or "partially" indicative of *intention* freeridership (in parentheses). Table B-1 shows results for the initial Prescriptive Rebates (Non-Midstream delivery channel) and Custom Incentive programs, while Table B-2 shows results for the Prescriptive Rebates (Midstream delivery channel) program, Table B-3 shows results for the Retro-Commissioning program, Table B-4 shows results for the initial Whole Home program–rebated HVAC measures, Table B-5 shows results for the Lighting and Appliance program appliance rebate, and Table B-6 shows results for the IPL Marketplace. For all tables, the values in brackets are the scoring decrement associated with each response option. Each participant *intention* freeridership score starts at 100%, then decreases based on responses to the survey questions.

Table B-1. 2019 Prescriptive Rebates Program (Non-Midstream) and 2019 Custom Incentives Program Raw Survey Responses Translation to Intention Freeridership Scoring Matrix

F1. Without the incentive and information or education from IPL, would you have still purchased [MEASURE]?	F2. [ASK IF F1 = Yes or DK] Had your organization already ordered or purchased the [MEASURE] before you heard about the program?	F3. Did your organization have specific plans to install the [MEASURE] before learning about the IPL program's incentive?	F4. [ASK IF F3 = Yes or DK] Prior to hearing about the program incentive, was the purchase of the [MEASURE] included in your organization's capital budget?	F5. [ASK IF F1=No] So, without the incentive and information or education from IPL, you would not have installed [MEASURE] at all. Is that correct?	F6. And would you have installed the same quantity of [MEASURE] without the incentive and information or education from IPL?	F7. Without the incentive and information and education from IPL, would you most likely have purchased a lower-efficiency [MEASURE], the same-efficiency [MEASURE], or a higher-efficiency [MEASURE]?	F8. Without the incentive and program information from IPL, when would you have installed this equipment without the program? Would you have installed it …	F9. Does your company use a minimum acceptable return on investment (ROI) or hurdle rate when selecting energy efficiency projects?	F10. Was the program incentive key to meeting this ROI rate?
Yes (Yes) [-0%]	Yes (Yes) [100% FR]	Yes (Yes) [-0%]	Yes (Yes) [-0%]	Yes/correct, we would not have installed anything without the program incentive (No) [-100%]	Yes, most likely the same quantity (Yes) [-0%]	Lower efficiency (No) [-100%]	In the same year (Yes) [-0%]	Yes (No) [-0%]	Yes, the program incentive was key to meeting the ROI (No) [-50%]
No (No) [-50%]	No (No) [-0%]	No (No) [-50%]	No (No) [-50%]	No/not correct, would have installed something without the incentive (Yes) [-0%]	No, most likely would have installed fewer (No) [-50%]	Same efficiency (Yes) [-0%]	Within one to two years (Partial) [-25%]	Yes (Yes) [-0%]	No, the program incentive was not key to meeting the ROI (Yes) [-0%]
Don't know (Partial) [-25%]	Don't know (Partial) [-0%]	Don't know (Partial) [-25%]	Don't know (Partial) [-25%]	Don't know (Partial) [-25%]	No, most likely would not have installed any at all (No) [-100%]	Higher efficiency (Yes) [-0%]	Within three to five years (No) [-100%]	Don't know (Partial) [-0%]	Don't know (Partial) [-0%]

F1. Without the incentive and information or education from IPL, would you have still purchased [MEASURE]?	F2. [ASK IF F1 = Yes or DK] Had your organization already ordered or purchased the [MEASURE] before you heard about the program?	F3. Did your organization have specific plans to install the [MEASURE] before learning about the IPL program's incentive?	F4. [ASK IF F3 = Yes or DK] Prior to hearing about the program incentive, was the purchase of the [MEASURE] included in your organization's capital budget?	F5. [ASK IF F1=No] So, without the incentive and information or education from IPL, you would not have installed [MEASURE] at all. Is that correct?	F6. And would you have installed the same quantity of [MEASURE] without the incentive and information or education from IPL?	F7. Without the incentive and information and education from IPL, would you most likely have purchased a lower-efficiency [MEASURE], the same-efficiency [MEASURE], or a higher-efficiency [MEASURE]?	F8. Without the incentive and program information from IPL, when would you have installed this equipment without the program? Would you have installed it …	F9. Does your company use a minimum acceptable return on investment (ROI) or hurdle rate when selecting energy efficiency projects?	F10. Was the program incentive key to meeting this ROI rate?
--	--	--	--	--	No, would have installed more (Yes) [-0%]	Don't know (Partial) [-25%]	In more than five years (No) [-100%]	--	--
--	--	--	--	--	Don't know (Partial) [-25%]	--	Never (No) [-100%]	--	--
--	--	--	--	--	--	--	Don't know (Partial) [-25%]	--	--

Table B-2. 2019 Prescriptive Rebates Program (Midstream) Raw Survey Responses Translation to Intention Freeridership Scoring Matrix

F12. Without the per-unit discount of [DISCOUNT _$], would you still have purchased [MEASURE]?	F13. Did your organization have specific plans to install the [MEASURE] before learning about the per-unit discount of [DISCOUNT_$]?	F14. [ASK IF F13=No] So, without the per-unit discount of [DISCOUN _$], you would not have installed [MEASURE] at all. Is that correct?	F15. Would you have installed the same quantity of [MEASURE] without the per-unit discount of [DISCOUNT_$]?	F16. Without the per-unit discount of [DISCOUNT_$], would you most likely have purchased a lower-efficiency [MEASURE], the same-efficiency [MEASURE], or a higher-efficiency [MEASURE]?	F17. Without the per-unit discount of [DISCOUNT_$], when would you have installed this equipment without the program? Would you have installed it … [READ LIST]	F18. Does your company use a minimum acceptable return on investment (ROI) or hurdle rate when selecting energy efficiency projects?	F19. Was the program discount key to meeting this ROI rate?
Yes (Yes) [-0%]	Yes (Yes) [-0%]	Yes/correct, we would not have installed anything without the program incentive (No) [-100%]	Yes, most likely the same quantity (Yes) [-0%]	Lower efficiency (No) [-100%]	In the same year (Yes) [-0%]	Yes (No) [-0%]	Yes, the program discount was key to meeting the ROI (No) [-50%]
No (No) [-50%]	No (No) [-50%]	No/not correct, would have installed something without the incentive (Yes) [-0%]	No, most likely would have installed fewer (No) [-50%]	Same efficiency (Yes) [-0%]	Within one to two years (Partial) [-25%]	Yes (Yes) [-0%]	No, the program discount was not key to meeting the ROI (Yes) [-0%]
Don't know (Partial) [-25%]	Don't know (Partial) [-25%]	Don't know (Partial) [-25%]	No, most likely would not have installed any at all [a] (No) [-100%]	Higher efficiency (Yes) [-0%]	Within three to five years (No) [-100%]	Don't know (Partial) [-0%]	Don't know (Partial) [-0%]
--	--	--	No, would have installed more (Yes) [-0%]	Don't know (Partial) [-25%]	In more than five years (No) [-100%]	--	--
--	--	--	Don't know (Partial) [-25%]	--	Don't know (Partial) [-25%]	--	--

[a] No participants answered with this response.

Table B-3. 2019 Retro-Commissioning
Raw Survey Responses Translation to Intention Freeridership Scoring Matrix

F1. Without the incentive and information or education from IPL would you have still have pursued Retro-Commissioning program and implemented the upgrades identified as part of the study?	F2. [ASK IF F1 = Yes or DK] Had your organization already identified and planned to implement some of the upgrades identified in the Retro-Commissioning study BEFORE you heard about the program?	F3. Did your organization have specific plans to conduct a Retro-Commissioning study or Energy Project before learning about the IPL program incentive?	F4. [ASK IF F3 = Yes or DK] Prior to hearing about the program incentive, was cost of conducting a Retro-Commissioning study or the cost of implementing some of the identified upgrades included in your organization's capital budget?	F5. [ASK IF F1=No] So, without the incentive and information or education from IPL, you would not have pursued a Retro-Commissioning study this year and/or would not have implemented the upgrades identified within the study this year. Is that correct?	F6. And would you have most likely pursued as many energy efficiency measures as those identified in the study without the incentive and information or education from IPL?	F7. If applicable to the upgrades you pursued, without the incentive and information or education from IPL, would you most likely have purchased equipment with a lower efficiency, same efficiency or higher efficiency than the equipment specified in the study?	F8. Without the incentive and program information from IPL, when would you have implemented all of the measures without the program? Would you have implemented them…	F9. Does your company use a minimum acceptable return on investment (ROI) or hurdle rate when selecting energy efficiency projects?	F10. Was the program incentive key to meeting this ROI rate?
Yes (Yes) [-0%]	Yes (Yes) [100% FR]	Yes (Yes) [-0%]	Yes (Yes) [-0%]	Yes/correct, we would not have implemented anything without the program incentive (No) [-100%]	Yes, most likely the same scope (Yes) [-0%]	Lower efficiency (No) [-100%]	In the same year (Yes) [-0%]	Yes (No) [-0%]	Yes, the program incentive was key to meeting the ROI (No) [-50%]
No (No) [-50%]	No (No) [-0%]	No (No) [-50%]	No (No) [-50%]	No/not correct, would have implemented something without the incentive (Yes) [-0%]	No, most likely would have identified and pursued fewer (No) [-50%]	Same efficiency (Yes) [-0%]	Within one to two years (Partial) [-25%]	Yes (Yes) [-0%]	No, the program incentive was not key to meeting the ROI (Yes) [-0%]

F1. Without the incentive and information or education from IPL would you have still have pursued Retro-Commissioning program and implemented the upgrades identified as part of the study?	F2. [ASK IF F1 = Yes or DK] Had your organization already identified and planned to implement some of the upgrades identified in the Retro-Commissioning study BEFORE you heard about the program?	F3. Did your organization have specific plans to conduct a Retro-Commissioning study or Energy Project before learning about the IPL program incentive?	F4. [ASK IF F3 = Yes or DK] Prior to hearing about the program incentive, was cost of conducting a Retro-Commissioning study or the cost of implementing some of the identified upgrades included in your organization's capital budget?	F5. [ASK IF F1=No] So, without the incentive and information or education from IPL, you would not have pursued a Retro-Commissioning study this year and/or would not have implemented the upgrades identified within the study this year. Is that correct?	F6. And would you have most likely pursued as many energy efficiency measures as those identified in the study without the incentive and information or education from IPL?	F7. If applicable to the upgrades you pursued, without the incentive and information or education from IPL, would you most likely have purchased equipment with a lower efficiency, same efficiency or higher efficiency than the equipment specified in the study?	F8. Without the incentive and program information from IPL, when would you have implemented all of the measures without the program? Would you have implemented them…	F9. Does your company use a minimum acceptable return on investment (ROI) or hurdle rate when selecting energy efficiency projects?	F10. Was the program incentive key to meeting this ROI rate?
Don't know (Partial) [-25%]	Don't know (Partial) [-0%]	Don't know (Partial) [-25%]	Don't know (Partial) [-25%]	Don't know (Partial) [-25%]	No, most likely would not have pursued any at all [a] (No) [-100%]	Higher efficiency (Yes) [-0%]	Within three to five years (No) [-100%]	Don't know (Partial) [-0%]	Don't know (Partial) [-0%]
--	--	--	--	--	No, would have pursued more (Yes) [-0%]	Don't know (Partial) [-25%]	In more than five years (No) [-100%]	--	--
--	--	--	--	--	Don't know (Partial) [-25%]	--	Don't know (Partial) [-25%]	--	--

[a] No participants answered with this response.

Table B-4. 2019 Whole Home Program Rebated HVAC Measure Raw Survey Responses Translation to Intention Freeridership Scoring Matrix

H7. Before you heard about the IPL eScore program, had you already planned to purchase the [MEASURE]?	H8. [ASK IF H7 = Yes] Before you heard anything about the IPL eScore program, had you already purchased or installed your [MEASURE]?	H9. [ASK IF H8 = Yes] To confirm, you installed your new [MEASURE] before you heard anything about the IPL eScore program, correct?	H10. Would you have installed the same [MEASURE] without the in-Home Energy Assessment and IPL rebate?	H11. [ASK IF H10=No or DK] Would you have installed a different [MEASURE] without the in-Home Energy Assessment and IPL rebate, or would you have decided not to purchase it?	H12. Without the in-Home Energy Assessment and rebate from IPL, would you have purchased and installed a [MEASURE] that was just as efficient, less efficient, or more efficient than what you purchased?	H13. Would you have installed the same quantity of [MEASURE] without the in-Home Energy Assessment and rebate from IPL?	H14. Thinking about timing, without the in-Home Energy Assessment and IPL rebate, would you have installed the [MEASURE]…
Yes (Yes) [-0%]	Yes (Yes) [-0%]	Yes (Yes) [100% FR]	Yes (Yes) [-0%]	I would have installed a different [MEASURE] (Yes) [-0%]	Just as efficient (Yes) [-0%]	Yes, the same quantity (Yes) [-0%]	At the same time (Yes) [-0%]
No (No) [-50%]	No (No) [-0%]	No (No) [-0%]	No (No) [-25%]	I would have decided not to replace it (No) [-100%]	Less efficient (No) [-100%]	No, would have installed fewer (No) [-50%]	Within the same year (Partial) [-25%]
Don't know (Partial) [-25%]	Don't know (Partial) [-0%]	Don't know (Partial) [-0%]	Don't know (Partial) [-0%]	Don't know (Partial) [-25%]	More efficient (Yes) [-0%]	No, would have installed more (Yes) [-0%]	Within one to two years (No) [-100%]
--	--	--	--	--	Don't know (Partial) [-25%]	Don't know (Partial) [-25%]	More than two years out or Never (No) [-100%]
--	--	--	--	--	--	--	Don't know (Partial) [-25%]

Table B-5. 2019 Lighting and Appliance Program Appliance Rebate Raw Survey Responses Translation to Intention Freeridership Scoring Matrix

E1. Before you heard about the IPL rebate program, had you already planned to purchase the [MEASURE]?	E2. [ASK IF E1 = Yes] Before you heard anything about the IPL rebate program, had you already purchased or installed your [MEASURE]?	E3. [ASK IF E2 = Yes] To confirm, you installed your new [MEASURE] before you heard anything about the IPL rebate program, correct?	E4. Would you have installed the same [MEASURE] without the rebate from IPL?	E5. [ASK IF E4=No or DK] Would you have installed a different [MEASURE] without the IPL rebate, or would you have decided not to purchase it?	E6. Without the rebate from IPL, would you have purchased and installed a [MEASURE] that was just as efficient, less efficient, or more efficient than what you purchased?	E7. Without the rebate from IPL, what kind of thermostat would you have installed?	E8. Would you have installed the same quantity of [MEASURE] without the incentive from IPL?	E9. Thinking about timing, without the IPL rebate, would you have installed the [MEASURE]…
Yes (Yes) [-0%]	Yes (Yes) [-0%]	Yes (Yes) [100% FR]	Yes (Yes) [-0%]	I would have installed a different [MEASURE] (Yes) [-0%]	Just as efficient (Yes) [-0%]	A smart or learning thermostat (Yes) [-0%]	Yes, the same quantity (Yes) [-0%]	At the same time (Yes) [-0%]
No (No) [-50%]	No (No) [-0%]	No (No) [-0%]	No (No) [-25%]	I would have decided not to replace it (No) [-100%]	Less efficient (No) [-100%]	A WiFi thermostat (Yes) [-0%]	No, would have installed fewer (No) [-50%]	Within the same year (Partial) [-25%]
Don’t know (Partial) [-25%]	Don’t know (Partial) [-0%]	Don’t know (Partial) [-0%]	Don’t know (Partial) [-0%]	Don’t know (Partial) [-25%]	More efficient (Yes) [-0%]	A programmable or manual thermostat (No) [-100%]	No, would have installed more (Yes) [-0%]	Within one to two years (No) [-100%]
--	--	--	--	--	Don’t know (Partial) [-25%]	Would not have installed a new thermostat (No) [-100%]	Don’t know (Partial) [-25%]	More than two years out or Never (No) [-100%]
--	--	--	--	--	--	Don’t know (Partial) [-25%]	--	Don’t know (Partial) [-25%]

Table B-6. 2019 IPL Marketplace Raw Survey Responses Translation to Intention Freeridership Scoring Matrix

D1. Before you heard about the IPL Marketplace, had you already planned to purchase the [MEASURE](s)?	D2. Would you have installed the same [MEASURE] without the instant rebate from IPL?	D3. [ASK IF D2=No or DK] Would you have installed a different [MEASURE] without the IPL instant rebate, or would you have decided not to purchase it?	D4. Without the instant rebate from IPL, what kind of thermostat would you have installed?	D5. Would you have installed the same quantity of [MEASURE] without the instant rebate from IPL?	D6. Thinking about timing, without the IPL Marketplace instant rebate, would you have installed the [MEASURE]…
Yes (Yes) [-0%]	Yes (Yes) [-0%]	I would have installed a different [MEASURE] (Yes) [-0%]	A smart or learning thermostat (Yes) [-0%]	Yes, the same quantity (Yes) [-0%]	At the same time (Yes) [-0%]
No (No) [-50%]	No (No) [-25%]	I would have decided not to replace it (No) [-100%]	A WiFi thermostat (Yes) [-0%]	No, would have installed fewer (No) [-50%]	Within the same year (Partial) [-25%]
Don't know (Partial) [-25%]	Don't know (Partial) [-0%]	Don't know (Partial) [-25%]	A programmable or manual thermostat (No) [-100%]	No, would have installed more (Yes) [-0%]	Within one to two years (No) [-100%]
--	--	--	Would not have installed a new thermostat (No) [-100%]	Don't know (Partial) [-25%]	More than two years out or Never (No) [-100%]
--	--	--	Don't know (Partial) [-25%]	--	Don't know (Partial) [-25%]

Influence Freeridership Methodology and Scoring

To estimate an *influence* freeridership score, the evaluation team asked respondents to rate the importance of program elements on their purchasing decisions. The surveys captured responses using a four-point scale, with 1 meaning *not important* and 4 meaning *very important*. A surveyed participant's overall *influence* rating equaled the maximum importance of any single program element. This methodology was based on an underlying principle: if a single element had a substantial influence on a respondent's purchasing decision, the program successfully influenced the respondent.

For example, the team included the survey question shown in Table B-7 to capture respondents' perspectives on elements driving them to take energy-efficient actions.[56] A rating of 4 represents the maximum program influence, which determined the *influence* freeridership component score.

Table B-7. Example of *Influence* Freeridership Component Question

For the [MEASURE] purchases, on a scale from 1 to 4, with 1 being *not at all important* and 4 being *very important*, how important was each of the following factors in deciding which equipment to install.						
Rate Influence of Program Elements						
	Not at all important	***Not too important***	***Somewhat important***	***Very important***	**Don't Know**	**Not Applicable**
Recommendation from contractor or vendor	1	2	3	4	DK	N/A
Information provided by IPL on energy-savings opportunities	1	2	3	4	DK	N/A
Information on payback period	1	2	3	4	DK	N/A
The IPL incentive	1	2	3	4	DK	N/A
Previous participation in a IPL energy efficiency program	1	2	3	4	DK	N/A

High program-*influence* levels and freeridership maintain an inverse relationship: the greater the program's *influence*, the lower the participant's final freeridership score. Table B-8 presents the freeridership level implied by each *influence* rating.

[56] The question wording and program factors included in surveys varied slightly based on the specific program component. The *Influence Freeridership* sections in the program report chapters list the factors included for each specific program component.

Table B-8. *Influence* Freeridership Implied by Response to Influence Items

Influence Rating	*Influence* Freeridership Score
1 (*not at all important*)	100%
2 (*not too important*)	75%
3 (*somewhat important*)	25%
4 (*very important*)	0%
Don't know	50%
Not applicable	50%

Spillover

Spillover refers to additional savings generated by program participants due to their program participation, but not captured by program records. Spillover occurs when participants choose to purchase energy-efficient measures or adopt energy-efficient practices due to a program's influence, but they do not receive a financial incentive for the additional measures. As these customers did not receive a financial incentive, they did not appear in program-savings records.

Spillover Methodology

The energy efficiency programs' spillover effect serves as an additional impact that is added to the program's direct results. The evaluation team measured spillover by asking a sample of participants who purchased a particular measure and received an incentive whether they installed another efficient measure or undertook another energy efficiency activity due to the program. Survey respondents rated the program's (and incentive's) relative influence as *very important*, *somewhat important*, *not too important*, or *not at all important* on their decisions to pursue additional savings.

Participant Spillover Analysis

The team used a top-down approach to calculate spillover savings, beginning the analysis with a subset containing only survey respondents who indicated that they installed additional energy-saving measures after participating in the program. The team removed participants from this subset who indicated that the program had little influence on their decisions to purchase additional measures; thus, the subset only retained participants that rated the program as *very important* on their purchasing decisions.

From these participants, the team then estimated energy savings for additional measures installed, based on average savings calculated for this evaluation (and using the Indiana TRM (V2.2) as a reference when evaluation data could not be used).

The evaluation team calculated the percentage of spillover per program category, dividing the sum of additional spillover savings reported by respondents for a given program category by total incentivized *ex post* gross savings achieved by all respondents in the program category:

$$Spillover\ \% = \frac{\sum \text{Spillover Measure Energy Savings for All Survey Respondents}}{\sum \text{Program Measure Energy Savings for All Survey Respondents}}$$

Appendix C. Demand Response Program Per-Unit *Ex post* Savings Detailed Methodology

This appendix provides details of the savings methodology for the L+G switches and smart thermostats provided through the Demand Response program.

L+G Switches

The evaluation team modeled AC consumption by the specifications shown in the following equation, which we used to estimate what AC consumption would have been absent the event:

$$kw_{it} = \alpha_i + \sum_{h=1}^{23} \beta_{1h} Hour_h + \sum_{h=1}^{24} \beta_{2h}(Hour_h \times CDH_{it}) + \sum_{h=1}^{24} \beta_{3h}(Hour_h \times CDH_{it} \times Weekend) + \sum_{j=1}^{3}\sum_{k=1}^{4} \beta_{4kj}(Hour_k \times Event_j) + \sum_{j=1}^{3}\sum_{k=1}^{6} \beta_{5kj}(Pre\ Hour_k \times Event_j) + \sum_{j=1}^{3}\sum_{k=1}^{6} \beta_{6kj}(Post\ Hour_k \times Event_j) + \varepsilon_{it}$$

Where:

kw_{it}	=	Hourly demand in hour 't' for participant 'i'
α_i	=	Average hourly demand for participant 'i'
β_{1h}	=	Change in hourly demand expected for each hour 'h' of the day
$Hour_h$	=	Set of 23 indicator variables for the hour 'h' of the day (one dropped for reference)
β_{2h}	=	Change in hourly demand associated with a change in CDH in hour 'h' of the day
CDH_{it}	=	CDH observed for each hour 't' and participant 'i'
$Hour_h \times CDH_{it}$	=	Set of variables indicating hour 'h' interacted with CDH
β_{3h}	=	Change in hourly demand associated with a change in CDH in hour 'h' on a weekend day
$Weekend$	=	Variable indicating whether hour 't' falls on a weekend
$Hour_h \times CDH_{it} \times Weekend$	=	Set of variables indicating hour 'h' interacted with CDH on a weekend day
β_{4kj}	=	Change in hourly demand associated with hour 'k' of event 'j'
$Hour_k \times Event_j$	=	Variables indicating whether hour 't' falls during hour 'k' of event 'j'
β_{5kj}	=	Change in hourly demand associated with pre-event hour 'k' of event 'j'

$Pre\ Hour_k \times Event_j$ = Variables indicating whether hour 't' falls during pre-event hour 'k' of event 'j'

β_{6kj} = Change in hourly demand associated with post-event hour 'k' of event 'j'

$Post\ Hour_k \times Event_j$ = Variables indicating whether hour 't' falls during post-event hour 'k' of event 'j'

ε_{it} = Error term

Smart Thermostats

The evaluation team collected runtime data for Nest, Ecobee, and Honeywell thermostats. The data from the manufacturers did not include wattage information, instead providing fan and compressor run times for each device in 15-minute intervals across the event season. The team converted the run times to wattages using the following equation from Cutler 2013,[57] then aggregated these to the hour. The formula estimates the instantaneous kilowatts for the AC unit, including power for the unit's condenser and evaporator fans and compressor, as a function of unit size (tonnage), efficiency, and indoor wet-bulb and outdoor dry-bulb temperatures:

$$Instantaneous\ System\ kW = \frac{(Tons * 12{,}000 * CAP * \frac{3.413}{EER} * EIR)}{3{,}413}$$

Where:

Tons = Tonnage of central AC (since this was not collected during thermostat installation, the evaluation team used the average for central ACs defined in the Indiana TRM (v2.2) of 2.42 tons)

12,000 = Conversion factor to convert tons to Btu

EER = EER of central AC unit (since this was not collected during thermostat installation, the evaluation team converted the average 11.15 SEER defined in the Indiana TRM (v2.2) to EER by multiplying it by 0.9, leading to 10.035)

The team calculated CAP (total capacity) and EIR (energy input ratio) using two equations:

$$CAP = a_{CAP} + (b_{CAP} * EWB) + (c_{CAP} * EWB^2) + (d_{CAP} * ODB) + (e_{CAP} * ODB^2) + (f_{CAP} * EWB * ODB)$$

$$EIR = a_{EIR} + (b_{EIR} * EWB) + (c_{EIR} * EWB^2) + (d_{EIR} * ODB) + (e_{EIR} * ODB^2) + (f_{EIR} * EWB * ODB)$$

The terms "*a*" through "*f*" are standardized performance curve coefficients obtained from the Cutler 2013 study, while ODB is the outdoor dry-bulb temperature and EWB is the indoor wet-bulb

[57] Cutler, D., J. Winkler, N. Kruis, and C. Christensen. January 2013. *Improved Modeling of Residential Air Conditioners and Heat Pumps for Energy Calculations.* NREL Technical Report, NREL/TP-5500-56354. http://www.nrel.gov/docs/fy13osti/56354.pdf

temperature. The evaluation team assumed an indoor wet-bulb temperature of 67°F, the AHRI standard, as indoor wet-bulb temperatures were not available in the thermostat data. The evaluation team used outdoor dry-bulb temperatures collected from the Indianapolis International Airport weather dataset.

For each hour, the evaluation team multiplied the central AC runtime by the instantaneous kilowatts to estimate the unit's kilowatt-hours per hour.

The evaluation team estimated per-unit demand reduction for Nest and Honeywell smart thermostats by modeling demand on non-event days and estimating a baseline during event hours:

$$kw_{it} = \alpha_i + \sum_{h=1}^{24} \beta_{1h}(Hour_h \times CDH_{it}) + \sum_{h=1}^{24} \beta_{2h}(Hour_h \times CDH_{it} \times Weekend) + \sum_{j=1}^{3}\sum_{k=1}^{4} \beta_{3kj}(Hour_k \times Event_j) + \sum_{j=1}^{3}\sum_{k=1}^{6} \beta_{4kj}(Pre\ Hour_k \times Event_j) + \sum_{j=1}^{3}\sum_{k=1}^{6} \beta_{5kj}(Post\ Hour_k \times Event_j) + \varepsilon_{it}$$

Where:

kw_{it} = Hourly demand in hour 't' for participant 'i'

α_i = Average hourly demand for participant 'i' (participant fixed effect)

$Hour_h$ = Set of 23 indicator variables for the hour 'h' of the day (one dropped for reference)

β_{1h} = Change in hourly demand associated with a change in CDH in hour 'h' of the day

CDH_{it} = CDH observed for each hour 't' and participant 'i'

β_{2h} = Change in hourly demand associated with a change in CDH in hour 'h' on a weekend day

$Weekend$ = Variable indicating whether hour 't' falls on a weekend

β_{3kj} = Change in hourly demand associated with hour 'k' of event 'j'

$Hour_k \times Event_j$ = Variable indicating whether hour 't' falls during hour 'k' of event 'j'

β_{4kj} = Change in hourly demand associated with pre-event hour 'k' of event 'j'

$Pre\ Hour_k \times Event_j$ = Variable indicating whether hour 't' falls during pre-event hour 'k' of event 'j'

β_{5kj} = Change in hourly demand associated with post-event hour 'k' of event 'j'

$Post\ Hour_k \times Event_j$ = Variable indicating whether hour 't' falls during post-event hour 'k' of event 'j'

ε_{it} = Error term

Differences in hourly baseline and actual demand provided demand reduction attributable to the event. The evaluation team estimated the regression model with standard errors clustered on households.

The evaluation team was only able to collect Ecobee thermostat data on the event days, and instead used data for Ecobee devices not yet enrolled in the program as controls for devices enrolled and participating in each event. The team estimated a baseline during event hours:

$$kw_{it} = \alpha_i + \sum_{h=1}^{24} \beta_{1h}(Hour_h \times CDH_{it}) + \sum_{j=1}^{4}\sum_{k=1}^{4} \beta_{2kj}(Hour_k \times Event_j \times Part_{ij}) + \sum_{j=1}^{4}\sum_{k=1}^{6} \beta_{3kj}(Pre\ Hour_k \times Event_j \times Part_{ij}) + \sum_{j=1}^{4}\sum_{k=1}^{6} \beta_{4kj}(Post\ Hour_k \times Event_j \times Part_{ij}) + \varepsilon_{it}$$

Where:

kw_{it} = Hourly demand in hour 't' for participant 'i'

α_i = Average hourly demand for participant 'i' (participant fixed effect)

$Hour_h$ = Set of 23 indicator variables for the hour 'h' of the day (one dropped for reference)

β_{1h} = Change in hourly demand associated with a change in CHD in hour 'h' of the day

CDH_{it} = CDH observed for each hour 't' and participant 'i'

β_{2kj} = Change in hourly demand associated with hour 'k' of event 'j'associated with participation

$Hour_k \times Event_j \times Part_{ij}$ = Variable indicating whether hour 't' falls during hour 'k' of event 'j' and if customer 'I' was enrolled in the event

β_{4kj} = Change in hourly demand associated with pre-event hour 'k' of event 'j' associated with participation

$Pre\ Hour_k \times Event_j \times Part_{ij}$ = Variable indicating whether hour 't' falls during pre-event hour 'k' of event 'j' and if participant 'i' was enrolled in the event

β_{5kj} = Change in hourly demand associated with post-event hour 'k' of event 'j' associated with participation

$Post\ Hour_k \times Event_j \times Part_{ij}$ = Variable indicating whether hour 't' falls during post-event hour 'k' of event 'j' and if participant 'i' was enrolled in the event

ε_{it} = Error term

Differences in hourly baseline and actual demand provided demand reduction attributable to the event. The evaluation team estimated the regression model with standard errors clustered on households.

Appendix D. Appliance Recycling Program Measures, Assumptions, and Algorithms

For the 2019 program year, the evaluation team estimated per-unit savings estimates for recycled refrigerators and freezers using meter data and multivariate regression models.

Refrigerator Regression Model

Table D-1 shows the UMP model specification used to estimate the annual unit energy consumption (UEC) of refrigerators recycled in 2019, along with the model's estimated coefficients.

Table D-1. 2019 Appliance Recycling Program Refrigerator Unit Energy Consumption Regression Model Estimates (Dependent Variable = Average Daily kWh, R-square = 0.38)

Independent Variable	Coefficient	p-Value
Intercept	0.81	0.134
Age (years)	0.021	0.035
Dummy: Manufactured Pre-1990	1.04	0.000
Size (cubic feet)	0.06	0.021
Dummy: Single Door	-1.75	0.000
Dummy: Side-by-Side	1.12	0.000
Dummy: Primary	0.56	0.003
Interaction: Unconditioned Space * HDDs [a]	-0.04	0.000
Interaction: Unconditioned Space * CDDs [a]	0.03	0.239

[a] The evaluation team derived HDDs and CDDs from the weighted average from TMY3 data for weather stations we mapped to participating appliance zip codes. TMY3 uses median daily values for a variety of weather data collected from 1991 through 2005.

Freezer Regression Model

Table D-2 details the final model specifications the evaluation team used to estimate the energy consumption of participating recycled freezers, along with the results.

Table D-2. 2019 Appliance Recycling Program Freezer Unit Energy Consumption Regression Model Estimates (Dependent Variable = Average Daily kWh, R-square = 0.38)

Independent Variable	Coefficient	p-Value
Intercept	-0.96	0.236
Age (years)	0.045	0.010
Dummy: Manufactured Pre-1990	0.54	0.202
Size (cubic feet)	0.12	0.001
Dummy: Chest Freezer	0.30	0.273
Interaction: Unconditioned Space * HDDs	-0.03	0.035
Interaction: Unconditioned Space * CDDs	0.08	0.026

Extrapolation

After estimating the final regression models, the evaluation team analyzed the corresponding characteristics (the independent variables) for participating appliances (as captured in ARCA's program database). Table D-3 summarizes program averages or proportions for each independent variable.

Table D-3. 2019 Appliance Recycling Program Participant Mean Explanatory Variables

Appliance	Independent Variable	Participant Population Mean Value
Refrigerator	Age (years)	18.39
	Dummy: Manufactured Pre-1990	0.15
	Size (cubic feet)	19.54
	Dummy: Single Door	0.03
	Dummy: Side-by-Side	0.31
	Dummy: Primary	0.41
	Interaction: Unconditioned Space * HDDs [a]	7.90
	Interaction: Unconditioned Space * CDDs [a]	1.41
Freezer	Age (years)	22.35
	Dummy: Manufactured Pre-1990	0.34
	Size (cubic feet)	14.71
	Dummy: Chest Freezer	0.36
	Interaction: Unconditioned Space * HDDs [a]	11.90
	Interaction: Unconditioned Space * CDDs [a]	2.12

[a] The evaluation team derived HDDs and CDDs from the weighted average from TMY3 data for weather stations that we mapped to participating appliance zip codes. TMY3 uses median daily values for a variety of weather data collected from 1991 through 2005.

The following regression model shows how the UMP-defined model would be used. For the refrigerator UEC calculation, this included average appliance characteristics:

$$UEC_{Ref} = 365.25 * [0.81 + (0.021 * (18.39\ years)) + \big(1.04 * (15\%\ \text{manufactured before 1990})\big) + (0.06 * 19.54\ ft.^3) - (1.75 * 3\%\ \text{single door units}) + (1.12 * 31\%\ \text{side} - \text{by} - \text{side}) + (0.56 * 41\%\ \text{primary usage}) + (0.03 * 1.41\ unconditioned\ CDDs) - (0.04 * 7.9\ unconditioned\ HDDs)]$$

Using the values from Table D-1, Table D-2, and Table D-3, the evaluation team estimated the *ex post* annual UEC for an average program refrigerator and freezer. Table D-4 displays estimated *ex post* estimates compared to program initial *ex ante* values. The team determined *ex ante* values using average gross usage by measure type in the program tracking database. ARCA based these *ex ante* values on IPL's 2015 ARP verified savings values for refrigerators and freezers.

Table D-4. 2019 Appliance Recycling Program Average Unit Energy Consumption by Appliance Type

Appliance	*Ex Ante* Annual UEC (kWh/year)	*Ex Post* Annual UEC (kWh/year)	Relative Precision (90% Confidence)
Refrigerators	765.09	1,014	±14%
Freezers	543.22	698	±33%

Demand Reduction Impacts

To calculate demand reduction, the team used adjustment factors shown in Table D-5, drawn from the Indiana TRM (v2.2), to calculate per-measure demand reduction for refrigerators and freezers. The evaluation team used the following equation to calculate demand reduction separately for refrigerator and freezer appliance measures.

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

Where:

TAF = Temperature adjustment factor

LSAF = Load shape adjustment factor

Table D-5. 2019 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 Factor

Since a participant survey was not conducted during the 2019 evaluation year, the team used the part-use factors from the 2018 evaluation. Part-use, an adjustment factor specific to appliance recycling, is used to convert a UEC into an average per-unit gross savings value. The UEC itself does not equal the gross savings value due to two considerations:

- The UEC model yields an estimate of annual consumption
- Not all recycled refrigerators would have operated year-round if they had not been decommissioned through the program

The part-use methodology relies on information collected from surveyed customers regarding pre-program usage patterns (that is, how many months of the year, prior to recycling, the customer had the appliance plugged in and running).

The final part-use estimate reflects how appliances would likely have been operated, had they not been recycled (rather than being based on how they were previously operated). For example, a primary refrigerator, operated year-round, could become a secondary appliance that operated part-time.

This methodology accounts for potential shifts in usage; specifically, it calculates part-use with a weighted average of three prospective part-use categories and factors:

- Appliances that would have been run full-time (part-use = 1.0)
- Appliances that would not have been run at all (part-use = 0.0)
- Appliances that would have been operated for a portion of the year (part-use = between 0.0 and 1.0)

The evaluation team calculated a weighted average part-use factor representing the three participant usage categories as defined by each appliance's operational status during the year prior to recycling. For example, the team assigned a part-use factor of zero to participants who did not use their appliance at all during the year prior to recycling, as no immediate savings were generated by retiring the appliance.

Using information gathered through the 2018 participant surveys, the evaluation team followed three steps to determine part use:

1. The team determined whether recycled refrigerators were primary or secondary units (treating all stand-alone freezers as secondary units).
2. The team asked participants who had recycled a secondary refrigerator or freezer if they had operated that appliance year-round, for a portion of the preceding year, or had it unplugged (not operational). The team assumed all primary units operated year-round.
3. The team asked participants who operated their secondary refrigerator or freezer for only a portion of the preceding year to estimate the total number of months that the appliance remained plugged in. This allowed the team to calculate the portion of the year that the appliance remained in use. The team determined that the average refrigerator, operating part-time, had a part-use factor of 0.89 (roughly 11 months). Freezers operating part-time had a part-use factor of 0.82 (roughly 10 months).

Applying the part-use factors calculated from the 2018 survey to the modeled annual consumption from Table D-4 yielded average gross, per-unit energy savings. Table D-6 shows average gross savings for refrigerators as 902 kWh and average gross savings for freezers as 572 kWh.

Table D-6. 2019 Appliance Recycling Program Per-Unit Gross Energy Savings by Measure

Appliance	Average Per-Unit Annual Energy Consumption (kWh/Year)	Part-Use Factor	Adjusted Per-Unit Gross Energy Savings (kWh/Year)	Precision at 90% Confidence
Refrigerators	1,014	0.89	902	±26%
Freezers	698	0.82	572	±41%

Room Air Conditioners

The evaluation team used the following equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for recycled room 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 Indianapolis, 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 D-7 shows a summary of the recycled room air conditioners' savings assumptions and identifies each assumption's source.

Table D-7. 2019 Appliance Recycling Program
Variable Assumptions for Recycled Room Air Conditioners

Variable	Room Air Conditioner Value	Source
Equivalent Full-Load Hours ($EFLH_{clg}$)	332	Indiana TRM (v2.2)
Btuh	11,357	
Energy Efficiency Rating - Existing(EER_{exist})	7.7	
Percentage Replaced ($\%_{replaced}$)	76%	
Energy Efficiency Rating - New (EER_{new})	10.9	
Coincidence Factor (CF)	0.30	

Table D-8 shows *ex ante* deemed savings and resulting *ex post* per-measure savings for recycled room air conditioners.

Table D-8. 2019 Appliance Recycling Program
Room Air Conditioner *Ex Ante* and *Ex Post* Per-Measure Savings

Measure	*Ex Ante* Deemed Savings		*Ex Post* Per-Measure Savings	
	kWh	kW	kWh	kW
Room Air Conditioner	226.78	0.205	226.78	0.205

Light Emitting Diode Bulbs

ARCA distributed three 9-watt LEDs to program participants who were present at the time of their scheduled appliance pick-up appointments. The evaluation team used the following equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for the distributed LEDs:

$$kWh\ savings\ per\ pack\ = kWh\ savings\ per\ lamp * 3$$

$$kWh\ savings\ per\ lamp = \frac{(W_{base} - W_{LED})}{1{,}000} * ISR * \ Hours * \ (1 + WHFe)$$

$$kW\ savings\ per\ pack\ = kW\ savings\ per\ lamp * 3$$

$$kW\ reduction = \frac{(W_{base} - W_{LED})}{1{,}000} * \ ISR * \ (1 + WHFd)$$

Where:

W_{base} = Baseline wattage of existing bulb replaced with an LED

W_{LED} = LED wattage of the actual distributed LEDs

ISR = In-service rate, or the percentage of rebated units installed

Hours = Average hours of use per year

WHFe = Waste heat factor for energy use, accounting for the effects of more efficient lighting on cooling energy use

WHFd = Waste heat factor for demand, accounting for the effects of more efficient lighting on cooling energy demand

CF = Coincidence factor, a number between 0 and 1 indicating the ratio of LEDs expected to be in use and saving energy during the peak summer demand period

Table D-9 summarizes *ex post* savings assumptions for the distributed LEDs and each assumption's source.

Table D-9. 2019 Appliance Recycling Program Variable Assumptions for LEDs

Variable	LED Value	Source
Baseline Wattage (W_{base})	43	Compared lumens with ENERGY STAR and applied the EISA halogen baseline equivalent wattages
LED Wattage (W_{LED})	9	Actual wattage of distributed LEDs
In-Service Rate (ISR)	31.5%	2018 IPL ARP participant survey
Hours per Year (HOU)	902	Indiana TRM (v2.2); Cadmus. July 29, 2013. *Indiana Core Lighting Logger Hours of Use Study.*
Waste Heat Factor for Energy Use (WHFe)	-0.061	Indiana TRM (v2.2) for Indianapolis, weighted based on HVAC type
Waste Heat Factor for Demand (WHFd)	0.055	Indiana TRM (v2.2) for Indianapolis, weighted based on HVAC type
Coincidence Factor (CF)	0.11	Indiana TRM (v2.2)

Table D-10 shows *ex ante* deemed savings (updated with removed installation rates) and the resulting *ex post,* per-measure savings for distributed LEDs. Demand reduction per bulb follow the Indiana TRM (v2.2). The team assumed that small differences in per-measure savings for the current program year resulted from rounding.

Table D-10. 2019 Appliance Recycling Program LEDs *Ex Ante* and *Ex Post* Per-Measure Savings

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
9-Watt LEDs (per bulb)	28.80	0.004	28.80	0.004
9-Watt LEDs (per pack of three)	86.40	0.012	86.40	0.012

The evaluation team relied on the UMP to calculate lifetime ISRs through 2022 to account for future installations of bulbs in storage. The methodology assumed that 24% of all bulbs in storage would be installed in each subsequent year after purchase. To account for the time sensitivity of these added savings (which stem from increased ISRs but take place after 2019), the team discounted the lifetime ISR by 10% annually to determine NPV lifetime ISRs for each LED. Table D-11 shows a comparison of first-year and lifetime ISRs, showing how marginal increases to first-year ISRs using the UMP methodology results in the NPV lifetime ISRs used in measure impact calculations.

Table D-11. 2019 Appliance Recycling Program First-Year and Lifetime In-Service Rate Calculations

Measure	First-Year ISR	2020	2021	2022	Lifetime ISR	NPV ISR
General Service LED	31.5%	16%	13%	N/A[a]	97%	61%

Notes: Percentages are rounded. General service lamps were not anticipated to have gross savings post EISA 2020 implementation, and the UMP recommended a 61% final ISR for these measures.

Net-to-Gross

The evaluation team used the NTG results from the 2018 evaluation for all program measures, since a new participant survey was not conducted for the 2019 evaluation.

Table D-12 summarizes the final NTGs used in the 2019 evaluation.

Table D-12. 2019 Appliance Recycling Program Net-to-Gross Percentages

Appliance	NTG
Refrigerator	53%
Freezer	56%
Room Air Conditioner	100%
9-Watt LED – Three Pack	59%

Appendix E. Community Based Lighting Program Assumptions and Algorithms

This appendix details the algorithms and savings for the LED bulbs provided through the CBL program.

Algorithms and Variable Assumptions

The program implementer distributed four-packs of 9-watt LEDs to program participants at two food banks within IPL's territory. The team used the following equations from the UMP to calculate *ex post* per-measure energy savings and demand reduction for the distributed LEDs:

$$kWh\ savings\ per\ pack\ = kWh\ savings\ per\ lamp * 4$$

$$kWh\ savings\ per\ lamp = \frac{(W_{base} - W_{LED})}{1{,}000} * ISR * \ Hours * \ (1 + WHFe)$$

$$kW\ savings\ per\ pack\ = kW\ savings\ per\ lamp * 4$$

$$kW\ reduction = \frac{(W_{base} - W_{LED})}{1{,}000} * \ ISR * \ (1 + WHFd)$$

Where:

W_{base}	=	Baseline wattage of existing bulb replaced with an LED
W_{LED}	=	Wattage of the distributed LEDs
ISR	=	In-service rate, or percentage of rebated units that get installed
Hours	=	Average hours of use per year
WHFe	=	Waste heat factor for energy use, accounting for the effects of more efficient lighting on cooling energy use
WHFd	=	Waste heat factor for demand, accounting for the effects of more efficient lighting on cooling energy demand

Table E-1 summarizes *ex post* savings assumptions and the sources of each assumption for the distributed LEDs.

Table E-1. 2019 CBL Program Variable Assumptions for LEDs

Variable	LED Value	Source
Baseline Wattage (W_{base})	43	Compared lumens with ENERGY STAR and applied the EISA halogen baseline equivalent wattages from the UMP
LED Wattage (W_{LED})	9	Actual wattage of distributed LEDs
First Year Installation Rate (ISR)	0.83	2019 participant surveys
Carryover Installation Rate (ISR)	0.91	Lifetime ISR for lamps that are installed in later years
Hours per Year (Hours)	902	Indiana TRM (v2.2); *Indiana Core Lighting Logger Hours of Use Study*. July 29, 2013.
Waste Heat Factor for Energy Use (WHFe)	-0.061	Indiana TRM (v2.2) for Indianapolis, weighted based on HVAC type
Waste Heat Factor for Demand (WHFd)	0.055	Indiana TRM (v2.2) for Indianapolis, weighted based on HVAC type

First Year Installation Rate Summary

As mentioned in the *Online Survey Findings* section, when calculating the ISR, the evaluation team assumed that survey respondents who said they received one to three bulbs interpreted the survey questions about bulb quantities received and installed as the number of packs rather than the number of bulbs. The ISR for participants who reported receiving four bulbs is 79% while the ISR for people that reported any other quantity is 88%.

Table E-2 shows a matrix of participant survey responses to the bulbs received and installed questions. The shaded cells represent participants with 100% of their lamps installed under the assumption that both the quantity received and the quantity installed are in units of four-packs. No assumptions were necessary for the participants that reported four or eight lamps received. For the remaining responses, the numbers that fall above the shaded diagonal represent participants who misinterpreted both of the questions while the numbers that fall below the diagonal represent participants who misinterpreted only the quantity received question. In effect, responses above the diagonal are in units of four-packs while responses below the diagonal are in units of bulbs.

Table E-2. 2019 CBL Program Quantity of Bulbs Received and Installed

Number Bulbs Installed	Number of Packs (Bulbs) Received				
	1 (4)	2 (8)	3 (12)	4 (4)	8 (8)
0	1	1	1	5	
1	6	-	1	10	
2	1	32	2	27	1
3	1	2	7	16	
4	2	-	-	82	
8					1

Note: Responses sum to 199. One respondent claimed 15 installs and was removed.

Lifetime Installation Rate Summary

The evaluation team relied on the UMP to calculate lifetime ISRs through 2023 to account for future installations of bulbs in storage. The methodology assumes 24% of all bulbs in storage will be installed in each subsequent year after receipt. To account for the time sensitivity of these added savings, which stem from increased ISRs but take place after 2019, we discounted the lifetime ISR 10% annually to achieve NPV lifetime ISRs for each LED. Table E-3 compares first-year and lifetime ISRs, showing how marginal increases to first-year ISRs using the UMP methodology result in the NPV lifetime ISRs used in measure impact calculations.

Table E-3. 2019 CBL Program First-Year and Lifetime ISR Calculations

Measure	First-Year ISR	2020	2021	2022	2023	Lifetime ISR	NPV ISR
General Service LED	83%	3%	2%	2%	N/A	97%	91%

Note: General service lamps were not anticipated to have gross savings post EISA 2020 implementation; however, recent rule changes have delayed that implementation beyond 2020. The evaluation team assumes that these lamps will eventually become baseline around 2023. As such, final lifetime NPV lifetime ISR is capped at 91% (and percentages are rounded).

Savings Summary

Table E-4 shows *ex ante* deemed savings (updated without installation rates) and the resulting *ex post* per-measure savings for distributed LEDs.

Table E-4. 2019 CBL Program LEDs *Ex Ante* and *Ex Post* Per-Measure Savings

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
9-watt LEDs (per bulb)	21.6	0.003	26.2	0.004
9-watt LEDs (per four-pack)	86.4	0.012	104.8	0.014

Appendix F. Income Qualified Weatherization Program Measures, Assumptions, and Algorithms

This appendix presents information for several IQW measures, including algorithms, variable assumptions and sources, and differences between *ex ante* and *ex post* per-measure savings:

- LEDs (9 watt, 16 watt, 5-watt globe, 5-watt candelabra, 7-watt track, and R30)
- Bathroom and kitchen aerators
- Low-flow showerheads
- Pipe wrap insulation
- Smart strips
- Programmable thermostats
- Smart thermostats
- Water heater setback
- Attic insulation
- Radiant barrier
- Air sealing
- Duct sealing
- Air sealing
- Refrigerator replacements
- LED night lights
- Filter whistles
- Audit recommendations

Unless otherwise specified, algorithms, variable assumptions, and measure savings apply to multifamily and manufactured homes.

LEDs

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate the *ex post* per-measure energy savings and demand reduction for LEDs:

$$kWh\ savings = \frac{(W_{base} - W_{LED}) * (Hrs/day * 365) * \ (1 + WHFe)}{1{,}000}$$

$$kW\ reduction = \frac{(W_{base} - W_{LED}) * \ CF * \ (1 + WHFd)}{1{,}000}$$

Where:

W_{base} = Baseline wattage of existing bulb being replaced with a LED (see Table F-1)

Table F-1. 2019 IQW Program LED Baseline Wattages

Measure	Baseline Wattage
9-watt LED	43
16-watt LED	65
5-watt globe LED	40
5-watt candelabra LED	40
7-watt track LED	50
R30, 10-watt LED	65

W_{LED} = Actual installed LED wattage

Hrs/day = Average number of hours per day the light is in use

WHF_e = Waste heat factor for energy use; this accounts for the effects of more efficient lighting on cooling energy use

WHF_d = Waste heat factor for demand; this accounts for the effects of more efficient lighting on cooling energy demand

CF = Coincidence factor; a number between 0 and 1 indicating the ratio of LEDs expected to be in use and saving energy during the peak summer demand period

WHF_d = Waste heat factor for demand; this accounts for the effects of more efficient lighting on cooling energy demand

Table F-2 summarizes the *ex post* assumptions and sources for the installed LEDs.

Table F-2. 2019 IQW Program *Ex Post* Variable Assumptions for LEDs

Variable	Value	Source
Baseline Wattage (W_{base})	As shown in Table F-1	Lumens compared with ENERGY STAR and EISA halogen baseline equivalent wattages applied
LED Wattage (W_{LED})	As shown in Table F-1	Wattages of installed LED
Hrs/day (interior lights)	902	Indiana TRM (v2.2)
Hrs/day (9-watt exterior lights)	1,607	Indiana TRM (v2.2)
WHFe –weighted average waste heat factor	-0.061 for interior, 0 for exterior	Indiana TRM (v2.2) for Indianapolis
Coincidence factor (CF)	0.11	Indiana TRM (v2.2)
WHFd – weighted average waste heat factor	0.055 for interior, 0 for exterior	Indiana TRM (v2.2) for Indianapolis

Savings Summary for LEDs

Table F-3 shows the *ex ante* deemed savings and the resulting *ex post* per-measure savings for LEDs.

Table F-3. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for LEDs

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
9-watt LED	18.14	0.002	28.80	0.004
16-watt LED	32.66	0.004	41.50	0.005
5-watt globe LED	26.67	0.004	29.64	0.004
5-watt candelabra LED	25.56	0.004	29.64	0.004
7-watt track LED	10.89	0.002	36.42	0.005
R30, 10-watt LED	26.73	0.006	46.58	0.006
9-watt exterior LED	28.27	0.000	54.64	0.000

Ex ante and *ex post* savings differ for one reason:

- ***Differences in baseline wattage calculations for LEDs:*** To calculate *ex ante* savings, CLEAResult applied the Indiana TRM (v2.2) baseline wattages and WHFs for 9-watt bulbs and applied a separate electric WHF and ISR for specialty bulbs. The evaluation team did not receive detailed information about the source of the separate WHFs; therefore we calculated *ex post* savings by applying the EISA-adjusted baseline wattages and the Indiana TRM (v2.2) WHF across all bulbs, as specified in the program materials. The UMP and ENERGY STAR equivalent baseline wattages were larger than the Indiana TRM (v2.2) baseline wattages, which were designed to reflect a balance of replacing various bulb types, hence resulting in *ex post*, per-bulb savings values greater than *ex ante* values.

Carryover Bulbs

To calculate carryover bulbs, the team referenced the UMP to estimate how many bulbs would be installed each year. The team used the initial first-year installation rate for kit measures and extrapolated out the estimated lifetime installation rates for these bulbs using the 24% estimation, plus a discount factor to account for installation delays. A lifetime cumulative installation rate of 83% (Table F-4) was applied rather than the original calculated installation rate for kit LEDs to account for future installations of bulbs in storage.

Table F-4. 2019 IQW Program Adjusted Lifetime Installation Rates for Kit Lighting Measures

Year	Calendar Year	Cumulative ISR
Year 1	2019	67%
Year 2	2020	74%
Year 3	2021	79%
Year 4	**2022**	**83%**

Bathroom and Kitchen Faucet Aerators

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for bathroom and kitchen faucet aerators installed in homes with an electric water heater:

$$kWh\ savings_{aerator} = (gpm_{base} - gpm_{low})\ x\ MPD * \frac{PH}{FH} * \mathrm{DR} * \mathrm{S} * (T_{mix} - T_{Inlet}) * \frac{365}{RE * 3{,}412}$$

$$kW\ reduction_{aerator} = (gpm_{base} - gpm_{low}) * 60 * \mathrm{DR} * S * \frac{(T_{mix} - T_{Inlet})}{RE * 3{,}412} * CF$$

Where:

gpm_{base}	=	Baseline flow rate of existing faucet in gallons per minute
gpm_{low}	=	Low-flow rate of aerator in gallons per minute
MPD	=	Average minutes of faucet use per day per person
PH	=	Average number of people per household
FH	=	Average number of faucets per household
DR	=	Drain recovery factor representing the percentage of water flowing down the drain
S	=	Constant used to convert the weight of water from gallons to pounds (8.3 lbs/gallon)
T_{mix}	=	Temperature of water leaving the aerator (°F)
T_{inlet}	=	Temperature of water entering the water heater (°F)
RE	=	Recovery efficiency of the electric water heater in operation
CF	=	Coincidence factor; a number between 0 and 1 indicating the ratio of aerators expected to be in use and saving energy during the peak summer demand period

Table F-5 summarizes *ex post* assumptions and sources for installed faucet aerators.

Table F-5. 2019 IQW Program *Ex Post* Variable Assumptions for Faucet Aerators

Variable	Value		Source
	Bathroom	Kitchen	
gpm_{base}	1.9	2.44	Indiana TRM (v2.2)
gpm_{low}	1.0	1.5	Gallons per minute of installed aerators
Minutes/person/day (MPD)	1.6	4.5	Indiana TRM (v2.2)
People per household (PH)	2.64	2.64	Indiana TRM (v2.2)
Faucets per household (FH)	2.04	1	Indiana TRM (v2.2)
Drain recovery factor (DR)	0.7	0.5	Indiana TRM (v2.2)
Conversion factor (S)	8.3	8.3	Engineering constant in units of Btu/(gal˚F)
Mixed temperature (T_{mix})	86	93	Indiana TRM (v2.2)
Inlet temperature (T_{Inlet})	58.1	58.1	Indiana TRM (v2.2) for Indianapolis
Recovery efficiency (RE)	0.98	0.98	Indiana TRM (v2.2)
Coincidence factor (CF)	0.0012	0.0033	Indiana TRM (v2.2)

Savings Summary for Faucet Aerators

Table F-6 shows *ex ante* deemed savings and the resulting *ex post,* per-measure savings for faucet aerators. The evaluation team calculated savings for faucet aerators installed through the IQW program using efficient faucet information and the Indiana TRM (v2.2).

Table F-6. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Faucet Aerators

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Bathroom Aerators	13.33	0.003	32.97	0.003
Kitchen Aerators	167.73	0.008	176.55	0.008

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited a deemed savings value, while the evaluation team leveraged the Indiana TRM (v2.2).

Low-Flow Showerheads

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for low-flow showerheads installed in homes with an electric water heater:

$$kWh\ savings_{Showerhead} = (gpm_{base} - gpm_{low}) * \mathrm{MS} * \mathrm{SPD} * \frac{PH}{SH} * S * (T_{mix} - T_{Inlet}) * \frac{365}{RE * 3{,}412}$$

$$kW\ reduction_{Showerhead} = (gpm_{base} - gpm_{low}) * 60 * S * \frac{(T_{mix} - T_{Inlet})}{RE * 3{,}412} * CF$$

Where:

gpm_{base} = Baseline flow rate of existing showerhead in gallons per minute

gpm_{low} = Low-flow rate of showerhead in gallons per minute

MS = Average minutes per shower per person per day

SPD = Average number of showers per person per day

PH = Average number of people per household

SH = Average number of showerheads per household

S = Constant used to convert the weight of water from gallons to pounds (8.3 lbs/gallon)

T_{mix} = Temperature of the water leaving the showerhead (°F)

T_{inlet} = Temperature of the water entering the water heater (°F)

RE = Recovery efficiency of the electric water heater in operation

CF = Coincidence factor; a number between 0 and 1 indicating the ratio of showerheads expected to be in use and saving energy during the peak summer demand period

Table F-7 summarizes *ex post* assumptions and sources for installed low-flow showerheads.

Table F-7. 2019 IQW Program *Ex Post* Variable Assumptions for Low-Flow Showerheads

Variable	Value	Source
gpm_{base}	2.63	Indiana TRM (v2.2)
gpm_{low}	1.5	Gallons per minute of installed showerhead
Minutes per shower per person per day (MS)	7.8	Indiana TRM (v2.2)
Showers per person per day (SPD)	0.6	Indiana TRM (v2.2)
People per household (PH)	2.64	Indiana TRM (v2.2)
Showerheads per household (SH)	1.6	Indiana TRM (v2.2)
Conversion factor (S)	8.3	Engineering constant in units of Btu/(gal˚F)
Mixed temperature (T_{mix})	101	Indiana TRM (v2.2)
Inlet temperature (T_{Inlet})	58.1	Indiana TRM (v2.2)
Recovery efficiency (RE)	0.98	Indiana TRM (v2.2)
Coincidence factor (CF)	0.0023	Indiana TRM (v2.2)

Savings Summary for Low-Flow Showerheads

For this measure, an efficient, low-flow showerhead replaces an existing, less-efficient showerhead. Table F-8 shows *ex ante* deemed savings and the resulting *ex post* per-measure savings for low-flow showerheads installed through the IQW program.

Table F-8. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Low-Flow Showerheads

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Low-Flow Showerhead	322.20	0.016	339.16	0.017

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited a deemed savings value, while the evaluation team leveraged the Indiana TRM (v2.2).

Pipe Wrap Insulation

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for pipe wrap insulation installed in homes with an electric water heater:

$$kWh\ savings_{pipe\ insulation} = \frac{\left(\frac{1}{R_{existing}} - \frac{1}{R_{new}}\right) * \ L * C * (\Delta T) * Hrs/yr}{3{,}412 * EF_{electric\ WH}}$$

$$kW\ reduction_{pipe\ insulaton} = \frac{kWh\ savings_{pipe\ insulation}}{Hrs/yr}$$

Where:

$R_{existing}$	=	R-value of uninsulated hot water pipe
R_{new}	=	R-value after installation of new pipe insulation
L	=	Total linear feet of installed pipe insulation
C	=	Circumference of hot water pipe in feet (assumed pipe diameter of 0.5 inches): C = $\pi * pipe\ diameter * 0.083$
ΔT	=	Difference between ambient temperature where the water heater is installed and temperature of the distributed hot water
EF	=	Energy factor of the electric water heater in operation
Hrs/yr	=	Total number of hours per year the water heater is in operation
EF	=	Energy factor of the electric water heater in operation

Table F-9 summarizes *ex post* assumptions and sources for the installed pipe wrap insulation.

Table F-9. 2019 IQW Program *Ex Post* Variable Assumptions for Pipe Wrap Insulation

Variable	Value	Source
$R_{existing}$	1	Indiana TRM (v2.2)
R_{new}	3	Indiana TRM (v2.2)
Pipe length (L)	1	To calculate savings in 1-foot increments
Circumference (C)	0.19635	Assumes 0.75-inch diameter pipe
Temperature change (ΔT)	65	Indiana TRM (v2.2)
Hours per year (Hrs/yr)	8760	Indiana TRM (v2.2)
Energy factor (EF)	1	Indiana TRM (v2.2)

Savings Summary for Pipe Wrap Insulation

Table F-10 shows *ex ante* deemed savings and the resulting *ex post* savings for pipe wrap insulation, per installed foot.

Table F-10. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Installed Foot Savings for Pipe Wrap Insulation

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Pipe Wrap Insulation	26.84	0.003	22.29	0.003

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited deemed savings, while the evaluation team leveraged the Indiana TRM (v2.2).

Smart Strips

Algorithms and Variable Assumptions

The evaluation teamed used two deemed values from the Indiana TRM (v2.2) to determine energy savings and demand reduction from computer and audio-visual equipment:

$$kWh\ savings_{Smart\ Strip} = deemed = 24.3$$

$$kW\ reduction_{Smart\ Strip} = deemed = 0.0044$$

Savings Summary for Smart Strips

Ex ante deemed savings and resulting *ex post,* per-measure savings for smart strips are shown in Table F-11.

Table F-11. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Smart Strips

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Smart Strips	24.8	0.004	24.8	0.004

Programmable Thermostats

Algorithms and Variable Assumptions

The evaluation team used three equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for programmable thermostats:

$$kWh\ savings_{PStat} = kWh\ savings_{AC\ cooling} + kWh\ savings_{Elec\ htg}$$

$$kWh\ savings_{AC\ cooling} = \frac{1}{n_{cool}} * FLH_{cool} * \frac{BTUh_{cool}}{1000} * ESF_{cool}$$

$$kWh\ savings_{Elec\ htg} = FLH_{heat} * \frac{BTUh_{heat}}{n_{heat} * 3{,}412} * ESF_{heat}$$

Where:

n_{cool}	=	Efficiency of existing cooling system controlled by programmable thermostat (in SEER units)
FLH_{cool}	=	Full-load cooling hours for Indianapolis
$Btuh_{cool}$	=	Capacity of cooling system (Btu/hour)
ESF_{cool}	=	Energy savings factor for cooling
FLH_{heat}	=	Full-load heating hours for Indianapolis
Btu_{cool}	=	Capacity of cooling system (Btu/hour)
$Btuh_{heat}$	=	Capacity of heating system (Btu/hour)
n_{cool}	=	Efficiency of existing cooling system controlled by programmable thermostat (in SEER units)
n_{heat}	=	Efficiency of an existing heating system controlled by a programmable thermostat (in units of coefficient of performance)
ESF_{cool}	=	Energy savings factor for cooling
ESF_{heat}	=	Energy savings factor for heating

Table F-12 summarizes *ex post* assumptions and sources for installed programmable thermostats.

Table F-12. 2019 IQW Program *Ex Post* Variable Assumptions for Programmable Thermostats

Variable	Value	Source
n_{cool}	11.15	Indiana TRM (v2.2)
FLH_{cool}	487	Indiana TRM (v2.2) for Indianapolis
$Btuh_{cool}$	28,994	Indiana TRM (v2.2)
ESF_{cool}	0.09	Indiana TRM (v2.2)
FLH_{heat}	1,341	Indiana TRM (v2.2) for Indianapolis
$Btuh_{heat}$	32,000	2016 Pennsylvania TRM
n_{heat} (electric resistance)	1	Indiana TRM (v2.2)
n_{heat} (heat pump)	2.26	Indiana TRM (v2.2)
ESF_{heat}	0.068	Indiana TRM (v2.2)

Savings Summary for Programmable Thermostats

Table F-13 shows *ex ante* deemed savings and the resulting *ex post,* per-measure savings for programmable thermostats.

Table F-13. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Programmable Thermostats

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Programmable Thermostat (Electric Heat + Central AC)	897.56	0	969.20	0
Programmable Thermostat (ASHP)	507.29	0	492.39	0
Programmable Thermostat (Electric Heat Only)	774.88	0	855.22	0
Programmable Thermostat (Natural Gas Heat + Central AC)	113.97	0	113.97	0

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited a deemed savings value for programmable thermostats. The evaluation team referred to the Indiana TRM (v2.2) to calculate savings, using equipment capacities as specified in the Indiana TRM (v2.2) and the 2016 Pennsylvania TRM for Btuh cooling values.

Smart Thermostats

Algorithms and Variable Assumptions

The evaluation team used three equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for smart thermostats:

$$kWh\ savings_{PStat} = kWh\ savings_{AC\ cooling} + kWh\ savings_{Elec\ htg}$$

$$kWh\ savings_{AC\ cooling} = \frac{1}{n_{cool}} * FLH_{cool} * \frac{BTUh_{cool}}{1{,}000} * ESF_{cool}$$

$$kWh\ savings_{Elec\ htg} = FLH_{heat} * \frac{BTUh_{heat}}{n_{heat} * 3{,}412} * ESF_{heat}$$

Where:

n_{cool} = Efficiency of existing cooling system controlled by programmable thermostat (in units of SEER)

FLH_{cool} = Full-load cooling hours for Indianapolis

$Btuh_{cool}$ = Capacity of cooling system (Btu/hour)

ESF_{cool} = Energy savings factor for cooling

FLH_{heat} = Full-load heating hours for Indianapolis

Btu_{cool} = Capacity of cooling system (Btu/hour)

$Btuh_{heat}$ = Capacity of heating system (Btu/hour)

n_{cool} = Efficiency of existing cooling system controlled by programmable thermostat (in units of SEER)

n_{heat} = Efficiency of existing heating system controlled by programmable thermostat (in units of coefficient of performance)

ESF_{cool} = Energy savings factor for cooling

ESF_{heat} = Energy savings factor for heating

Table F-14 summarizes *ex post* assumptions and sources for installed smart thermostats.

Table F-14. 2019 IQW Program *Ex Post* Variable Assumptions for Smart Thermostats

Variable	Value	Source
n_{cool}	11.15	Indiana TRM (v2.2)
FLH_{cool}	487	Indiana TRM (v2.2) for Indianapolis
$Btuh_{cool}$	28,994	Indiana TRM (v2.2)
ESF_{cool}	0.049 if replacing programmable in use, else 0.139	Vectren 2015 report
FLH_{heat}	1,341	Indiana TRM (v2.2) for Indianapolis
$Btuh_{heat}$	32,000	2016 Pennsylvania TRM
n_{heat} (electric resistance)	1	Indiana TRM (v2.2)
n_{heat} (heat pump)	2.26	Indiana TRM (v2.2)
ESF_{cool}	0.049 if replacing Programmable in use, else 0.139	Vectren 2015 report
ESF_{heat}	0.057 if replacing programmable in use, else 0.125	Vectren 2015 report

Savings Summary for Smart Thermostats

Table F-15 shows *ex ante* deemed savings and the resulting *ex post,* per-measure savings for smart thermostats.

Table F-15. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Smart Thermostats

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Smart Thermostat (Electric Heat + Central AC)	1,700.73	0	1,461.77	0
Smart Thermostat (ASHP)	747.74	0	642.17	0
Smart Thermostat (Natural Gas Heat + Central AC)	155.68	0	134.34	0

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Btuh assumptions:*** CLEAResult referred to actual equipment capacities. Since the evaluation team did not receive equipment capacity information, we leveraged the Indiana TRM (v2.2) and the 2016 Pennsylvania TRM for equipment capacities to calculate *ex post* savings.

Water Heater Setback

Algorithms and Variable Assumptions

The evaluation team used two equations from the Illinois TRM (v7) to calculate *ex post,* per-measure energy savings and demand reduction for water heater setback:

$$kWh\ savings_{WH} = \frac{\left(U * A * \left(T_{pre} - T_{post}\right) * Hours * ISR\right)}{3{,}412 * RE_{elec}}$$

$$kW\ reduction_{WH} = \Delta kWh/\ Hours * CF$$

Where:

U	=	Overall heat transfer coefficient of tank (Btu/hr-F-ft^2)
A	=	Surface area of tank (square feet)
T_{pre}	=	Hot water setpoint prior to adjustment (°F)
T_{post}	=	Hot water setpoint after adjustment (°F)
Hours	=	Hours per year
ISR	=	In service rate
RE_{elec}	=	Recovery efficiency of electric water heater
CF	=	Coincidence factor

Table F-16 summarizes *ex post* assumptions and sources for water heater setback.

Table F-16. 2019 IQW Program *Ex Post* Variable Assumptions for Water Heater Setback

Variable	Value	Source
U	0.083	Illinois TRM (v7)
A	Actual	Program tracking data
T_{pre}	Actual	Program tracking data
T_{post}	120	Illinois TRM (v7)
Hours	8,766	Illinois TRM (v7)
ISR	1	Illinois TRM (v7)
RE_{elec}	0.98	Illinois TRM (v7)
CF	1.0	Illinois TRM (v7)

Savings Summary for Water Heater Setback

Table F-17 shows *ex ante* deemed savings and the resulting *ex post,* per-measure savings for water heater setbacks.

Table F-17. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Water Heater Setback

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Water Heater Setback	175.16	0.020	98.61	0.011

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***U-value:*** The evaluation team received in-field conditions for existing inlet temperature and tank size but did not receive existing tank insulation. The evaluation team used the Illinois TRM (v7) default U value for when existing conditions are unknown.

Attic Insulation

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for attic insulation:

$$kWh\ savings_{Insulation} = kSF * \left(\frac{\Delta kWh}{kSF}\right)$$

$$kW\ reduction_{Insulation} = kSF * \left(\frac{\Delta kW}{kSF}\right) * CF$$

Where:

kSF	=	Total area (in 1,000 square feet) of installed insulation
ΔkWh/kSF	=	Energy savings for every 1,000 square feet of installed insulation, accounting for pre- and post-installation R-value conditions (varies by HVAC equipment)
ΔkW/kSF	=	Demand reduction for every 1,000 square feet of installed insulation, accounting for pre- and post-installation R-value conditions (varies by HVAC equipment)
CF	=	Coincidence factor; a number between 0 and 1 indicating the ratio of cooling equipment expected to be in use and saving energy during the peak summer demand period

The Indiana TRM (v2.2) provides lookup tables that include expected energy savings and demand reduction (per 1,000 square feet of installed insulation) for different pre- and post-insulation R-values. The evaluation team calculated these R-values using a three-step process:

1. Determine variables for insulation compression, R-value ratios, and void factors.
2. Calculate the adjusted R-values.
3. Interpolate within Indiana TRM (v2.2) tables[58] using the adjusted R-values and obtain savings per 1,000 square feet of insulation (ΔkWh/kSF and ΔkW/kSF).

[58] "Appendix C – Insulation Measures in Single Family Buildings."

Step 1: Determine Variables for Insulation Compression, R-Value Ratios, and Void Factors

Insulation Compression ($F_{compression}$)

Insulation compressed during installation results in reduced R-values. Therefore, it is important to account for compression when calculating insulation savings. There was no information for this evaluation that supports adjusting R-values due to compression, so the team assumed 0% compression.

R-Value Ratio (R_{ratio})

The void factor varies based on the ratio between the full assembly R-value and the nominal R-value with the inclusion of compression effects. This ratio was used to identify the void factor in lookup tables provided in the Indiana TRM (v2.2). The evaluation team calculated pre- and post-installation R-value ratios using an equation from Indiana TRM (v2.2):

$$R_{ratio} = (R_{nominal} * F_{compression})/((R_{nominal} + R_{frame\,\&\,air})$$

Where:

$R_{nominal}$ = Pre- or post-installation R-value provided in program database

$F_{compression}$ = Compression factor dependent on the percentage of insulation compression; this value is 1, assuming 0% compression

$R_{frame\,\&\,air}$ = The R-value for materials, framing, and air space for the area where insulation is installed (= R-5 per the Indiana TRM (v2.2))

Void Factor (F_{void})

Table F-18 outlines the void factor, based on the calculated R_{ratio}. The evaluation team assumed a 2% void for pre- and post-insulation installation, as this information remained unknown.

Table F-18. 2019 IQW Program Insulation Void Factors

R_{ratio}	Fvoid	
	2% Void (Grade II) [a]	5% Void (Grade III)
0.50	0.96	0.90
0.55	0.96	0.90
0.60	0.95	0.88
0.65	0.94	0.87
0.70	0.94	0.85
0.75	0.92	0.83
0.80	0.91	0.79
0.85	0.88	0.74
0.90	0.83	0.66
0.95	0.71	0.49
0.99	0.33	0.16

Source: Indiana TRM (v2.2).

[a] The evaluation team assumed a 2% void.

Step 2: Calculate the Adjusted R-Values

The evaluation team used R-values from the 2019 program tracking database to calculate adjusted R-values that accounted for factors such as compression, void factors, and installation grade levels via the following formula:

$$Rvalue_{Adjusted} = R_{nominal} * F_{compression} * F_{void}$$

Where:

$R_{nominal}$ = Pre- or post-installation R-value provided in program database

$F_{compression}$ = Compression factor dependent on the percentage of insulation compression; this value is 1, assuming 0% compression

F_{void} = Void factor dependent on the insulation installation grade level and percentage of coverage

Step 3: Interpolate within Indiana TRM (v2.2) Tables

The evaluation team interpolated per-measure energy savings and demand reduction values found in the Indiana TRM (v2.2) to determine savings per 1,000 square feet for the adjusted pre- and post-installation R-values (calculated in Step 2).

Savings Summary for Attic Insulation

The evaluation team calculated *ex ante* and *ex post* savings using a custom approach that leveraged project-specific information where available (such as pre- and post-installation R-values), therefore developing unique savings per participant. Rather than display all unique savings values, Table F-19 shows average savings per participant.

Table F-19. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Participant Savings for Attic Insulation

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Attic Insulation – Electric Heat + Central AC (per sf)	0.58	0.000	1.31	0.000 [a]

[a] *Ex post* savings are 0.0002 kW per square foot.

The differences between *ex ante* and *ex post* savings resulted for two reasons:

- ***Actual pre- and post-installation R-values:*** The evaluation team determined that CLEAResult applied the Indiana TRM (v2.2) deemed kWh/kSF and kW/kSF values that most closely resembled the pre-determined R-value bins, whereas the evaluation team interpolated within the Indiana TRM (v2.2) kWh/SF and kW/SF deemed savings values such that savings reflected actual pre- and post-installation conditions.
- ***Per unit and program kilowatt savings values:*** CLEAResult reported the total kilowatt savings for both the participant's unit savings and for total savings.

Radiant Barrier

Algorithms and Variable Assumptions

The evaluation team applied an *ex post* radiant barrier value from the IPL 2018-2020 DSM Programs Technical Specifications, consistent with CLEAResult's's approach.

Savings Summary for Audit Recommendations

Table F-20 shows a comparison of *ex ante* and *ex post,* per-square-foot savings for the radiant barrier.

Table F-20. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Square-Foot Savings for Radiant Barrier

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Radiant Barrier	0.48	0.000 [a]	0.4815	0.000 [a]

[a] *Ex ante* and *ex post* savings are both 0.000067 kW per square foot.

Duct Sealing

Algorithms and Variable Assumptions

The evaluation team used four equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for duct sealing:

$$kWh\ savings_{PStat} = kWh\ savings_{heat} + kWh\ savings_{cool}$$

$$kWh\ Savings_{heat} = \frac{(DE_{After} - DE_{Before})}{DE_{after}} * \frac{FLH_{heat} * Btuh_{heat}}{n_{heat} * 3{,}412}$$

$$kWh\ Savings_{cool} = \frac{(DE_{After} - DE_{Before})}{DE_{after}} * \frac{FLH_{cool} * Btuh_{cool}}{SEER * 1{,}000}$$

$$kW\ Savings = \frac{(DE_{Afterpeak} - DE_{Beforepeak})}{DE_{afterpeak}} * \frac{Btuh_{cool}}{EER * 1{,}000} * CF$$

Where:

DE_{after} = Distribution system efficiency after duct sealing

DE_{before} = Distribution system efficiency before duct sealing

FLH_{heat} = Full-load cooling hours for Indianapolis

$Btuh_{heat}$ = Capacity of heating system (Btu/hour)

n_{heat} = Efficiency of the existing heating system controlled by a programmable thermostat (in units of coefficient of performance)

FLH_{cool} = Full-load heating hours for Indianapolis

$Btuh_{cool}$ = Capacity of cooling system (Btu/hour)

Btu_{heat} = Capacity of heating system (Btu/hour)

SEER = Seasonal average efficiency of AC equipment (in SEER units)

EER = Peak efficiency of AC equipment in EER units (if unknown, EER = SEER * 0.9)

CF = Coincidence factor

Table F-21 summarizes *ex post* assumptions and sources for duct sealing.

Table F-21. 2019 IQW Program *Ex Post* Variable Assumptions for Duct Sealing

Variable	Value	Source
DE_{after} (cool)	Actual	Program tracking data
DE_{after} (heat)	Actual	Program tracking data
DE_{before} (cool)	Actual	Program tracking data
DE_{before} (heat)	Actual	Program tracking data
FLH_{heat}	1,341	Indiana TRM (v2.2)
$Btuh_{heat}$	Actual	Program tracking data
n_{heat} (heat pump)	2.26	Indiana TRM (v2.2), heat pump
n_{heat} (electric furnace)	1	Indiana TRM (v2.2), electric furnace
FLH_{cool}	487	Indiana TRM (v2.2)
$Btuh_{cool}$	Actual	Program tracking data
SEER	11.15	Program tracking data
$De_{peakafter}$	Actual	Program tracking data
$De_{peakbefore}$	Actual	Program tracking data
EER	10.035	Program tracking data
CF	0.88	Indiana TRM (v2.2)

Savings Summary for Duct Sealing

Table F-22 shows *ex ante* deemed savings and resulting *ex post,* per-measure savings for duct sealing.

Table F-22. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Duct Sealing

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Duct Sealing (Electric Heat Only)	958.69	0.123	959.50	0.128
Duct Sealing (Heat Pump)	482.26	0.269	482.26	0.239

Air Sealing

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for air sealing:

$$kWh\ savings_{Air\ Sealing} = (CFM50_{existing} - CFM50_{air\ sealed}) * \frac{\left(\frac{\Delta kWh}{cfm}\right)}{N_{factor}}$$

$$kW\ reduction_{Air\ Sealing} = (CFM50_{existing} - CFM50_{air\ sealed}) * \frac{\left(\frac{\Delta kW}{CFM}\right)}{N_{factor}} * CF$$

Where:

$CFM50_{existing}$	=	Initial blower door results, measured in cubic feet per minute and pressurized at 50 pascal, of the amount of leakage in the home prior to air-sealing measures
$CFM50_{air\ sealed}$	=	Blower door results measures, in cubic feet per minute and pressurized at 50 pascal, of the amount of leakage in the home after installing air-sealing measures
ΔkWh/CFM	=	Energy savings for each cfm reduction (varies by HVAC equipment)
N_{factor}	=	Constant used to convert 50-pascal air flow to natural air flow (the latter dependent on exposure levels)
ΔkW/CFM	=	Demand reduction for each cfm reduction (varies by HVAC equipment)
N_{factor}	=	Constant used to convert 50-pascal air flow to natural air flow (the latter dependent on exposure levels)
CF	=	Coincidence factor; a number between 0 and 1 indicating the ratio of cooling equipment expected to be in use and saving energy during the peak summer demand period

Table F-23 summarizes *ex post* assumptions and sources for the air-sealing measure.

Table F-23. 2019 IQW Program *Ex Post* Variable Assumptions for Air Sealing

Variable	Value	Source
$CFM50_{existing}$	Actual	IQW program data
$CFM50_{air\ sealed}$	Actual	
ΔkWh/CFM (Electric Resistance Heat and AC)	50.1	Indiana TRM (v2.2)
ΔkWh/CFM (Heat Pump)	30.9	
ΔkWh/CFM (Electric Heat Only)	48.2	
ΔkWh/CFM (Natural Gas Heat and AC)	2.4	
N_{factor}	16.3	Indiana TRM (v2.2) for unknown number of stories and exposure
ΔkW/CFM (Electric Resistance Heat and AC)	0.006	Indiana TRM (v2.2)
ΔkW/CFM (Heat Pump)	0.003	
ΔkW/CFM (Natural Gas Heat and AC)	0.001	
CF (coincidence factor)	0.88	Indiana TRM (v2.2)

Savings Summary for Air Sealing

Table F-24 shows *ex ante* deemed savings and resulting *ex post,* per-measure savings for air sealing.

Table F-24. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Air Sealing

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Air Sealing (Electric Heat with Central AC)	1,122.82	0.118	1,122.82	0.118
Air Sealing (Heat Pump)	662.44	0.057	662.44	0.057
Air Sealing (Electric Heat Only)	1,386.86	0	1,386.86	0
Air Sealing (Natural Gas Heat with Central AC)	73.29	0.027	73.29	0.027

Refrigerator Replacement

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for low-income, early refrigerator replacement.

$$kWh\ savings = UEC_{exist} - UEC_{efficient}$$

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

Where:

UEC_{exist} = Unit energy consumption of existing refrigerator

$UEC_{efficient}$ = Unit energy consumption of new, ENERGY STAR refrigerator

TAF = Temperature adjustment factor

$LSAF_{exist}$ = Load shape adjustment factor for existing unit

$LSAF_{efficient}$ = Load shape adjustment factor of new, ENERGY STAR refrigerator

Table F-25 summarizes *ex post* assumptions and sources for the refrigerator replacement measure.

Table F-25. 2019 IQW Program *Ex Post* Variable Assumptions for Refrigerator Replacement

Variable	Value	Source
UEC_{exist}	1,696	Indiana TRM (v2.2)
$UEC_{efficient}$	397	Indiana TRM (v2.2)
TAF	1.21	Indiana TRM (v2.2)
$LSAF_{exist}$	1.06	Indiana TRM (v2.2)
$LSAF_{efficient}$	1.124	Indiana TRM (v2.2)

Savings Summary for Refrigerator Replacement

Table F-26 shows *ex ante* deemed savings and resulting *ex post,* per-measure savings for refrigerator replacements.

Table F-26. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Refrigerator Replacement

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Refrigerator Replacement	1299.00	0.187	1,299.00	0.187

LED Night Lights

Algorithms and Variable Assumptions

The evaluation team used an equation from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for LED night lights provided in the kits.

$$kWh\ savings = \frac{\left(W_{base} - W_{Night\ light}\right) * (Hours)}{1{,}000}$$

Where:

W_{base} = Baseline wattage of existing night light replaced with a LED night light (= 5 watts)

$W_{Night\ Light}$ = Actual wattage of installed LED night light (= 0.5 watts)

Hours = Average number of hours per day the night light remains in use

Table F-27 summarizes *ex post* assumptions and sources for LED night lights.

Table F-27. 2019 IQW Program *Ex Post* Variable Assumptions for LED Night Lights

Variable	Value	Source
Baseline Wattage (W_{base})	5	Indiana TRM (v2.2)
LED Night Light Wattage ($W_{Night\ Light}$)	0.33	Indiana TRM (v2.2)
Hours	2,920	Indiana TRM (v2.2)

Savings Summary for LED Night Lights

Table F-28 shows *ex ante* deemed savings and resulting *ex post,* per-measure savings for LED night lights.

Table F-28. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for LED Night Lights

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
LED Night Lights	13.64	0	13.64	0

Filter Whistle

Algorithms and Variable Assumptions

The evaluation team used four equations from the 2016 Pennsylvania TRM to calculate the *ex post,* per-measure energy savings and demand reduction for filter whistles:

$$kWh\ savings_{Filter\ Whistle} = \Delta \mathrm{kWh}/yr\ savings_{\ heat} + \Delta \mathrm{kWh}/yr\ savings_{\ cool}$$

$$kWh/yr\ savings_{heat} = \mathrm{kW}_{motor} * FLH_{heat} * EI * ISR$$

$$kWh/yr\ savings_{cool} = \mathrm{kW}_{motor} * FLH_{cool} * EI * ISR$$

$$kW\ reduction_{Filter\ Whistle} = \frac{kWh/yr_{cool}}{FLH_{cool}} * \mathrm{CF}$$

Where:

kW_{motor}	=	Average motor full load electric demand
FLH_{heat}	=	Full-load heating hours
FLH_{cool}	=	Full-load cooling hours
EI	=	Efficiency improvement
ISR	=	In-service rate
FLH_{cool}	=	Full-load cooling hours
CF	=	Coincidence factor

Table F-29 summarizes *ex post* assumptions and sources for filter whistles.

Table F-29. 2019 IQW Program *Ex Post* Variable Assumptions for Filter Whistles

Variable	Value	Source
kW_{motor}	0.5	2016 Pennsylvania TRM
FLH_{heat}	1,341	Indiana TRM (v2.2) for Indianapolis
EI	0.15	2016 Pennsylvania TRM
ISR	1	Assumed for analysis
FLH_{cool}	487	Indiana TRM (v2.2) for Indianapolis
CF	0.647	2016 Pennsylvania TRM
ISR	1	Assumed for analysis

Savings Summary for Filter Whistles

Table F-30 shows *ex ante* deemed savings and resulting *ex post,* per-measure savings for filter whistles provided in the kits.

Table F-30. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Filter Whistles

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Filter Whistle – heating and central air conditioning	64.17	0.098	137.05	0.049
Filter Whistle – heating only	64.17	0.098	100.58	0

The differences between *ex ante* and *ex post* savings resulted for three reasons:

- ***In-service rate for filter whistles:*** For the *ex ante* analysis, CLEAResult applied the embedded 2016 Pennsylvania TRM ISR of 0.474. The evaluation team applied an ISR of 1.0 for the *ex post* analysis and applied the actual ISR after the *ex post* calculations. This resulted in *ex post*, per-measure savings being higher than *ex ante* savings.
- ***Demand reduction calculation:*** CLEAResult included both heating and cooling energy savings is the demand reduction calculation. The evaluation team applied the cooling energy savings.
- ***Cooling type:*** The evaluation team applied only the heating component of energy savings and did not apply demand reduction savings to customer without central air conditioning.

Audit Recommendations

Algorithms and Variable Assumptions

The evaluation team applied an *ex post* audit recommendation value from the 2014 *Energizing Indiana Statewide Core Program Report*, consistent with CLEAResult's approach.

Savings Summary for Audit Recommendations

Table F-31 shows a comparison of *ex ante* and *ex post,* per-measure savings for the audit recommendations.

Table F-31. 2019 IQW Program *Ex Ante* and *Ex Post* Per-Measure Savings for Audit Recommendations

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Audit Recommendations	75.74	0	75.74	0

As the evaluation team did not conduct a participant audit survey in 2019, we recommend that future assessments include a follow-up survey with program participants to determine the number who are implementing one or more audit recommendations. Survey results will be leveraged with a per-measure TRM evaluation to inform and estimate savings that more closely reflect energy savings resulting from implementing audit measures.

Appendix G. Lighting and Appliance Program Measures, Assumptions, and Algorithms

This appendix contains the algorithms and assumptions for calculating energy savings and demand reduction for measures offered through the Lighting and Appliance program—LED lighting, smart thermostats, air purifiers, dehumidifiers, and smart power strips. The evaluation team compared each assumption used in the savings algorithms against the Indiana TRM (v2.2), as well as to other state and industry approaches.

LED Lighting

The evaluation team used two equations to calculate energy savings and demand reduction for LEDs:

$$\Delta kWh = \frac{(W_{base} - W_{LED})}{1{,}000} * HOU * (1 + WHF_e) * ISR$$

$$\Delta kW = \frac{(W_{base} - W_{LED})}{1{,}000} * CF * (1 + WHF_d) * ISR$$

Where:

W_{base}	=	Weighted average wattage of bulb being replaced
W_{LED}	=	Wattage of LED bulb
1,000	=	Constant to convert watts to kilowatts
HOU	=	Average hours of use per year
WHF_e	=	Waste heat factor for energy to account for HVAC interactions with lighting (= depends on location)
ISR	=	In-service rate, lifetime net present value
CF	=	Summer peak coincidence factor
WHF_d	=	Waste heat factor for demand to account for HVAC interactions with lighting (= depends on location)

Table G-1 lists the input assumptions and sources for the LEDs measure savings calculations.

Table G-1. 2019 Lighting and Appliance Program *Ex Post* Variable Assumptions for LEDs

Input	Value	Source
W_{base}	Varies	ENERGY STAR lumens bins
W_{LED}	Varies	2019 tracking data
HOU	902	Indiana TRM (v2.2)
WHF_e	-0.061	Indiana TRM (v2.2), Indianapolis values
ISR	First Year, all lamps: 86% General service: 92% Reflector/specialty: 96%	2014 Indiana Market Effects Study, augmented using UMP
CF	0.11	Indiana TRM (v2.2)
WHF_d	0.055	Indiana TRM (v2.2), Indianapolis values

Baseline Wattages for Non-PAR, MR, and MRX Lamp Types

Table G-2 shows the distribution of baseline wattages applied using the lumen equivalence method. This approach is specified in the UMP and uses the ENERGY STAR online database to calculate final baseline wattages for all program LEDs except certain PAR, MR, and MRX lamp types (depending on their stated lumen output).

Table G-2. Baseline Wattages for 2019 Lighting and Appliance Program Qualifying LED Lamps by Lumens and Shape

Lamp Shape	Lumen Range		
	Lower	Upper	2017–2019 $Watts_{base}$
Omnidirectional, Medium Screw-Base Lamps (A, BT, P, PS, S or T) See exceptions in gray rows below	250	309	25
	310	749	29
	750	1,049	43
	1,050	1,489	53
	1,490	2,600	72
	2,601	3,300	150
	3,301	3,999	200
	4,000	6,000	300
S Shape ≤749 lumens and T Shape ≤749 lumens or T Shape >10-inches long	250	309	25
	310	749	40
Decorative, Medium Screw-Base Lamps (G) See exceptions in gray rows below	250	309	25
	310	749	29
	750	1,049	43
	1,050	1,300	53
G16-1/2, G25, and G30 ≤499 lumens	250	309	25
	310	349	25
	350	499	40
G Shape with diameter ≥5 inches	250	349	25
	350	499	40
	500	574	60
	575	649	75
	650	1,099	100
	1,100	1,300	150

Lamp Shape	Lumen Range		
	Lower	Upper	2017–2019 $Watts_{base}$
Decorative, Medium Screw-Base Lamps (B, BA, C, CA, DC, F, and ST) See exceptions in gray rows below	70	89	10
	90	149	15
	150	299	25
	300	309	40
	310	499	29
	500	699	29
B, BA, CA, and F ≤499 lumens	70	89	10
	90	149	15
	150	299	25
	300	309	40
	310	499	40
Omnidirectional, Intermediate Screw-Base Lamps (A, BT, P, PS, S or T) See exceptions in gray rows below	250	309	25
	310	749	40
S Shape with a first number ≤12.5 and T Shape with a first number ≤8 and nominal overall length <12 inches	250	309	25
	310	749	40
Decorative, Intermediate Screw-Base Lamps (G) See exceptions in gray rows below	250	309	25
	310	349	25
	350	499	40
G Shape with a first number ≤12.5 or diameter ≥5 inches	250	349	25
	350	499	40
Decorative, Intermediate Screw-Base Lamps (B, BA, C, CA, DC, F, and ST)	70	89	10
	90	149	15
	150	299	25
	300	309	40
	310	499	40
Omnidirectional, Candelabra Screw-Base Lamps (A, BT, P, PS, S, and T) See exceptions in gray rows below	250	309	25
	310	749	40
	750	1,049	60
S Shape with a first number ≤12.5 and T Shape with a first number ≤8 and nominal overall length <12 inches	250	309	25
	310	749	40
	750	1,049	60
Decorative, Candelabra Screw-Base Lamps (G) See exceptions in gray rows below	250	309	25
	310	349	25
	350	499	40
	500	574	60
G Shape with a first number ≤12.5 or diameter ≥5 inches	250	349	25
	350	499	40
	500	574	60
Decorative, Candelabra Screw-Base Lamps (B, BA, C, CA, DC, F, and ST)	70	89	10
	90	149	15
	150	299	25
	300	309	40
	310	499	40

Lamp Shape	Lumen Range		
	Lower	Upper	2017–2019 $Watts_{base}$
	500	699	60
Directional, Medium Screw-Base Lamps with Diameter ≤2.25 Inches	400	449	40
	450	499	45
	500	649	50
	650	1,199	65
Directional, Medium Screw-Base Lamps (R, ER, BR, BPAR, and similar bulb shapes with diameter >2.5 inches) See exceptions in gray rows below	640	739	40
	740	849	45
	850	1,179	50
	1,180	1,419	65
	1,420	1,789	75
	1,790	2,049	90
	2,050	2,579	100
	2,580	3,300	120
	3,301	3,429	120
	3,430	4,270	150
Directional, Medium Screw-Base Lamps (R, ER, BR, BPAR, and similar bulb shapes with medium screw bases and diameter >2.26 inches and ≤2.5 inches See exceptions in gray rows below	540	629	40
	630	719	45
	720	999	50
	1,000	1,199	65
	1,200	1,519	75
	1,520	1,729	90
	1,730	2,189	100
	2,190	2,899	120
	2,900	3,300	120
	3,301	3,850	150
ER30, BR30, BR40, or ER40	400	449	40
	450	499	45
	500	649 to 1,179	50
BR30, BR40, or ER40	650	1419	65
R20	400	449	40
	450	719	45
All reflector lamps below lumen ranges specified above	200	299	20
	300	399 to 639	30
Rough Service, Shatter Resistant, 3-Way Incandescent, and Vibration	250	309	25
	310	749	40
	750	1,049	60
	1,050	1,489	75
	1,490	2,600	100
	2,601	3,300	150
	3,301	3,999	200
	4,000	6,000	300

Baseline Wattages for PAR, MR, and MRX Lamp Types

For highly focused directional lamps, center beam candle power and beam angle measurements are needed to accurately estimate the equivalent baseline wattage. The evaluation team used a WattsBase algorithm based on the ENERGY STAR Center Beam Candle Power tool:[59]

$$\text{WattsBase} = 375.1 - 4.355(D) - \sqrt{227{,}800 - 937.9(D) - 0.9903(D^2) - 1{,}479(BA) - 12.02(D * BA) + 14.69(BA^2) - 16{,}720 * \ln(CBCP)}$$

Where:

D = Bulb diameter (= 20 for PAR20 D)

BA = Beam angle

CBCP = Center beam candle power

The team rounded down the result of the equation above to the nearest wattage established by ENERGY STAR, presented in Table G-3.

Table G-3. Baseline Wattages for 2019 Lighting and Appliance Program Qualifying LED PAR, MR, and MRX Lamps

Lamp Diameter	Permitted Wattages
16	20, 35, 40, 45, 50, 60, 75
20	50
30S	40, 45, 50, 60, 75
30L	50, 75
38	40, 45, 50, 55, 60, 65, 75, 85, 90, 100, 120, 150, 250

If center beam candle power and beam angle information were not available or if the equation returned a negative (or undefined) value, the evaluated team used the manufacturer's recommended baseline wattage equivalent.

First Year, Lifetime, and Net Present Value In-Service Rates

The evaluation team relied on the UMP to calculate lifetime ISRs through 2022 to account for future installations of bulbs in storage. The methodology assumes that 24% of all bulbs in storage will be installed in each subsequent year after purchase. To account for the time sensitivity of these added savings, which stem from increased ISRs but take place after 2019, we discounted the lifetime ISR by 10% annually to achieve NPV lifetime ISRs for each LED. Table G-4 shows a comparison of first-year and lifetime ISRs for upstream lighting, showing how marginal increases to first-year ISRs using the UMP methodology result in the NPV lifetime ISRs used in measure impact calculations.

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59 The ENERGY STAR Center Beam Candle Power tool does not accurately model baseline wattages for lamps with certain bulb characteristic combinations, specifically for lamps with very high center beam candle power (http://www.energystar.gov/ia/products/lighting/iledl/IntLampCenterBeamTool.zip).

Table G-4. First-Year and Lifetime In-Service Rate Calculations for 2019 Lighting and Appliance Program

Measure	First-Year ISR	2020	2021	2022	2023	Lifetime ISR	NPV ISR
General Service LED	86%	3%	2%	2%	N/A [a]	97%	92%
Specialty/Reflector LED	86%	3%	2%	2%	2%	97%	96%

Note: Table percentages are rounded.

[a] General Service Lamps were not anticipated to have gross savings post EISA 2020 implementation, However, recent rule changes have delayed that implementation beyond 2020. The evaluation team assumes that these lamps will eventually become baseline around 2023. As such, final lifetime NPV lifetime ISR is capped at 92%. Percentages are rounded.

Waste Heat Factors

The evaluation applied Indiana TRM (v2.2) WHFs for Indianapolis to each program lamp (these values are shown in Table G-5).

Table G-5. Indiana TRM (v2.2) Waste Heat Factors by City for 2019 Lighting and Appliance Program

HVAC Type	WHF_e	WHF_d	Distribution
Indianapolis	***-0.061***	***0.055***	***-0.0018***
South Bend	-0.070	0.038	-0.0019
Evansville	-0.034	0.092	-0.0017
Ft Wayne	-0.082	0.038	-0.0019
Terre Haute	-0.048	0.061	-0.0018
Statewide	**-0.059**	**0.057**	**-0.0018**

Smart Thermostats

The Indiana TRM (v2.2) calculates energy savings for smart thermostats using two equations:

$$\Delta kWh = 1/SEER * EFLH_{COOL} * Btuh_{COOL}/1{,}000 * ESF_{COOL}$$

$$\Delta kWh = EFLH_{HEAT} * Btuh_{HEAT}/\eta_{HEAT} * 3{,}412 * ESF_{HEAT}$$

Where:

SEER = Seasonal average energy efficiency ratio (Btu/watt-hour; = actual, 10 for equipment installed before 2006, 11.15 for equipment installed after 2006)

$EFLH_{COOL}$ = Equivalent full-load cooling hours (= 487 for Indianapolis)

$Btuh_{COOL}$ = Cooling system capacity in Btu/hr (= actual; otherwise assume 28,994 Btuh)[60]

1,000 = Conversion from watts to kilowatt-hours

ESF_{COOL} = Cooling energy savings fraction (= 0.139)[61]

$EFLH_{HEAT}$ = Equivalent full-load heating hours (= 1,341 for Indianapolis)

η_{HEAT} = Efficiency in coefficient of performance of heating equipment (= actual; 2.00 for heat pump equipment installed before 2006, 2.26 for heat pump equipment installed after 2006, 1.0 for resistance heat)

3,412 = Conversion from Btuh to kilowatts

ESF_{HEAT} = Heating energy savings fraction (= 0.125; Cadmus 2015)

In the absence of detailed information on the homes and HVAC systems in which smart thermostats were installed, the evaluation team calculated smart thermostat savings using the equation below. We found that savings appeared overestimated for smart thermostats replacing manual thermostats. Reported savings appeared to be using 429 kWh based on the Cadmus 2015 report. The evaluation team therefore used an equation to adjust *ex ante* savings:

$$Annual\ kWh\ savings = ISR * \Delta kWh * \frac{Indianapolis\ EFLH_{COOL}}{Evansville\ EFLH_{COOL}}$$

The evaluation team calculated savings using inputs from the 2015 Indiana TRM. The Cadmus 2015 report listed electric savings of 429 kWh for smart thermostats; however, the evaluation team adjusted savings to reflect the cooling needs of Indianapolis customers using the Indiana TRM (v2.2) ratio of full-load cooling hours for Indianapolis (as opposed to Evansville, where units were metered for the Cadmus 2015 study). The values determined by the evaluation team are shown in Table G-6.

Table G-6. 2019 Lighting and Appliance Program Smart Thermostat Savings Inputs

Input	Assumption	Source
ΔkWh	429	Cadmus 2015 report (single-family findings)
Indianapolis $EFLH_{COOL}$	487	2015 Indiana TRM
Evansville $EFLH_{COOL}$	600	2015 Indiana TRM

Where the tracking data indicated that a programmable thermostat was replaced, IPL claimed a more conservative 170 kWh. The evaluation team accepted this number as *ex post*.

To cite the Indiana TRM (v2.2), which aligns with the Illinois TRM (v7), “There is no expected peak demand reduction associated with this measure” (page 123).

[61] Cadmus. January 29, 2015. *Evaluation of the 2013-2014 Programmable and Smart Thermostat Program.* Prepared for Northern Indiana Public Service Company and Vectren Corporation.

Dehumidifiers

The Indiana TRM (v2.2) uses two equations to calculate energy savings and demand reduction for dehumidifiers:

$$\Delta kWh = C * 0.473 \ / \ 24 * \text{Hours} \ / \ L/kWh$$

$$\Delta kW = \Delta kWh \ / \ \text{Hours} * \text{CF}$$

Where:

C	=	Average capacity of dehumidifier in pints per day
0.473	=	Constant to convert pints to liters
24	=	Hours in a day
Hours	=	Run hours per year (= 1,620)[62]
L/kWh	=	Liters of water consumed per kilowatt-hour
CF	=	Summer peak coincidence factor (= 0.37)[63]

The evaluation team accepted IPL's *ex ante* claim of 212.9 kWh and 0.0304 kW per unit as appropriate for *ex post* savings based the Indiana TRM (v2.2) values shown in Table G-7 and Table G-8.

Table G-7. 2019 Lighting and Appliance Program Annual Dehumidifier Savings by Capacity

Capacity Range	Pints Used Per Day	ENERGY STAR	Federal Standard	Savings (kWh)
≤25	22.4	596	650	54
>25 to ≤35	30	684	798	114
>35 to ≤45	40	851	1,064	213
>45 to ≤54	49.5	988	1,285	297
>54 to ≤75	64.5	1,144	1,329	185
>75 to ≤185	92.8	1,185	1559	374

[62] "ENERGY STAR Dehumidifier Calculator." http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDehumidifier.xls

[63] This value is based on usage being evenly distributed day versus night and weekend versus weekday, and dehumidifiers being used from April through September (for 4,392 possible hours). The ENERGY STAR Dehumidifier Calculator lists 1,620 operating hours; therefore the summer peak coincidence is 36.9% (1,620 / 4,392).

Table G-8. 2019 Lighting and Appliance Program Summer Peak Coincident Demand Reduction by Capacity

Capacity Range	Pints Used Per Day	ENERGY STAR	Federal Standard	Savings (kWh)
≤25	22.4	0.136	0.148	0.012
>25 to ≤35	30	0.156	0.182	0.027
>35 to ≤45	40	0.194	0.242	0.048
>45 to ≤54	49.5	0.225	0.293	0.068
>54 to ≤75	64.5	0.261	0.303	0.042
>75 to ≤185	92.8	0.270	0.355	0.085

Air Purifiers

The Indiana TRM (v2.2) does not have an entry for air purifiers. Therefore, the evaluation team relied on two equations in the Illinois TRM (v7) to determine deemed energy savings values based on clean air deliver rate:

$$\Delta kWh = kWh_{base} - kWh_{ESTAR}$$

$$\Delta kW = \Delta kWh \;/\; Hours * CF$$

Where:

kWh_{base}	=	Baseline kilowatt-hour consumption per year[64]
kWh_{ESTAR}	=	Constant to convert pints to liters
Hours	=	Run hours per year (= 5,844)[65]
CF	=	Summer peak coincidence factor (= 0.667)[66]

The evaluation team accepted IPL's *ex ante* claim of 568.2 kWh and 0.0813 kW per unit as appropriate for *ex post* savings based the Illinois TRM (v7) values shown in Table G-9 and Table G-10. Most units had a clean air delivery rate between of 101 and 200.

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64 "ENERGY STAR Qualified Room Air Cleaner Calculator."

65 This value is consistent with the ENERGY STAR Qualified Room Air Cleaner Calculator assumption of 16 hours per day (16 * 365.25 = 5,844).

66 This value assumes that the purifier usage is evenly spread throughout the year; therefore, coincident peak is calculated as 66.7% (5,844 / 8,766).

Table G-9. 2019 Lighting and Appliance Program Annual Air Purifier Energy Savings by Clean Air Delivery Rate

Clean Air Delivery Rate		Unit Energy Consumption (kWh/year)		ΔkWh
Range	Used in Calculation (midpoint)	Baseline	ENERGY STAR	
51-100	75	441	148	293
101-150	**125**	**733**	**245**	**488**
151-200	**175**	**1,025**	**342**	**683**
201-250	225	1,317	440	877
Over 250	300	1,755	586	1,169

Table G-10. 2019 Lighting and Appliance Program Annual Air Purifier Demand Reduction by Clean Air Delivery Rate

Clean Air Delivery Rate	ΔkW
51-100	0.033
101-150	**0.056**
151-200	**0.078**
201-250	0.100
Over 250	0.133

Smart Power Strips

While the Indiana TRM (v2.2) has a section for smart power strips, the evaluation team chose to use two equations from the Illinois TRM (v7) because it includes Tier 2 smart power strips, which are specifically designed for residential audio-visual applications. The Illinois TRM (v7) also provides deemed energy-savings values based on several energy reduction percentage ranges:

$$\Delta kWh = \text{ERP} * \text{BaselineEnergy}_{AV} * \text{ISR}$$

$$\Delta kW = \Delta kWh \,/\, \text{Hours} * \text{CF}$$

Where:

ERP = Energy reduction percentage of qualifying Tier 2 audio-visual APS product range (as provided in Table G-11 and Table G-12)

$\text{BaselineEnergy}_{AV}$ = Baseline energy usage (= 432 kWh)[67]

ISR = In-service rate (= 100% based on surveys)

[67] AESC, Inc. "Energy Savings of Tier 2 Advanced Power Strips in Residential AV Systems." p. 28. Note that this load represents the average controlled audio-visual devices only and will likely be lower than total audio-visual usage.

Hours = Annual number of hours during which smart power strips provides savings (= 4,380)[68]

CF = Summer peak coincidence factor (= 0.8)[69]

The evaluation team accepted IPL's *ex ante* claim of 150 kWh and 0.027 kW per unit as appropriate for *ex post* savings based on similarity to the Illinois TRM (v7) values shown in Table G-11 and Table G-12, which indicate an assumed Class E power strip scenario.

Table G-11. 2019 Lighting and Appliance Program Smart Power Strip Energy Savings by Product Class

Product Class	Field Trial ERP Range	ERP used	Baseline $Energy_{AV}$ (kWh)
A	55% to 60%	55%	238
B	50% to 54%	50%	216
C	45% to 49%	45%	194
D	40% to 44%	40%	173
E	**35% to 39%**	**35%**	**151**
F	30% to 34%	30%	130
G	25% to 29%	25%	108
H	20% to 24%	20%	86

Table G-12. 2019 Lighting and Appliance Program Smart Power Strip Demand Reduction by Product Class

Product Class	ERP Used	ΔkW
A	55%	0.043
B	50%	0.039
C	45%	0.035
D	40%	0.032
E	**35%**	**0.028**
F	30%	0.024
G	25%	0.020
H	20%	0.016

68 This estimate is based on the assumption that approximately half of savings are during active hours (supported by the AESC study), assumed to be 5.3 hours per day, for 1,936 hours per year (New York State Energy Research and Development Authority. 2011. *Advanced Power Strip Research Report.*) and half during standby hours (8,760 - 1,936 = 6,824 hours). The weighted average is 4,380 hours.

69 In the absence of empirical evaluation data, the team based this value on assumptions of the typical run pattern for televisions and computers in homes. This appears to be supported by the "Average Weekday AV Demand Profile and Reduction" charts in the AESC study (p. 33-34), which show that the average demand reduction is relatively flat across the year.

Appendix H. Demand Elasticity Model

This appendix contains a description of the demand elasticity modeling used to determine upstream lighting freeridership for the Lighting and Appliance program

Net-to-Gross Ratio Methodology

Lighting products that incur price changes and promotion over the program period provide valuable information regarding the correlation between sales volume and prices. Demand elasticity modeling is based on the same economic principle driving program design: demand for efficient lighting is elastic and changes in price and merchandising generate changes in quantities sold (i.e., the upstream buydown approach). Demand elasticity modeling uses sales and merchandising information to achieve the following:

- Quantify the relationship of price and merchandising to sales
- Predict the likely sales level without the program's intervention (baseline sales)
- Estimate free ridership by comparing predicted baseline savings with predicted program savings

After estimating variable coefficients, the evaluation team used the resulting model to predict sales that would have occurred *without* the program's price and merchandising impact and sales that would have occurred *with* the program (which should be close to actual sales with a representative model). Predicted bulb sales were then multiplied by evaluated savings by bulb type. Freeridership was then calculated using this formula:

$$Freerership = \left(\frac{Savings\ without\ Program}{Savings\ with\ Program}\right)$$

All available data were used for this analysis in 2019, though products without observed variation provide no information to the model. Overall, the model relied on products with price variation or products that were featured in the special promotions that accounted for 88% of total lamp sales in 2019 with the remaining 12% having no price variation or promotions.

The estimated freeridership from the demand elasticity model was 44%.

Input Data

Because the demand elasticity approach relies exclusively on program data, a model's robustness depends on data quality. Overall, in 2019 the available data achieved a sufficient quality to support the analysis.

Seasonality Adjustment

In economic analysis, it is critical to separate data variations resulting from seasonality from those resulting from relevant external factors. To illustrate this, suppose prices had been reduced on umbrellas at the beginning of the rainy season. Any estimate of this price shift's impact would be skewed if the analysis did not account for the natural seasonality of umbrella sales.

To control for seasonality, the evaluation team used a trend provided by an evaluation partner that provides the expected share of annual sales for each month. This expected trend is based on national lighting sales from a major lighting manufacturer. Controlling for seasonality with the national manufacturer trend allows the team to attribute this additional lift, beyond what would typically occur, to program activities.

Additional Incentives

In addition to program incentives, one retailer provided additional manufacturer incentives during several months of the program year. The evaluation team assumed these additional discounts were complementary and would not have occurred absent the program incentives. Therefore, when predicting freerider sales the team set these additional discounts equal to zero and applied the additional discounts when predicting program sales.

Price Variation

For the demand elasticity model, the evaluation team combined sales and prices across all comparable products within a given retailer store location. The average price for each bulb type within each store was the monthly sales-weighted, per-bulb price across all comparable products. Monthly sales were the sum of all sales within each store across the same group of comparable products. For example, prices and monthly sales for all 60-watt incandescent-equivalent general purpose bulbs at a single Home Depot store.

Combining sales and prices this way, rather than observing changes in price and sales for each individual model number, had the advantage of capturing any substitutions between comparable products, such as decreases in the average price per-bulb when a three-pack of an existing bulb or a new model was added to the program.

Similarly, suppose one bulb model was replaced with an updated version (with a different model number). Sales of the first model would likely drop because the retailer was running out of back-stock. Aggregating prices and sales captured variation across both products rather than trying to control for the influence on sales of factors unrelated to price (i.e., products being phased out and replaced).

Only sales with price variation or merchandising displays were included in the model. The greater the level of price variation across retailers and lamp styles, the more representative the elasticity estimates when applied to the portion of the program that did not exhibit price variation.

Promotional Displays

The evaluation team was provided records of retailer/manufacturers special promotions during 2019, with associated time periods. These events included end cap displays, special seasonal promotions, and additional discounts for specific SKUs.

Model Specification

The evaluation team used an econometric model to organize bulb and pricing data as a panel, with a cross-section of program bulb quantities for each unique retail location, bulb type, and baseline wattage combination modeled over time as a function of price, retail channel (do-it-yourself, other), and promotional events. This study also involved testing a variety of specifications to ascertain price impacts—the main instrument affected by the program—on the demand for bulbs. The estimated basic equation for the model as follows (for cross-section *i*, in month *t*):

$$\ln(Q_{it}) = \sum_{\pi}\left(\beta_{\pi} ID_{\pi,\mathrm{i}}\right) + \sum_{\theta}(\beta_{\theta 1}[ln(P_{it}) * \ Retail\ Channel_{\delta}]) + \beta_2 * Reflector * ln(P_{it})$$
$$+ \sum_{\delta}(\beta_{\delta 1} SpecialPromo_t * Retail\ Channel_{\mathrm{i}}) + \beta_4 * Trend + \varepsilon_{it}$$

Where:

ln	=	Natural log
Q	=	Quantity of bulb packs sold during the month
P	=	Retail price in that month
Retail Channel	=	Retailer category (do-it-yourself, other)
Reflector	=	Dummy variable equaling 1 if the bulb is a reflector; 0 otherwise
SpecialPromo	=	Dummy variable equaling 1 if products were featured in a special promotion in month t; 0 otherwise
ID	=	Dummy variable equaling 1 for each unique retail location, bulb type; 0 otherwise
Trend	=	Expected typical share of bulb sales in each month
	=	Cross-sectional random-error term in time period *t*

The model specification assumed a negative binomial distribution. This distribution serves as the best fit of the plausible distributions (log normal, poisson, or gamma).

The evaluation team ran numerous model scenarios to identify the model with the best parsimony and explanatory power using these criteria:

- Model coefficient p-values (keeping values less than <0.1)[70]
- Explanatory variable cross-correlation (minimizing where possible)
- Model Akaike's Information Criteria (minimizing between models)[71]

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70 Where a qualitative variable had many states (such as bulb type), the evaluation team did not omit variables if one of the states was not significant, but rather considered the joint significance of all states. The team used robust estimation of model standard errors to properly represent model accuracy and to guide the specification process. The error structure involved clustering around cross-sectional units.

71 The team used Akaike's Information Criteria to assess model fit, as the R-square statistic is undefined for nonlinear models. Akaike's Information Criteria also has the desirable property that it penalizes overly complex models, similar to the adjusted R-square.

- Utilizing the heteroskedastic consistent covariance matrix and clustered standard errors to account for heteroskedasticity
- Minimizing multicollinearity
- Optimizing model fit

Model Estimates

Table H-1 presents the model parameter estimates as well as the standard errors and significance values.

Table H-1. Demand Elasticity Model Parameter Estimates

Parameter	Estimate	Standard Error	p-value
DIY*logPrice	-1.13	0.29	0.000
Other*logPrice	-1.07	0.08	-
Reflector*logPrice	-0.39	0.17	0.021
Seasonal trend	-4.24	1.23	0.001
DIY*Promo	-0.02	0.03	0.483
Other*Promo	0.20	0.04	0.000

Price parameters for the retail channels slightly greater than one, meaning, on average, a one percent decrease in the price of program LEDs increases sales between 1.07% and 1.13%, depending on the retail channel where the bulb is sold. The reflector price parameter means that if the LED is a reflector, sales increase by an additional 0.39%.

The promo parameters show that sales increase an additional 0.2% for Other retailer and there was no significant lift from promotions at DIY retailers. Note that promotional displays at DIY stores were less frequent and tended to coincide with price changes so it is likely that the model was simply unable to estimate the promo effect and price effect separately.

Appendix I. Multifamily Direct Install Program Measures, Assumptions, and Algorithms

This appendix presents information—including algorithms, variable assumptions and sources, and differences between *ex ante* and *ex post* per-measure savings—for several MFDI measures:

- LEDs (9-watt, 16-watt, 5-watt globe, 5-watt candelabra, 7-watt track, and R30)
- Bathroom and kitchen aerators
- Low-flow showerheads
- Pipe wrap insulation
- Water heater setback
- Programmable thermostats
- Smart strips
- Duct sealing
- Air sealing
- LED night-lights
- Filter whistles

Unless otherwise specified, these algorithms, variable assumptions, and measure savings apply to direct install and energy-savings kits measures installed in both multifamily and manufactured homes.

LEDs

Algorithms and Variable Assumptions

The evaluation team used equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for LEDs:

$$kWh\ savings = \frac{(W_{base} - W_{LED}) * (Hrs/day * 365) * \ (1 + WHFe)}{1{,}000}$$

$$kW\ reduction = \frac{(W_{base} - W_{LED}) * \ CF * \ (1 + WHFd)}{1{,}000}$$

Where:

W_{base} = Baseline wattage of existing bulb being replaced with LED (= varies by measure; see Table I-1)

Table I-1. 2019 MFDI Program LED Baseline Wattages

Measure	Baseline Wattage
9-Watt LED	43
16-Watt LED	65
5-Watt Globe LED	40
5-Watt Candelabra LED	40
7-Watt Track LED	50
R30	65

W_{LED} = Actual installed LED wattage

Hrs/day = Average number of hours per day the light is in use

WHF_e = Waste heat factor for energy use; this accounts for the effects of more efficient lighting on cooling energy use

CF = Coincidence factor; a number between 0 and 1 indicating the ratio of LEDs expected to be in use and saving energy during the peak summer demand period

WHF_d = Waste heat factor for demand; this accounts for the effects of more efficient lighting on cooling energy demand

CF = Coincidence factor; a number between 0 and 1 indicating the ratio of LEDs expected to be in use and saving energy during the peak summer demand period

Table I-2 summarizes the *ex post* assumptions and source for the installed LEDs.

Table I-2. 2019 MFDI Program *Ex Post* Variable Assumptions for LEDs

Variable	Value	Source
Baseline Wattage (W_{base})	As shown in Table I-1	Lumens compared with ENERGY STAR and EISA halogen baseline equivalent wattages applied
LED Wattage (W_{LED})	As shown in Table I-1	Wattages of installed LED
Hours per Day (Hrs/day, interior lights)	902	Indiana TRM (v2.2)
Hours per Day (Hrs/day, 9-watt exterior)	1,607	Indiana TRM (v2.2)
Weighted Average Waste Heat Factor for Energy (WHFe)	-0.061 for interior, 0 for exterior	Indiana TRM (v2.2) for Indianapolis
Coincidence factor (CF)	0.11	Indiana TRM (v2.2)
Weighted Average Waste Heat Factor for Demand (WHFd)	0.055 for interior, 0 for exterior	Indiana TRM (v2.2) for Indianapolis
Coincidence Factor (CF)	0.11	Indiana TRM (v2.2)

Savings Summary for LEDs

Table I-3 shows the *ex ante* deemed savings and the resulting *ex post* per-measure savings for LEDs.

Table I-3. 2019 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for LEDs

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
9-Watt LED	18.14	0.002	28.80	0.004
16-Watt LED	32.66	0.004	41.50	0.005
5-Watt Globe LED	18.13	0.004	29.64	0.004
5-Watt Candelabra LED	18.39	0.004	29.64	0.004
9-Watt Exterior LED	30.49	0.00	54.64	0.000
7-Watt Track LED	11.75	0.003	36.42	0.005
R30	28.86	0.007	46.58	0.006

The differences between *ex ante* and *ex post* savings are due to one reason:

- ***Differences in baseline wattage calculations for LEDs:*** To calculate *ex ante* savings, CLEAResult applied the Indiana TRM (v2.2) baseline wattages and WHFs for 9-watt, 16-watt, and 7-watt bulbs, and applied UMP wattages and a different electric WHF for the 5-watt and R30 bulb types. The evaluation team did not receive information about the separate electric WHF; therefore, to calculate *ex post* savings, the team applied the EISA-adjusted baseline wattages and the Indiana TRM (v2.2) WHF across all bulbs. The UMP and ENERGY STAR equivalent baseline wattages are larger than the Indiana TRM (v2.2) baseline wattages, which are designed to reflect the replacement of a variety of bulb types.

Bathroom and Kitchen Faucet Aerators

Algorithms and Variable Assumptions

The evaluation team used equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for bathroom and kitchen faucet aerators installed in homes with an electric water heater:

$$kWh\ savings_{aerator} = (gpm_{base} - gpm_{low})\ x\ MPD * \frac{PH}{FH} * \mathrm{DR} * \mathrm{S} * (T_{mix} - T_{Inlet}) * \frac{365}{RE * 3{,}412}$$

$$kW\ reduction_{aerator} = (gpm_{base} - gpm_{low}) * 60 * \mathrm{DR} * S * \frac{(T_{mix} - T_{Inlet})}{RE * 3{,}412} * CF$$

Where:

gpm_{base}	=	Baseline flow rate of existing faucet in gallons per minute
gpm_{low}	=	Low-flow rate of aerator in gallons per minute
MPD	=	Average minutes per day per person of faucet use
PH	=	Average number of people per household
FH	=	Average number of faucets per household
DR	=	Drain recovery factor that represents the percentage of water that flows down the drain

S	=	Constant used to convert the weight of water from gallons to pounds (8.3 lbs/gallon)
T_{mix}	=	Temperature of water leaving the aerator (°F)
T_{inlet}	=	Temperature of water entering the water heater (°F)
RE	=	Recovery efficiency of electric water heater in operation
CF	=	Coincidence factor; a number between 0 and 1 indicating the ratio of aerators expected to be in use and saving energy during the peak summer demand period

Table I-4 summarizes the *ex post* assumptions and source for the installed faucet aerators.

Table I-4. 2019 MFDI Program *Ex Post* Variable Assumptions for Faucet Aerators

Variable	Value		Source
	Bathroom	Kitchen	
Baseline Flow Rate (gpm_{base})	1.9	2.44	Indiana TRM (v2.2)
Low-Flow Rate (gpm_{low})	1	1.5	Program data
Minutes per Person per Day (MPD)	1.6	4.5	Indiana TRM (v2.2)
People per Household (PH)	1.83	1.83	Indiana TRM (v2.2)
Faucets per Household (FH)	1.43	1	Indiana TRM (v2.2)
Drain Recovery Factor (DR)	0.7	0.5	Indiana TRM (v2.2)
Conversion Factor (S)	86	93	Engineering constant in units of Btu/(gal˚F)
Mixed Temperature (T_{mix})	58.1	58.1	Indiana TRM (v2.2)
Inlet Temperature (T_{Inlet})	0.98	0.98	Indiana TRM (v2.2) for Indianapolis
Recovery Efficiency (RE)	0.0012	0.0033	Indiana TRM (v2.2)
Coincidence Factor (CF)	1.83	1.83	Indiana TRM (v2.2)

Savings Summary for Faucet Aerators

Table I-5 shows the *ex ante* deemed savings and the resulting *ex post* per-measure savings for faucet aerators. Savings for the aerators installed through the MFDI program were calculated using equipment information and the Indiana TRM (v2.2).

Table I-5. 2019 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for Faucet Aerators

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Bathroom Aerators	30.98	0.003	32.61	0.003
Kitchen Aerators	116.26	0.008	122.38	0.008

The differences between *ex ante* and *ex post* savings are due to one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited a deemed savings value, while the evaluation team leveraged the Indiana TRM (v2.2).

Low-Flow Showerheads

Algorithms and Variable Assumptions

The evaluation team used equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for low-flow showerheads installed in homes with an electric water heater:

$$kWh\ savings_{Showerhead} = (gpm_{base} - gpm_{low}) * \mathrm{MS} * \mathrm{SPD} * \frac{PH}{SH} * S * (T_{mix} - T_{Inlet}) * \frac{365}{RE * 3{,}412}$$

$$kW\ reduction_{Showerhead} = (gpm_{base} - gpm_{low}) * 60 * S * \frac{(T_{mix} - T_{Inlet})}{RE * 3{,}412} * CF$$

Where:

gpm_{base}	=	Baseline flow rate of existing showerhead in gallons per minute
gpm_{low}	=	Low-flow rate of showerhead in gallons per minute
MS	=	Average minutes per shower per person per day
SPD	=	Average number of showers per person per day
PH	=	Average number of people per household
SH	=	Average number of showerheads per household
S	=	Constant used to convert the weight of water from gallons to pounds (8.3 lbs/gallon)
T_{mix}	=	Temperature of the water leaving the showerhead (°F)
T_{inlet}	=	Temperature of the water that enters the water heater (°F)
RE	=	Recovery efficiency of electric water heater in operation
CF	=	Coincidence factor; a number between 0 and 1 indicating the ratio of showerheads expected to be in use and saving energy during the peak summer demand period

The low-flow showerhead measure replaces an existing, less efficient water head. Table I-6 summarizes the *ex post* assumptions and source for the installed low-flow showerheads. Savings were calculated using equipment information and the Indiana TRM (v2.2).

Table I-6. 2019 MFDI Program *Ex Post* Variable Assumptions for Low-Flow Showerheads

Variable	Value	Source
Baseline Flow Rate (gpm_{base})	2.63	Indiana TRM (v2.2)
Low-Flow Rate (gpm_{low})	1.5	Program data
Minutes per Shower per Person per Day (MS)	7.8	Indiana TRM (v2.2)
Showers per Person per Day (SPD)	0.6	Indiana TRM (v2.2)
People per Household (PH)	1.83	Indiana TRM (v2.2)
Showerheads per Household (SH)	1.2	Indiana TRM (v2.2)
Mixed Temperature (T_{mix})	101	Indiana TRM (v2.2)
Inlet Temperature (T_{Inlet})	58.1	Indiana TRM (v2.2)
Recovery Efficiency (RE)	0.98	Indiana TRM (v2.2)
Coincidence Factor (CF)	0.0023	Indiana TRM (v2.2)

Savings Summary for Low-Flow Showerheads

Table I-7 shows the *ex ante* deemed savings and the resulting *ex post* per-measure savings for low-flow showerheads.

Table I-7. 2019 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for Low-Flow Showerheads

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Low-Flow Showerhead	297.79	0.016	313.46	0.017

The differences between *ex ante* and *ex post* savings are due to one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited a deemed savings value, while the evaluation team leveraged the Indiana TRM (v2.2).

Pipe Wrap Insulation

Algorithms and Variable Assumptions

The evaluation team used equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for pipe wrap insulation installed in homes with an electric water heater:

$$kWh\ savings_{pipe\ insulation} = \frac{\left(\frac{1}{R_{existing}} - \frac{1}{R_{new}}\right) * L * C * (\Delta T) * Hrs/yr}{3{,}412 * EF_{electric\ WH}}$$

$$kW\ reduction_{pipe\ insulaton} = \frac{kWh\ savings_{pipe\ insulation}}{Hrs/yr}$$

Where:

$R_{existing}$ = R-value of uninsulated hot water pipe

R_{new} = R-value after installation of new pipe insulation

L = Total linear feet of installed pipe insulation

C = Circumference of hot water pipe in feet (assumed pipe diameter of 0.5 inches): C = $\pi * pipe\ diameter * 0.083$

ΔT = Difference between ambient temperature where water heater is installed and temperature of distributed hot water

Hrs/yr = Total number of hours per year the water heater remains in operation

$EF_{electric\ WH}$ = Energy factor of the electric water heater in operation

Table I-8 summarizes *ex post* assumptions and sources for installed pipe wrap insulation.

Table I-8. 2019 MFDI Program *Ex Post* Variable Assumptions for Pipe Wrap Insulation

Variable	Value	Source
Existing R-Value ($R_{existing}$)	1	Indiana TRM (v2.2)
Post-Install R-Value (R_{new})	3	Indiana TRM (v2.2)
Pipe Length (L)	1	Per-foot increments
Circumference (C)	0.19635	Assumes 0.75-inch diameter pipe
Temperature Change (ΔT)	65	Indiana TRM (v2.2)
Hours per Year (Hrs/yr)	8,760	Indiana TRM (v2.2)
Energy Factor ($EF_{electric\ WH}$)	1	Indiana TRM (v2.2)

Savings Summary for Pipe Wrap Insulation

Table I-9 shows *ex ante* deemed savings and resulting *ex post* savings for pipe wrap insulation, per installed foot.

Table I-9. 2019 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for Pipe Wrap Insulation

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Pipe Wrap Insulation	26.84	0.003	22.29	0.003

The differences between *ex ante* and *ex post* savings are due to the following reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited a deemed savings value, while the evaluation team leveraged the Indiana TRM (v2.2).

Water Heater Setback

Algorithms and Variable Assumptions

The evaluation team used equations from Illinois TRM (v7) to calculate *ex post,* per-measure energy savings and demand reduction for water heater setback:

$$kWh\ savings_{WH} = \frac{\left(U * A * \left(T_{pre} - T_{post}\right) * Hours * ISR\right)}{3{,}412 * RE_{elec}}$$

$$kW\ reduction_{WH} = \Delta kWh/\ Hours * CF$$

Where:

U	=	Overall heat transfer coefficient of tank (Btu/hr-F-ft^2)
A	=	Surface area of tank in square feet
T_{pre}	=	Hot water setpoint prior to adjustment (°F)
T_{post}	=	Hot water setpoint after adjustment (°F)
Hours	=	Hours per year
ISR	=	In service rate
RE_{elec}	=	Recovery efficiency of electric water heater
CF	=	Coincidence factor

Table I-10 summarizes *ex post* assumptions and sources for water heater setback.

Table I-10. 2019 MFDI Program *Ex Post* Variable Assumptions for Water Heater Setback

Variable	Value	Source
Heat Transfer Coefficient (U)	0.083	Illinois TRM (v7)
Surface Area (A)	24.99	Illinois TRM (v7), assumes 50-gallon tank
Hot Water Setpoint before Adjustment (T_{pre})	135	Illinois TRM (v7)
Hot Water Setpoint after Adjustment (T_{post})	120	Illinois TRM (v7)
Hours per Year (Hours)	8,766	Illinois TRM (v7)
In-Service Rate (ISR)	1	Illinois TRM (v7)
Recovery Efficiency of Electric Water Heater (RE_{elec})	0.98	Illinois TRM (v7)
Coincidence Factor (CF)	1	Illinois TRM (v7)

Savings Summary for Water Heater Setback

Table I-11 shows *ex ante* deemed savings and the resulting *ex post* savings for water heater setback.

Table I-11. 2019 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for Water Heater Setback

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Water Heater Setback	81.43	0.009	81.56	0.009

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Tank size:*** The evaluation team did not receive participant water heater capacity or existing water heater outlet temperature information, so instead leveraged the Illinois TRM (v7) and assumed a default tank size of 50 gallons and an initial water temperature of 135°F.

Programmable Thermostats

Algorithms and Variable Assumptions

The evaluation team used equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for programmable thermostats:

$$kWh\ savings_{PStat} = kWh\ savings_{AC\ cooling} + kWh\ savings_{Elec\ htg}$$

$$kWh\ savings_{AC\ cooling} = \frac{1}{n_{cool}} * FLH_{cool} * \frac{BTUh_{cool}}{1{,}000} * ESF_{cool}$$

$$kWh\ savings_{Elec\ htg} = FLH_{heat} * \frac{BTUh_{heat}}{n_{heat} * 3{,}412} * ESF_{heat}$$

Where:

n_{cool} = Efficiency of existing cooling system controlled by programmable thermostat (in units of SEER)

FLH_{cool} = Full-load cooling hours for Indianapolis

$Btuh_{cool}$ = Capacity of cooling system (Btu/hour)

ESF_{cool} = Energy savings factor for cooling

FLH_{heat} = Full-load heating hours for Indianapolis

$Btuh_{heat}$ = Capacity of heating system (Btu/hour)

n_{heat} = Efficiency of existing heating system controlled by programmable thermostat (in units of coefficient of performance)

ESF_{heat} = Energy savings factor for heating

Table I-12 summarizes the *ex post* assumptions and source for the installed programmable thermostats.

Table I-12. 2019 MFDI Program *Ex Post* Variable Assumptions for Programmable Thermostats

Variable	Value	Source
Efficiency of Existing Cooling System (n_{cool})	11.15	Indiana TRM (v2.2)
Full-Load Cooling Hours (FLH_{cool})	487	Indiana TRM (v2.2) for Indianapolis
Capacity of Cooling System ($Btuh_{cool}$)	28,994	Indiana TRM (v2.2)
Energy Savings Factor for Cooling (ESF_{cool})	0.09	Indiana TRM (v2.2)
Full-Load Heating Hours (FLH_{heat})	1,341	Indiana TRM (v2.2) for Indianapolis
Capacity of Heating System ($Btuh_{heat}$)	32,000	2016 Pennsylvania TRM
Efficiency of Existing Heating System (n_{heat}, electric resistance)	1	Indiana TRM (v2.2)
Efficiency of Existing Heating System (n_{heat}, ASHP)	2.26	Indiana TRM (v2.2)
Energy Savings Factor for Heating (ESF_{heat})	0.068	Indiana TRM (v2.2)

Savings Summary for Programmable Thermostats

Table I-13 shows the *ex ante* deemed savings and resulting *ex post* per-measure savings for programmable thermostats.

Table I-13. 2019 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for Programmable Thermostats

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Programmable Thermostat (Electric Heat + CAC)	897.56	0	969.20	0
Programmable Thermostat (ASHP)	507.29	0	492.39	0
Programmable Thermostat (Electric Heat no CAC)	774.88	0	855.22	0

The differences between *ex ante* and *ex post* savings are due to one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited a deemed savings value. The evaluation team leveraged the Indiana TRM (v2.2) for equipment capacities and the 2016 Pennsylvania TRM for Btuh cooling capacity.

Smart Strips

Algorithms and Variable Assumptions

The evaluation teamed used deemed values from the Indiana TRM (v2.2) for energy savings and demand reduction for computer and audio-visual equipment smart strips:

$$kWh\ savings_{Smart\ Strip} = deemed = 24.3$$

$$kW\ reduction_{Smart\ Strip} = deemed = 0.0044$$

Savings Summary for Smart Strips

Ex ante deemed savings and resulting *ex post,* per-measure savings for smart strips are shown in Table I-14.

Table I-14. 2019 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for Smart Strips

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Smart Strips	24.8	0.004	24.8	0.004

Duct Sealing

Algorithms and Variable Assumptions

The evaluation team used equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for duct sealing:

$$kWh\ savings_{PStat} = kWh\ savings_{heat} + kWh\ savings_{cool}$$

$$kWh\ Savings_{heat} = \frac{\left(DE_{After} - DE_{Before}\right)}{DE_{after}} * \frac{FLH_{heat} * \ Btuh_{heat}}{n_{heat} * 3{,}412}$$

$$kWh\ Savings_{cool} = \frac{(DE_{After} - DE_{Before})}{DE_{after}} * \frac{FLH_{cool} * \ Btuh_{cool}}{SEER * 1{,}000}$$

$$kW\ Savings = \frac{(DE_{After} - DE_{Before})}{DE_{After}} * \frac{Btuh_{cool}}{EER * 1{,}000} * CF$$

Where:

DE_{after}	=	Distribution system efficiency after duct sealing
DE_{before}	=	Distribution system efficiency before duct sealing
FLH_{heat}	=	Full-load heating hours for Indianapolis
$Btuh_{heat}$	=	Capacity of heating system (Btu/hour)
n_{heat}	=	Efficiency of existing heating system controlled by programmable thermostat (in coefficient of performance units)
FLH_{cool}	=	Full-load cooling hours for Indianapolis
$Btuh_{cool}$	=	Capacity of cooling system (Btu/hour)
SEER	=	Seasonal average efficiency of air conditioning equipment
EER	=	Peak efficiency of air conditioning equipment (in EER units); if unknown, EER = SEER * 0.9
CF	=	Coincidence factor

Table I-15 summarizes *ex post* assumptions and sources for duct sealing.

Table I-15. 2019 MFDI Program *Ex Post* Variable Assumptions for Duct Sealing

Variable	Value	Source
Distribution System Efficiency after Duct Sealing (De_{after}, cool)	0.68	Indiana TRM (v2.2), 8% uninsulated
Distribution System Efficiency after Duct Sealing (De_{after}, heat)	0.69	Indiana TRM (v2.2), 8% uninsulated
Distribution System Efficiency after Duct Sealing (De_{after}, peak)	0.54	Indiana TRM (v2.2), 8% uninsulated
Distribution System Efficiency before Duct Sealing (De_{before}, cool)	0.66	Indiana TRM (v2.2), 10% uninsulated
Distribution System Efficiency before Duct Sealing (De_{before}, heat)	0.68	Indiana TRM (v2.2), 10% uninsulated
Distribution System Efficiency before Duct Sealing (De_{before}, peak)	0.52	Indiana TRM (v2.2), 10% uninsulated
Full-load heating hours (FLH_{heat})	1,341	Indiana TRM (v2.2)
Capacity of heating system ($Btuh_{heat}$)	Actual	Participant data
Efficiency of Existing Heating System (n_{heat})	2.26	Indiana TRM (v2.2), heat pump after 2006
Full-Load Cooling Hours (FLH_{cool})	487	Indiana TRM (v2.2)
Capacity of Cooling System ($Btuh_{cool}$)	Actual	Participant data
Seasonal Average Equipment Efficiency (SEER)	11.15	Indiana TRM (v2.2)
Peak Equipment Efficiency (EER)	10.035	Indiana TRM (v2.2), = SEER*0.9
Coincidence Factor (CF)	0.88	Indiana TRM (v2.2)

Savings Summary for Duct Sealing

Table I-16 shows *ex ante* deemed savings and resulting *ex post,* per-measure savings for duct sealing.

Table I-16. 2019 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for Duct Sealing

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Duct Sealing (Electric Heat + CAC)	354.96	0.072	265.09	0.094
Duct Sealing (ASHP)	778.48	0.132	317.64	0.266
Duct Sealing (Electric Heat no CAC)	683.48	0	273.41	0

The differences between *ex ante* and *ex post* savings are due to one reason:

- ***Actual versus Indiana TRM (v2.2) duct distribution efficiencies:*** For the *ex ante* analysis, CLEAResult cited actual duct distribution efficiency values. The evaluation team was not provided with the actual values, so instead leveraged the Indiana TRM (v2.2) and assumed distribution system efficiency leakages and insulation conditions, for both before and after duct sealing.

Air Sealing

Algorithms and Variable Assumptions

The evaluation team used equations from the Indiana TRM (v2.2) to calculate *ex post,* per-measure energy savings and demand reduction for air sealing measures:

$$kWh\ savings_{Air\ Sealing} = \left(CFM50_{existing} - CFM50_{air\ sealed}\right) * \frac{\left(\frac{\Delta kWh}{CFM}\right)}{N_{factor}}$$

$$kW\ reduction_{Air\ Sealing} = \left(CFM50_{existing} - CFM50_{air\ sealed}\right) * \frac{\left(\frac{\Delta kW}{CFM}\right)}{N_{factor}} * CF$$

Where:

$CFM50_{existing}$	=	Initial blower door test results measured in cubic feet per minute, pressurized at 50 pascal, of the leakage amount in the home prior to air-sealing measures
$CFM50_{air\ sealed}$	=	Blower door test results after air sealing measured in cubic feet per minute, pressurized at 50 pascal, of the leakage amount in the home after installing air-sealing measures
ΔkWh/CFM	=	Energy savings for each CFM reduction (varies by HVAC equipment)
N_{factor}	=	Constant used to convert 50-pascal airflow to natural airflow, dependent on exposure levels
ΔkW/CFM	=	Demand reduction for each CFM reduction (varies by HVAC equipment)
CF	=	Coincidence factor; a number between 0 and 1 indicating the ratio of cooling equipment expected to be in use and saving energy during the peak summer demand period

Table I-17 summarizes *ex post* assumptions and sources for the air sealing measure.

Table I-17. 2019 MFDI Program *Ex Post* Variable Assumptions for Air Sealing

Variable	Value	Source
Initial Blower Door Test Results ($CFM50_{existing}$)	750	Assumed, 15% reduction
Blower Door Test Results after Air Sealing ($CFM50_{air\ sealed}$)	637.5	
Energy Savings for each CFM Reduction (ΔkWh/CFM, Electric Heat + AC)	50.1	Indiana TRM (v2.2)
Energy Savings for each CFM Reduction (ΔkWh/CFM, ASHP)	30.9	
Energy Savings for each CFM Reduction (ΔkWh/CFM, Electric Heat Only)	48.2	
Conversion factor (N-factor)	16.3	Indiana TRM (v2.2) unknown number of stories and exposure
Demand Reduction for each CFM Reduction (ΔkW/CFM, Electric Heat + AC)	0.006	Indiana TRM (v2.2)
Demand Reduction for each CFM Reduction (ΔkW/CFM, ASHP)	0.003	
Demand Reduction for each CFM Reduction (ΔkW/CFM, Electric Heat Only)	0	
Coincidence factor (CF)	0.88	Indiana TRM (v2.2)

Savings Summary for Air Sealing

Table I-18 shows a comparison of average savings per participant for *ex ante* and *ex post*.

Table I-18. 2019 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for Air Sealing

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Air Sealing (Electric Heat with Central AC)	344.53	0.036	345.78	0.036
Air Sealing (Electric Heat Only)	260.54	0	332.67	0

The differences between *ex ante* and *ex post* savings are due to one reason:

- ***Actual versus assumed blower door test results:*** For the *ex ante* analysis, CLEAResult referred to actual blower door test results. The evaluation team was not provided with this information, so instead leveraged the Indiana TRM (v2.2) and assumed a 15% infiltration reduction after improvements.

LED Night-Lights

Algorithms and Variable Assumptions

The evaluation team used an equation from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings for LED night-lights included in the kits:

$$kWh\ savings = \frac{\left(W_{base} - W_{Night-light}\right) * (Hrs/day * 365)}{1{,}000}$$

Where:

W_{base} = Baseline wattage of existing night-light being replaced with a LED night-light (= 5 watts)

$W_{Night\text{-}Light}$ = Actual wattage of installed LED night-light (= 0.5 watts)

Hrs/day = Average number of hours per day the night-light is in use

Table I-19 summarizes the *ex post* assumptions and source for the LED night-lights.

Table I-19. 2019 MFDI Program *Ex Post* Variable Assumptions for LED Night-Lights

Variable	Value	Source
Baseline Wattage (W_{base})	5	Indiana TRM (v2.2)
LED Night-Light Wattage ($W_{Night\text{-}Light}$)	0.33	Indiana TRM (v2.2)
Hours per Day (Hrs/day)	2,920	Indiana TRM (v2.2)

Savings Summary for LED Night-Lights

Table I-20 shows the *ex ante* deemed savings and the resulting *ex post* per-measure savings for LED night-lights.

Table I-20. 2019 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for LED Night-Lights

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
LED Night-Lights	13.64	0	13.64	0

As shown in the table, there are no differences between *ex ante* and *ex post* savings for LED night-lights.

Filter Whistle

Algorithms and Variable Assumptions

The evaluation team used equations from the 2016 Pennsylvania TRM to calculate *ex post* per-measure energy savings and demand reduction for filter whistles included in the kit:

$$kWh\ savings_{Filter\ Whistle} = kWh/yr\ savings_{heat} + kWh/yr\ savings_{cool}$$

$$kWh/yr\ savings_{heat} = \mathrm{kW}_{motor} * FLH_{heat} * EI * ISR$$

$$kWh/yr\ savings_{cool} = \mathrm{kW}_{motor} * FLH_{cool} * EI * ISR$$

$$kW\ reduction_{Filter\ Whistle} = \frac{kWh/yr_{cool}}{FLH_{cool}} * \mathrm{CF}$$

Where:

kW_{motor}	=	Average motor full-load electric demand
FLH_{heat}	=	Full-load heating hours
EI	=	Efficiency improvement
ISR	=	In-service rate
FLH_{cool}	=	Full-load cooling hours
CF	=	Coincidence factor

Table I-21 summarizes the *ex post* assumptions and source for the filter whistles.

Table I-21. 2019 MFDI Program *Ex Post* Variable Assumptions for Filter Whistles

Variable	Value	Source
Average Motor Full-Load Electric Demand (kW_{motor})	0.5	2016 Pennsylvania TRM
Full-Load Heating Hours (FLH_{heat})	1,341	Indiana TRM (v2.2) for Indianapolis
Efficiency Improvement (EI)	0.15	2016 Pennsylvania TRM
In-Service Rate (ISR)	1	Assumed for analysis
Full-Load Cooling Hours FLH_{cool})	487	Indiana TRM (v2.2) for Indianapolis
Coincidence Factor (CF)	0.647	2016 Pennsylvania TRM

Savings Summary for Filter Whistles

Table I-22 shows the *ex ante* deemed savings and the resulting *ex post* per-measure savings for filter whistles.

Table I-22. 2017 MFDI Program *Ex Ante* and *Ex Post* Per-Measure Savings for Filter Whistles

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Filter Whistle	38.88	0	137.1	0.049

The differences between *ex ante* and *ex post* savings are due to one reason:

- ***In-service rate for filter whistles:*** For the *ex ante* analysis, CLEAResult applied the embedded 2016 Pennsylvania TRM ISR of 0.474. The evaluation team applied an ISR of 1.0 for the *ex post* analysis and applied the actual ISR after the *ex post* calculations. This resulted in *ex post* per-measure savings being higher than *ex ante* savings.

Appendix J. Peer Comparison Program Impact Evaluation Methodology

To evaluate the Peer Comparison program savings and efficiency uplift, the evaluation team conducted several tasks:

- Data collection, review, and preparation
- Equivalency checks on treatment and control groups
- Billing analysis
- Energy-savings estimations
- Energy efficiency program uplift analysis
- Demand reduction analysis

Data Collection, Review, and Preparation

The evaluation team received from Oracle monthly electricity bills from January 2011 through January 2020 for homes in treatment and control groups Wave 1 through Wave 9. The data included approximately six to 12 months of bills prior to the program's beginning and, depending on the wave, one to eight years of monthly of bills after the program began. These billing data included energy use during the monthly billing cycle and on the last day of the billing cycle, as well as several fields:

- Assignment to treatment or control group
- First report date[72]
- Opt-out date for customers who choose not to participate
- Account active and inactive dates (if applicable)
- Oracle account numbers for linking to IPL's customer information

The team also collected National Oceanic and Atmospheric Administration daily temperature data from the Indianapolis (Indiana) International Airport and Terre Haute (Indiana) municipal airport weather stations—the two stations nearest to all program treatment and control homes.

For the uplift analysis, the evaluation team included participation and measure savings data for the 2020 IQW, Appliance Recycling, Whole Home, Lighting and Appliance, and IPL Marketplace programs. These data for each program and measure included customer information, numbers and descriptions of measures installed, measure installation dates, and verified gross savings. The team used this information to estimate program participation and savings' effects on other efficiency programs.

The evaluation team estimated CDDs and HDDs for each home during the billing cycle, using a base temperature of 65°F. Using billing cycle end dates, the team calculated HDDs and CDDs that exactly matched energy use in each customer bill. To fit monthly designations for the billing analysis, the team

[72] Oracle assigned a first report date to control homes (representing when a first energy report would have been mailed).

calendarized the billing data by creating an average daily consumption value for each billing cycling and assigning that value proportionally to the number of days each month in the cycle.

As all weather data derived from only two stations, the temperatures did not vary significantly among homes. Most weather variations in the data occurred over time rather than across the territory.

Using the number of days in the billing cycle, the evaluation team determined monthly energy use, daily average energy use, and weather data, then merged the billing, weather, and program data, including the first home energy report's approximate delivery date.

The evaluation team performed the billing analysis on the program home population, with a few exceptions. Testing for potential issues with program homes included determining whether they missed a randomized control trial start date or usage information, among other filters (Table J-1 shows these filters and results). The billing analysis did not include customers with fewer than six pre-program monthly energy bills (note that the overall savings estimate includes these homes).

Table J-1. 2019 Peer Comparison Program Analysis Sample Selection

Wave and Group		Original Randomly Assigned Homes	Filters			Final Estimation Sample
			Missing Billing Data	Sufficient Bills for Post-Only Model	Total Filtered	
Wave 1	Treatment	27,162	559	55	614	26,548
	Control	16,302	365	25	390	15,912
Wave 2	Treatment	64,978	1017	1,864	2,881	62,097
	Control	19,206	276	572	848	18,358
Wave 3	Treatment	189,000	2225	17,011	19,236	169,764
	Control	21,000	221	1,863	2,084	18,916
Wave 4	Treatment	11,550	38	2,517	2,555	8,995
	Control	10,500	29	2,174	2,203	8,297
Wave 5	Treatment	31,499	81	2,649	2,730	28,769
	Control	10,500	27	883	910	9,590
Wave 6	Treatment	34,513	51	4,958	5,009	29,504
	Control	12,000	19	1,688	1,707	10,293
Wave 7	Treatment	58,850	50	8,409	8,459	50,391
	Control	20,000	12	2,909	2,921	17,079
Wave 8	Treatment	35,000	27	12,982	13,009	21,991
	Control	20,000	12	7,406	7,418	12,582
Wave 9	Treatment	42,000	36	14,398	14,434	27,566
	Control	16,000	8	5,517	5,525	10,475

Equivalency Checks on Treatment and Control Groups

The evaluation team summarized average daily consumption in the pre-period (for each wave) and used a two-sample *t*-test to assess the statistical significance in the mean consumption for control and treatment group customers. No statistical differences emerged in average daily electric consumption for any of the waves.

Billing Analysis

To estimate the program electricity savings, the evaluation team used regression analyses of monthly billing data. In the past, the team reported savings from a D-in-D model and used a post-only model to test for the robustness of savings. This year (and in past years), both models' estimates were contained with the other model's 90% confidence interval, meaning their results did not statistically differ. The team reported only the Post-Only model's results, conforming our billing analysis to the approach described in Chapter 8 and Chapter 17 of the UMP.[73]

The following sections provide additional details about both modeling approaches.

Post-Only Model

The evaluation team specified the post-only model assuming the average daily consumption (AD) of electricity of home 'i' in month 't:'

$$ADC_{it} = \beta_1 PART_i * PY_t + \beta_2 Pre\text{-}Usage_i \times \tau_t + \beta_3 Pre\text{-}Summer_i \times \tau_t + \beta_4 Pre\text{-}Winter_i \times \tau_t + W'\gamma + \tau_t + \varepsilon_{it}$$

Where:

β_1	=	Coefficient representing the conditional average treatment effect of the program on electricity use (kilowatt-hours per customer per day)
$PART_i$	=	Indicator variable for program participation (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 pre-treatment electricity use, given month 't,' on post-treatment average daily consumption (kilowatt-hours per customer per day)
$Pre\text{-}Usage_i$	=	Mean household energy consumption of customer 'i' across all pre-treatment months
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)
β_3	=	Coefficient representing the conditional average effect of pre-treatment summer electricity use, given month 't,' on post-treatment average daily consumption (kilowatt-hours per customer per day)
$Pre\text{-}Summer_i$	=	Mean household energy consumption of customer 'i' during June, July, August, and September of the pre-treatment period

73 "Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol." http://www1.eere.energy.gov/office_eere/de_ump_protocols.html
"Chapter 17: Residential Behavior Protocol." http://www1.eere.energy.gov/office_eere/de_ump_protocols.html

β_4	=	Coefficient representing the conditional average effect of pre-treatment winter electricity use, given month 't,' on post-treatment average daily consumption (kilowatt-hours per customer per day)
$Pre\text{–}Winter_i$	=	Mean household energy consumption of home 'i' during December, January, February, and March of the pre-treatment period
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
$\tau_t \varepsilon_{it}$	=	Error term for customer 'i' in month 't'

Difference-in-Differences Fixed Effects Model

The D-in-D fixed effects model was specified, assuming average daily consumption (AD) 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:

α_i	=	Average energy use of 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)
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
β_1	=	Coefficient representing the program's conditional average treatment effect on electricity use (kilowatt-hours per customer per day)
$PART_i$	=	Indicator variable for program participation (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 post-treatment (which equals 1 if month 't' was in the post-treatment period and 0 otherwise)
ϵ_{it}	=	Error term for customer 'i' in month 't'

Energy-Savings Estimation

The team estimated the Peer Comparison program energy savings for each wave in 2019. To illustrate the approach, let i=1, 2, …, N to index the number of homes receiving a home energy report, and let D(x) be the number of the days in 2019 from January 1 for a given date (such as D [February 1] = 32).

For each home, the gross program savings are equal to the product of the average daily savings, β_1, and the total number of home energy report days in the program:

$$Gross\ Savings = -\beta_1 * \sum_{i=1}^{N} D(x)_i$$

Where:

i	=	Index of the number of homes in the wave (= 1, 2, …, N)
$D(x)_i$	=	Number of days each customer was treated and active for in 2019.

Energy Efficiency Program Uplift Analysis

The Peer Comparison program could contribute to increased participation in IPL's other residential energy efficiency programs in two ways:

- The energy reports could educate customers about IPL programs and encourage them to take advantage of program offerings and incentives.
- The energy reports could raise customer awareness and knowledge of energy efficiency, which may independently cause them to participate in IPL programs.

We analyzed program uplift for two main reasons:

- IPL sought to learn whether, and to what extent, the Peer Comparison program caused participation in its other programs.
- To the extent the Peer Comparison program caused participation in other efficiency programs, energy savings resulting from this participation would be counted twice: once in the regression estimate of this program's savings and once in the other programs' savings (thus double-counting savings in the IPL portfolio). Subtracting these double-counted savings from the gross savings estimate is equivalent to net savings.

The uplift analysis yielded estimates of the program effect on participation in other programs and the amount of double-counted savings. However, we limited the analysis to voluntary residential programs that focus on energy savings and that IPL tracked at the customer level.

The evaluation team performed participation and savings uplift analyses for these residential efficiency programs:

- Appliance Recycling program
- Income Qualified Weatherization program
- Whole Home program
- The appliance rebate and Marketplace channels of the Lighting and Appliance program

The evaluation team did not perform uplift analyses for these residential efficiency programs:

- School Kits program (which targeted school children and their families, and for which participation was not voluntary)
- The Community Based Lighting program, which was an LED giveaway program

- The Upstream Lighting channel of the Lighting and Appliance program (for which customer-level data is not available; although the Peer Comparison program may have influenced high-efficiency lighting purchases, such purchases were tracked at the store level and cannot be linked to identifiable customers)
- Multifamily Direct Install program (which targeted multifamily property managers, who are not eligible to receive home energy reports and who did not make decisions about electricity use in multifamily buildings); the Peer Comparison Reports program targets residents of single-family and multifamily housing units, while the Multifamily Direct Install program targets property managers who did not receive home energy reports and who did not make decisions about electricity use in multifamily tenant units
- Demand Response program, (for which kilowatt-hour savings are not estimated)

As with the energy savings analysis, the evaluation team followed the logic of the program's experimental design for the uplift analysis. The team collected efficiency program participation and savings data in 2019, matched the data to treatment and control homes, and applied a simple differences analysis to each customer wave. The evaluation team used customer addresses to match efficiency program data to Peer Comparison data, because Oracle does not include a field for IPL's utility customer in its billing data, which contains wave and assignment information. Because customers in the treatment and control groups are expected to be identical (except for having participated in the program), the difference between these groups in other DSM program participation is the Peer Comparison Reports program uplift. In homes matching the 2019 DSM program data, we excluded measures installed after an account became inactive, and we excluded measures installed before 2019.

To calculate uplift, let ρ_m be the 2019 program participation rate (defined as the number of participants divided by the number of potential participants) for group 'm' (as before, m=1 for treatment homes and m=0 for control homes) in period 't' (t in {0,1}), as illustrated in this equation:

$$\text{Participation Uplift} = \rho_1 - \rho_0$$

We used this method to express participation uplift relative to the participation rate of control homes in 2019, which yielded an estimate of the percentage uplift, as illustrated in this equation:

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

We estimated Peer Comparison 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:

$$\text{Net savings per home from participation uplift} = \sigma_1 - \sigma_0$$ [57]

Multiplying net savings per home by the number of program homes yielded an estimate for each wave of Peer Comparison program net savings counted in IPL's other efficiency programs.

Demand Reduction Analysis

The evaluation team estimated the peak coincident demand reduction using Integral Analytics' DSMore software load shape for a typical IPL home and the evaluated net program energy savings as inputs (described below in Step 1). The evaluation team applied the Calibrated DSMore Load-Shape Differences (CLSD) approach because IPL did not have enough homes with AMI meters to estimate the demand reduction using electricity use measurements.

For this CLSD approach, the evaluation team used IPL-specific residential load shapes built into DSMore and calibrated the load shapes to match the verified annual consumption of the treatment group to equal the annual kilowatt-hour savings. We then identified the demand reduction during the coincident peak for the utility.

Using the CLSD approach, we followed five specific steps:

1. Conducted a pre-post D-in-D (experimental design with randomized control group) billing analysis to identify the average participant and program-wide energy savings achieved (this is detailed above in the *Billing Analysis* section)
2. Calibrated IPL-specific residential DSMore load shapes to match the kilowatt-hour consumption levels of the treatment group
3. Adjusted the load shape to reflect the annual savings identified in the billing analysis (this maintains the same shape while reducing the amplification of that shape)
4. Recorded the coincident load reduction on the calibrated DSMore load shape for the peak period defined by IPL
5. Multiplied the peak reduction determined in Step 4 by the number of participants to determine the program kilowatt impacts

The CLSD approach provided a reasonable estimate of the per-home and program-wide peak demand reduction given the available data.

Appendix K. School Kits Program Measures, Assumptions, Algorithms, and Net-to-Gross Methodology

This appendix presents assumptions the evaluation team employed for determining the energy savings and demand reduction for measures within the School Kits program. The evaluation team examined each assumption behind the algorithms used to capture savings and compared these against the Indiana TRM (v2.2), as well as against other state and industry approaches, for all School Kits measures:

- 9-watt LEDs
- 15-watt LEDs
- LED night light
- Kitchen faucet aerator
- Bathroom faucet aerator
- Low-flow showerhead
- Furnace filter whistle

Gross Impact Methodology

The following sections address algorithms and assumptions the evaluation team used to calculate *ex post* savings for each kit measure.

9-Watt and 15-Watt LEDs

The evaluation team used two equations to calculate energy savings and demand reduction for LEDs:

$$\Delta kWh = \frac{(W_{base} - W_{LED})}{1{,}000} * HOU * (1 + WHF_e) * ISR$$

$$\Delta kW = \frac{(W_{base} - W_{LED})}{1{,}000} * CF * (1 + WHF_d) * ISR$$

Where:

W_{base}	=	Weighted average wattage of bulbs being replaced
W_{LED}	=	Wattage of LED bulbs
1,000	=	Constant to convert watts to kilowatts
HOU	=	Average hours of use per year
WHF_e	=	Waste heat factor for energy to account for HVAC interactions with lighting, depending on location
ISR	=	Installation rate, lifetime NPV
CF	=	Summer peak coincidence factor
WHF_d	=	Waste heat factor for demand to account for HVAC interactions with lighting, depending on location

Table K-1 lists input assumptions and sources for the LEDs measures' savings calculations.

Table K-1. 2019 School Kits Program *Ex Post* Variable Assumptions for LEDs

Input	9-Watt Value	15-Watt Value	Source
W_{base}	37.8	48.6	2018 parent survey
W_{LED}	9.0	15.0	Actual installed wattage
HOU	1,135	1,135	Indiana TRM (v2.2)
WHF_e	-0.26	-0.26	Indiana TRM (v2.2), weighted using 2018 parent survey results
ISR	96.7%	90.2%	2018 parent survey; lifetime ISR calculation per UMP
CF	0.11	0.11	Indiana TRM (v2.2)
WHF_d	0.06	0.06	Indiana TRM (v2.2), weighted using 2018 parent survey results

Baseline Wattages

The evaluation team collected self-reported data from the 2018 parent survey to determine the distribution of bulb types the program participants replaced with kit LEDs. The team used the lumen equivalence method to assign baseline wattages to replaced bulbs self-reported by survey respondents. Table K-2 shows the distribution of baseline bulb types derived from survey responses as well as baseline wattages applied, using the lumen equivalence method to calculate the final weighted average baseline wattages for 9-watt and 15-watt LEDs.

Table K-2. 2019 School Kits Program Parent Survey Results for Baseline Light Bulbs

Measure	Incandescent[a]	Halogen	CFL	LED	New/Empty[b]
9-watt LEDs					
Distribution from survey results	51%	10%	10%	18%	12%
Baseline wattage	60	43	13	9	0
Weighted average baseline					**37.8**
15-watt LEDs					
Distribution from survey results	40%	6%	11%	12%	31%
Baseline wattage	100	72	23	15	0
Weighted average baseline					**48.6**

[a] Halogen bulbs are often confused with incandescent bulbs, which can no longer be purchased. To account for this, the evaluation team asked participants if they had incandescent bulbs in storage. If respondents answered yes, we assumed they replaced or would have installed an incandescent bulb. If they answered no, we assumed they replaced or would have installed a halogen bulb.

[b] New or empty fixture.

Lifetime In-Service Rates

The evaluation team relied on the UMP for calculating lifetime ISRs to account for future installations of bulbs in storage. The methodology assumed that 24% of all bulbs in storage would be installed in each subsequent year. To account for the time sensitivity of these added savings, stemming from increased ISRs but taking place after 2019, the evaluation team discounted the 2% annual lifetime ISR to determine NPV lifetime ISRs for each LED. Table K-3 shows a comparison of first-year and lifetime ISRs, illustrating how marginal increases to first-year ISRs using the UMP methodology resulted in NPV lifetime ISRs used in measure impact calculations.

Table K-3. 2019 School Kits Program First-Year and Lifetime In-Service Rate Calculations

Measure	First-Year ISR	2020	2021	Lifetime ISR	NPV ISR
9-watt LED	94.4%	1.4%	1.0%	96.7%	96.7%
15-watt LED	83.3%	4.0%	3.0%	90.4%	90.2%

Waste Heat Factors

For WHFs, the evaluation team employed a method similar to that used for deriving baseline wattages. This involved collecting self-reported heating and cooling data from participants through the 2018 parent survey. The evaluation team then applied Indiana TRM (v2.2) WHF values to the survey results, weighting them according to the survey response distribution shown in Table K-4.

Table K-4. 2019 School Kits Program Indiana TRM (v2.2) Waste Heat Factors, Weighted by Parent Survey

HVAC Type	WHF_e	WHF_d	Distribution
Air conditioning with natural gas heat	0.06	0.07	31%
Heat pump	-0.17	0.03	7%
Air conditioning with electric heat	-0.45	0.07	54%
Electric heat only	-0.52	0.00	4%
Natural gas heat only	0.00	0.00	3%
Weighted average	**-0.260**	**0.062**	**100%**

LED Night Lights

The evaluation team used the following equation to calculate energy savings for LED night lights:

$$\Delta kWh = \frac{(W_{base} - W_{LED})}{1{,}000} * HOU * ISR$$

Where:

W_{base} = Wattage of bulb being replaced, depending on condition

W_{LED} = Wattage of the LED night light

1,000 = Constant to convert watts to kilowatts

HOU = Average hours of use per year

ISR = In-service rate, lifetime NPV

Table K-5 lists input assumptions and sources for the LED night light measure's savings calculations.

Table K-5. 2019 School Kits Program *Ex Post* Variable Assumptions for LED Nightlights

Input	Value	Source
W_{base} for incandescent replacement	5.0	Indiana TRM (v2.2)
W_{base} for LED replacement	0.5	Equal to W_{LED}
W_{base} for no replacement	0	Measure definition
W_{LED}	0.5	Actual installed wattage
HOU	2,920	Indiana TRM (v2.2)
Percentage of incandescent replacement	37%	2018 parent survey
Percentage of LED replacement	15%	
Percentage not replaced	48%	
ISR	83%	

Table K-6 shows the weighting of savings calculations by replacement conditions.

Table K-6. 2019 School Kits Program Calculation of LED Night Light Savings

Baseline Condition	W_{base}	W_{LED}	Savings (kWh)	Distribution
Incandescent replacement	5.0	0.5	13.14	37%
LED replacement	0.5	0.5	0.00	15%
No replacement	0.0	0.5	-1.46	48%

Kitchen and Bathroom Faucet Aerators

The evaluation team used two equations to calculate energy savings and demand reduction for low-flow kitchen and bathroom faucet aerators:

$$\Delta kWh = \left(GPM_{base} - GPM_{low\ flow}\right) * MPD * \frac{PH}{FH} * DR * 8.33 * (T_{mix} - T_{inlet}) * \frac{365}{RE * 3{,}412} * ISR$$

$$\Delta kW\ savings = \left(GPM_{base} - GPM_{low\ flow}\right) * DR * 60 * 8.33 * \frac{T_{mix} - T_{inlet}}{RE * 3{,}412} * CF * ISR$$

Where:

GPM_{base}	=	Gallons per minute of baseline faucet aerator
$GPM_{low\ flow}$	=	Gallons per minute of low-flow faucet aerator
MPD	=	Average minutes of faucet use per person per day
PH	=	Average number of people per household
FH	=	Average number of faucets per household
DR	=	Percentage of water flowing down the drain
8.33	=	Specific weight of water in pounds per gallon, multiplied by specific water temperature (1.0 Btu/lb-°F)
T_{mix}	=	Mixed water temperature exiting faucet
T_{inlet}	=	Cold water temperature entering the DHW system
365	=	Days per year
RE	=	Recovery efficiency of electric hot water heater

3,412 = Constant to convert Btu to kilowatt-hours

ISR = In-service rate, first-year

60 = Minutes per hour

CF = Summer peak coincidence factor

Table K-7 lists input assumptions and source for the faucet aerator measure's savings calculations.

Table K-7. 2019 School Kits Program *Ex Post* Variable Assumptions for Faucet Aerators

Input	Kitchen Aerator Value	Bathroom Aerator Value	Source
GPM_{base}	2.44	1.90	Indiana TRM (v2.2)
$GPM_{low\ flow}$	1.5	1.0	Program materials
MPD	4.5	1.6	Indiana TRM (v2.2)
PH	4.63	4.63	2018 parent survey
FH	1.00	2.55	2018 parent survey
DR	50%	70%	Indiana TRM (v2.2)
T_{mix}	93	86	Indiana TRM (v2.2)
T_{inlet}	58.1	58.1	Indiana TRM (v2.2)
RE	0.98	0.98	Indiana TRM (v2.2)
ISR	62%	53%	2018 parent survey
CF	0.0033	0.0012	Indiana TRM (v2.2)

Low-Flow Showerheads

The evaluation team used two equations to calculate the energy savings and demand reduction for low-flow showerheads:

$$\Delta kWh = \left(GPM_{base} - GPM_{low\ flow}\right) * MS * SPD * \frac{PH}{SH} * 8.33 * (T_{mix} - T_{inlet}) * \frac{365}{RE * 3{,}412} * ISR$$

$$\Delta kW = \left(GPM_{base} - GPM_{low\ flow}\right) * 60 * 8.33 * \frac{T_{mix} - T_{inlet}}{RE * 3{,}412} * CF * ISR$$

Where:

GPM_{base} = Gallons per minute of baseline showerhead

$GPM_{low\ flow}$ = Gallons per minute of low-flow showerhead

MS = Average minutes per shower event

SPD = Average number of shower events per person per day

PH = Average number of people per household

SH = Average number of showerheads per household

8.33 = Specific weight of water in pounds per gallon, multiplied by specific water temperature (1.0 Btu/lb-°F)

T_{mix} = Mixed water temperature exiting faucet

T_{inlet} = Cold water temperature entering the DHW system

365 = Days per year

RE = Recovery efficiency of electric hot water heater

3,412	=	Constant to convert Btu to kilowatt-hours
ISR	=	In-service rate, first-year
60	=	Minutes per hour
CF	=	Summer peak coincidence factor

Table K-8 lists input assumptions and sources for the low-flow showerhead measure's savings calculations.

Table K-8. 2019 School Kits Program *Ex Post* Variable Assumptions for Low-Flow Showerheads

Input	Value	Source
GPM_{base}	2.35	Indiana TRM (v2.2)
$GPM_{low\ flow}$	1.5	Program materials
MS	7.8	Indiana TRM (v2.2)
SPD	0.6	Indiana TRM (v2.2)
PH	4.85	2018 parent survey
SH	1.75	2018 parent survey
T_{mix}	101	Indiana TRM (v2.2)
T_{inlet}	58.1	Indiana TRM (v2.2)
RE	0.98	Indiana TRM (v2.2)
ISR	61%	2018 parent survey
CF	0.0023	Indiana TRM (v2.2)

Furnace Filter Whistles

For the 2019 program, the evaluation team used the furnace whistle engineering savings algorithms outlined in the 2016 Pennsylvania TRM. Illume proposed (and the evaluation team agreed) to use the 2016 Pennsylvania TRM in lieu of a 1999 engineering assessment by Quantec, which the evaluation team considered outdated:

$$\Delta kWh = (EFLH_{heat} + EFLH_{cool}) * kW_{motor} * EI * ISR$$

$$\Delta kW = kW_{motor} * EI * CF * ISR$$

Where:

$EFLH_{heat}$	=	Equivalent full load hours for heating per year
$EFLH_{cool}$	=	Equivalent full load hours for cooling per year
kW_{motor}	=	Average motor full load electric demand in kilowatts
EI	=	Efficiency improvement
ISR	=	Installation rate, first-year
CF	=	Coincidence factor

Table K-9 lists input assumptions and sources for the furnace filter whistle measure's savings calculations. The evaluation team derived equivalent full-load hour assumptions from the Indiana TRM (v2.2) to reflect local weather conditions and furnace usage.

Table K-9. 2019 School Kits Program *Ex Post* Variable Assumptions for Furnace Filter Whistle

Input	Value	Source
$EFLH_{heat}$	1,341	Indiana TRM (v2.2)
$EFLH_{cool}$	487	Indiana TRM (v2.2)
kW_{motor}	0.5	2016 Pennsylvania TRM
EI	15%	2016 Pennsylvania TRM
ISR	39%	2018 parent survey
CF	0.647	2016 Pennsylvania TRM

Net-to-Gross Methodology

Using responses to the 2018 parent survey, the evaluation team estimated freeridership and spillover, explained below. General purpose LEDs had the highest freeridership rates, while furnace whistles had the lowest.

Freeridership

To determine freeridership, the evaluation team asked participants representing 275 measure-specific freeridership responses about whether, in absence of the School Kits program, they would have installed equipment to the same efficiency level within one year. Based on survey feedback, the team calculated overall freeridership for the program as 15%, as shown in Table K-10.

Table K-10. 2019 School Kits Program Freeridership Results

Measure	Sample (n)	Freeridership	*Ex Post* Gross Population Savings (kWh)
9-watt LED (3) 15-watt LED (2)	71	25% [a]	1,226,958
LED night light	56	18% [a]	38,313
Showerhead	43	13% [a]	1,352,744
Kitchen faucet aerator	43	9% [a]	1,051,356
Bathroom faucet aerator	37	14% [a]	133,199
Furnace whistle	25	8% [a]	542,563
Overall	**275**	**15%** [b]	**4,345,132**

Note: Values rounded for reporting purposes.

[a] The team weighted measure freeridership by the survey sample *ex post* gross program kilowatt-hour savings.

[b] The team weighted overall freeridership by the *ex post* gross program population kilowatt-hour savings.

The evaluation team estimated measure-level freeridership for each participant, based on responses to two questions:

- FR1. “If you had not received the kit, would you have purchased a [MEASURE] on your own?”
- FR2. “When would you have purchased the [MEASURE]?”

If a participant answered “no” to FR1, they were estimated as a 0% freerider. If a participant said they “already have the measure installed in all available locations” to FR1, they were estimated as a 100% freerider. If a participant answered “yes” to FR1, their freeridership estimate was based on their answer to FR2. Table K-11 shows response options to the freeridership questions, the freeridership score (FR Score) associated with each response, and the response frequency for each measure type.

Table K-11. 2019 School Kits Program Freeridership Responses and Scoring

Freeridership Questions / Response Options		Frequency of Responses						
FR1. If you had not received the kit, would you have purchased a [MEASURE] on your own?	**FR Score**	**9-Watt LED (3)**	**15-Watt LED (2)**	**LED Night Light**	**Shower-head**	**Kitchen Faucet Aerator**	**Bathroom Faucet Aerator**	**Furnace Whistle**
No	0%	32		44	35	35	33	22
Already have the measure installed in all available locations	100%	2		1	1	2	2	1
Yes								
FR2. When would you have purchased the [MEASURE]?								
Around the same time I received the kit	100%	6		5	3	0	1	0
Later but within one year	50%	24		1	3	4	1	2
More than one year later	0%	0		1	1	0	0	0
(Don't know)	25%	7		4	0	2	0	0
Total	**N/A**	**71**		**56**	**43**	**43**	**37**	**25**

Spillover

The evaluation team estimated spillover using specific information about participants (determined through the evaluation) and incorporating the Indiana TRM (v2.2) as a baseline reference. The team estimated the percentage of program spillover by dividing the sum of additional spillover savings (as reported by survey respondents) by the total gross savings achieved by all program respondents. Table K-12 shows that the spillover estimate for the School Kits program is 7% (when rounded to the nearest whole percentage).

Table K-12. 2019 School Kits Program Spillover

Spillover Savings (kWh)	Survey Respondent Program Savings (kWh)	Spillover
1,990	26,595	7%

Four participants said the program was *very important* in their decision to purchase and install additional energy efficient equipment. Table K-13 shows these additional spillover measures and the total resulting energy savings.

Table K-13. 2019 School Kits Program Spillover Measures, Quantity, and Savings

Spillover Measures	Quantity	Total Energy Savings (kWh)
ENERGY STAR clothes washer	2	404
ENERGY STAR dishwasher	1	150
ENERGY STAR refrigerator	1	83
ENERGY STAR room air conditioner	1	16
Programmable thermostat	1	1,336
Total	**N/A**	**1,990**

Note: Values rounded for reporting purposes.

Appendix L. Whole Home Program Measures, Assumptions, and Algorithms

This appendix presents savings details for several Whole Home measures, including algorithms, variable assumptions and sources, and differences between *ex ante* and *ex post*:

- LEDs (9 watt, 16 watt, 5-watt globe, 5-watt candelabra, 7-watt track light, R30, and 9-watt exterior)
- Bathroom and kitchen aerators
- Low-flow showerheads
- Heat pump water heaters
- Pipe wrap insulation
- Smart strips
- Programmable thermostats
- Smart thermostats
- Duct sealing
- Air sealing
- Duct sealing
- Central ACs
- Air-source heat pumps
- LED night-lights
- Furnace whistles
- Audit recommendations

Unless otherwise specified, the following algorithms, variable assumptions, and measure savings applied to multifamily and manufactured homes.

LEDs

Algorithms and Variable Assumptions

The evaluation team used equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for LEDs:

$$kWh\ savings = \frac{(W_{base} - W_{LED}) * (Hrs/day * 365) * \ (1 + WHFe)}{1{,}000}$$

$$kW\ reduction = \frac{(W_{base} - W_{LED}) * \ CF * \ (1 + WHFd)}{1{,}000}$$

Where:

W_{base} = Baseline wattage of existing bulb replaced with LED (see Table L-1)

Table L-1. 2019 Whole Home Program LED Baseline Wattages

Measure	Baseline Wattage
9-watt LED	43
16-watt LED	65
5-watt globe LED	40
5-watt candelabra LED	40
7-watt track light LED	50
R30, 10-watt LED	65

W_{LED} = Actual installed LED wattage

Hrs/day = Average number of hours per day the light remains in use

WHF_e = Waste heat factor for energy use; this accounts for effects from more efficient lighting on cooling energy use

WHF_d = Waste heat factor for demand; this accounts for effects from more efficient lighting on cooling energy demand

CF = Coincidence factor; a number between 0 and 1 indicating the ratio of LEDs expected to be in use and saving energy during the peak summer demand period

Table L-2 shows *ex post* assumptions and sources for the installed LEDs.

Table L-2. 2019 Whole Home Program *Ex Post* Variable Assumptions for LEDs

Variable	Value	Source
Baseline wattage (W_{base})	As shown in Table L-1	Lumens compared with ENERGY STAR and EISA halogen baseline equivalent wattages applied
LED wattage (W_{LED})	As shown in Table L-1	Program information
Hrs/day (interior lights)	902	Indiana TRM (v2.2)
Hrs/day (9-watt exterior)	1,607	Indiana TRM (v2.2)
Weighted average energy waste heat factor (WHFe)	-0.061 for interior, 0 for exterior	Indiana TRM (v2.2) for Indianapolis
Weighted average demand waste heat factor (WHFd)	0.055 for interior, 0 for exterior	Indiana TRM (v2.2) for Indianapolis
Coincidence factor (CF)	0.11	Indiana TRM (v2.2)

Savings Summary for LEDs

Table L-3 shows *ex ante* deemed savings and the resulting *ex post* per-measure savings for LEDs.

Table L-3. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for LEDs

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
9-watt LED	18.61	0.002	28.86	0.004
16-watt LED	32.66	0.004	41.50	0.005
5-watt Globe LED	19.44	0.004	29.64	0.004
5-watt Candelabra LED	19.71	0.004	29.64	0.004
7-watt track light LED	12.59	0.002	36.42	0.005
R30, 10-watt LED	30.93	0.006	46.58	0.006
9-watt exterior LED	32.68	0.000	54.64	0.000

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Differences in baseline wattage calculations for LEDs:*** To calculate *ex ante* savings, CLEAResult applied the Indiana TRM (v2.2) baseline wattages and WHFs for 9-watt bulbs and applied a separate electric WHF and ISR for specialty bulbs. The evaluation team did not receive detailed information about the source of the separate WHF; therefore, to calculate *ex post* savings, the evaluation team applied the EISA-adjusted, halogen equivalent baseline wattages and the Indiana TRM (v2.2) WHF across all bulbs to more closely reflect replacing incandescent bulbs, as specified in the program materials. The UMP and ENERGY STAR equivalent baseline wattages were larger than the Indiana TRM (v2.2) baseline wattages, which were designed to reflect a balance of replacing various bulb types, hence resulting in *ex post* per-bulb savings values greater than *ex ante* values.

Carryover Bulbs

To calculate carryover bulbs, the evaluation team referenced the UMP to estimate how many bulbs would be installed each year. The UMP recommends a 2021 sunset, given EISA standard implementation. However, recent changes at the U.S. Department of Energy mean that general service lamps will still have halogen baseline savings until at least 2022. The team used the initial first-year ISR for kit measures, then extrapolated estimated lifetime ISRs for these bulbs using the 24% estimation plus a discount factor to account for installation delays. The team used this 75% lifetime cumulative ISR rather than the original calculated ISR for kit LEDs, accounting for future installations of bulbs in storage (see Table L-4).

Table L-4. 2019 Whole Home Program Adjusted Lifetime In-Service Rates for Kit Lighting Measures

Year	Calendar Year	Cumulative ISR
Year 1	2019	52%
Year 2	2020	62%
Year 3	2021	70%
Year 4	2022	75%

Bathroom and Kitchen Faucet Aerators

Algorithms and Variable Assumptions

The evaluation team two used equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for bathroom and kitchen faucet aerators installed in homes with an electric water heater:

$$kWh\ savings_{aerator} = (gpm_{base} - gpm_{low})\ x\ MPD * \frac{PH}{FH} * \mathrm{DR} * \mathrm{S} * (T_{mix} - T_{Inlet}) * \frac{365}{RE * 3{,}412}$$

$$kW\ reduction_{aerator} = (gpm_{base} - gpm_{low}) * 60 * \mathrm{DR} * S * \frac{(T_{mix} - T_{Inlet})}{RE * 3{,}412} * CF$$

Where:

gpm_{base}	=	Baseline flow rate of existing faucet in gallons per minute
gpm_{low}	=	Low-flow rate of aerator in gallons per minute
MPD	=	Average minutes per day and per person of faucet use
PH	=	Average number of people per household
FH	=	Average number of faucets per household
DR	=	Drain recovery factor, representing the percentage of water flowing down the drain
S	=	Constant used to convert the weight of water from gallons to pounds (8.3 lbs/gallon)
T_{mix}	=	Temperature of the water leaving the aerator (°F)
T_{inlet}	=	Temperature of the water entering the water heater (°F)
RE	=	Recovery efficiency of the electric water heater in operation
CF	=	Coincidence factor; a number between 0 and 1 indicating the ratio of aerators expected to be in use and saving energy during the peak summer demand period

Table L-5 shows *ex post* assumptions and sources for installed faucet aerators.

Table L-5. 2019 Whole Home Program *Ex Post* Variable Assumptions for Faucet Aerators

Variable	Value		Source
	Bathroom	Kitchen	
Baseline flow rate (gpm_{base})	1.9	2.44	Indiana TRM (v2.2)
Low-flow rate (gpm_{low})	1.0	1.5	Program information
Minutes/person/day (MPD)	1.6	4.5	Indiana TRM (V2.2
People per household (PH)	2.64	2.64	Indiana TRM (v2.2)
Faucets per household (FH)	2.04	1	Indiana TRM (v2.2)
Drain recovery factor (DR)	0.7	0.5	Indiana TRM (v2.2)
Conversion factor (S)	8.3	8.3	Engineering constant in units of Btu/(gal˚F)
Mixed temperature (T_{mix})	86	93	Indiana TRM (v2.2)
Inlet temperature (T_{inlet})	58.1	58.1	Indiana TRM (v2.2) for Indianapolis
Recovery efficiency (RE)	0.98	0.98	Indiana TRM (v2.2)
Coincidence factor (CF)	0.0012	0.0033	Indiana TRM (v2.2)

Savings Summary for Faucet Aerators

Table L-6 shows *ex ante* deemed savings and resulting *ex post* per-measure savings for faucet aerators.

Table L-6. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Faucet Aerators

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Bathroom Aerators	29.35	0.003	32.97	0.003
Kitchen Aerators	157.13	0.007	176.55	0.008

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited a deemed savings value, while the evaluation team leveraged the Indiana TRM (v2.2).

Low-Flow Showerheads

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for low-flow showerheads installed in homes with an electric water heater:

$$kWh\ savings_{Showerhead} = (gpm_{base} - gpm_{low}) * \mathrm{MS} * \mathrm{SPD} * \frac{PH}{SH} * S * (T_{mix} - T_{Inlet}) * \frac{365}{RE * 3{,}412}$$

$$kW\ reduction_{Showerhead} = (gpm_{base} - gpm_{low}) * 60 * S * \frac{(T_{mix} - T_{Inlet})}{RE * 3{,}412} * CF$$

Where:

gpm_{base} = Baseline flow rate of existing showerhead in gallons per minute

gpm_{low} = Low-flow rate of showerhead in gallons per minute

MS	=	Average minutes per shower, per person, per day
SPD	=	Average number of showers per person, per day
PH	=	Average number of people per household
SH	=	Average number of showerheads per household
S	=	Constant used to convert the weight of water from gallons to pounds (8.3 lbs/gallon)
T_{mix}	=	Temperature of water leaving the showerhead (°F)
T_{inlet}	=	Temperature of water entering the water heater (°F)
RE	=	Recovery efficiency of the electric water heater in operation
CF	=	Coincidence factor; a number between 0 and 1 indicating the ratio of showerheads expected to be in use and saving energy during the peak summer demand period

For this measure, an efficient, low-flow showerhead replaced an existing, less-efficient showerhead. Table L-7 shows *ex post* assumptions and sources for low-flow showerheads installed through the Whole Home program.

Table L-7. 2019 Whole Home Program *Ex Post* Variable Assumptions for Low-Flow Showerheads

Variable	Value	Source
Baseline flow rate (gpm_{base})	2.63	Indiana TRM (v2.2)
Low-flow rate (gpm_{low})	1.5	Program information
Minutes per shower per person per day (MS)	7.8	Indiana TRM (v2.2)
Showers per person per day (SPD)	0.6	Indiana TRM (v2.2)
People per household (PH)	2.64	Indiana TRM (v2.2)
Showerheads per household (SH)	1.6	Indiana TRM (v2.2)
Conversion factor (S)	8.3	Engineering constant in units of Btu/(gal˚F)
Mixed temperature (T_{mix})	101	Indiana TRM (v2.2)
Inlet temperature (T_{inlet})	58.1	Indiana TRM (v2.2)
Recovery efficiency (RE)	0.98	Indiana TRM (v2.2)
Coincidence factor (CF)	0.0023	Indiana TRM (v2.2)

Savings Summary for Low-Flow Showerheads

Table L-8 shows *ex ante* deemed savings and resulting *ex post* per-measure savings for low-flow showerheads. Savings were calculated using installed equipment information and details from the Indiana TRM (v2.2).

Table L-8. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Low-Flow Showerheads

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Low-Flow Showerhead	322.20	0.016	339.16	0.017

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited a deemed savings value, while the evaluation team leveraged the Indiana TRM (v2.2) to calculate *ex post* savings.

Heat Pump Water Heater

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for heat pump water heaters replacing electric water heaters:

$$kWh\ savings_{HPWH} = kWh_{base} * \frac{COP_{new} - COP_{base}}{COP_{new}} + kWh_{cooling} - kWh_{heating}$$

$$kW\ reduction_{HPWH} = \frac{\Delta kWh}{Hours} * CF$$

Where:

kWh_{base}	=	Average electric domestic hot water consumption
COP_{new}	=	Coefficient of performance (efficiency) of heat pump water heater
COP_{base}	=	Coefficient of performance (efficiency) of standard electric water heater
$kWh_{cooling}$	=	Cooling savings from conversion of heat in home to water heat
$kWh_{heating}$	=	Heating savings from conversion of heat in home to water heat
Hours	=	Equivalent full-load hours of hot water heater
CF	=	Coincidence factor; a number between 0 and 1 indicating the ratio of showerheads expected to be in use and saving energy during the peak summer demand period

Table L-9 shows *ex post* assumptions and sources for the installed heat pump water heaters.

Table L-9. 2019 Whole Home Program *Ex Post* Variable Assumptions for Heat Pump Water Heaters

Variable	Value	Source
Average hot water consumption (kWh_{base})	3460	Indiana TRM (v2.2)
Coefficient of performance of heat pump water heater (COP_{new})	Actual	Participant data
Coefficient of performance of standard electric water heater (COP_{base})	0.904	Indiana TRM (v2.2)
Cooling savings ($kWh_{cooling}$)	180	Indiana TRM (v2.2)
Heating savings ($kWh_{heating}$)	779	Indiana TRM (v2.2), heat pump
Hours of use (Hours)	2,533	Indiana TRM (v2.2)
Coincidence factor (CF)	0.346	Indiana TRM (v2.2)

Savings Summary for Heat Pump Water Heaters

Table L-10 shows *ex ante* deemed savings and resulting *ex post* per-measure savings for heat pump water heaters. Note that *ex post* results are specific to the participant.

Table L-10. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Heat Pump Water Heaters

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Heat Pump Water Heater	2,076.00	0.280	1,890.71	0.258

Pipe Wrap Insulation

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for pipe wrap insulation installed in homes with an electric water heater:

$$kWh\ savings_{pipe\ insulation} = \frac{\left(\frac{1}{R_{existing}} - \frac{1}{R_{new}}\right) * L * C * (\Delta T) * Hrs/yr}{3{,}412 * EF_{electric\ WH}}$$

$$kW\ reduction_{pipe\ insulaton} = \frac{kWh\ savings_{pipe\ insulation}}{Hrs/yr}$$

Where:

$R_{existing}$	=	R-value of uninsulated hot water pipe
R_{new}	=	R-value after installation of new pipe insulation
L	=	Total linear feet of installed pipe insulation
C	=	Circumference of hot water pipe in feet (assumed pipe diameter of 0.5 inches): C = $\pi * pipe\ diameter * 0.083$
ΔT	=	Difference between ambient temperature where water heater is installed and temperature of distributed hot water
Hrs/yr	=	Total number of hours per year the water heater remains in operation
$EF_{electric\ WH}$	=	Energy factor of electric water heater in operation
Hrs/yr	=	Total number of hours per year the water heater remains in operation

Table L-11 shows *ex post* assumptions and sources for installed pipe wrap insulation.

Table L-11. 2019 Whole Home Program *Ex Post* Variable Assumptions for Pipe Wrap Insulation

Variable	Value	Source
R-value of uninsulated pipe ($R_{existing}$)	1	Indiana TRM (v2.2)
R-value after new pipe insulation (R_{new})	3	Indiana TRM (v2.2)
Pipe length (L)	1	To calculate savings in 1-foot increments
Circumference (C)	0.19635	Assumes 0.75-inch diameter pipe
Temperature change (ΔT)	65	Indiana TRM (v2.2)
Hours per year (Hrs/yr)	8,760	Indiana TRM (v2.2)
Energy Factor (EF)	1	Indiana TRM (v2.2)

Savings Summary for Pipe Wrap Insulation

Table L-12 shows *ex ante* deemed savings and resulting *ex post* savings for pipe wrap insulation, per installed foot.

Table L-12. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per Installed Foot Savings for Pipe Wrap Insulation

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Pipe Wrap Insulation	26.84	0.003	22.29	0.003

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited deemed savings, while the evaluation team leveraged the Indiana TRM (v2.2) to calculate *ex post* savings.

Smart Strips

Algorithms and Variable Assumptions

The evaluation teamed used deemed energy savings and demand reduction values from the Indiana TRM (v2.2) for smart strips:

$$kWh\ savings_{Smart\ Strip} = \text{deemed} = 24.3$$

$$kW\ reduction_{Smart\ Strip} = deemed = 0.0044$$

Savings Summary for Smart Strips

Ex ante deemed savings and resulting *ex post* per-measure savings for smart strips are shown in Table L-13.

Table L-13. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Smart Strips

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Smart Strips	24.8	0.0044	24.8	0.004

Programmable Thermostats

Algorithms and Variable Assumptions

The evaluation team used three equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings for programmable thermostats:

$$kWh\ savings_{PStat} = kWh\ savings_{AC\ cooling} + kWh\ savings_{Elec\ htg}$$

$$kWh\ savings_{AC\ cooling} = \frac{1}{n_{cool}} * FLH_{cool} * \frac{BTUh_{cool}}{1000} * ESF_{cool}$$

$$kWh\ savings_{Elec\ htg} = FLH_{heat} * \frac{BTUh_{heat}}{n_{heat} * 3{,}412} * ESF_{heat}$$

Where:

n_{cool} = Efficiency of existing cooling system controlled by programmable thermostat (in units of SEER)

FLH_{cool} = Full-load cooling hours for Indianapolis

$Btuh_{cool}$ = Capacity of cooling system (Btu/hour)

ESF_{cool} = Energy savings factor for cooling

FLH_{heat} = Full-load heating hours for Indianapolis

Btu_{cool} = Capacity of cooling system (Btu/hour)

$Btuh_{heat}$ = Capacity of heating system (Btu/hour)

n_{cool} = Efficiency of existing cooling system controlled by programmable thermostat (in units of SEER)

n_{heat} = Efficiency of existing heating system controlled by programmable thermostat (in units of Coefficient of Performance)

ESF_{cool} = Energy savings factor for cooling

ESF_{heat} = Energy savings factor for heating

Table L-14 shows *ex post* assumptions and sources for installed programmable thermostats.

Table L-14. 2019 Whole Home Program *Ex Post* Variable Assumptions for Programmable Thermostats

Variable	Value	Source
Efficiency of existing cooling system (n_{cool})	11.15	Indiana TRM (v2.2)
Full-load cooling hours (FLH_{cool})	487	Indiana TRM (v2.2) for Indianapolis
Capacity of cooling system ($Btuh_{cool)}$	28,994	Indiana TRM (v2.2)
Energy savings factor for cooling (ESF_{cool})	0.09	Indiana TRM (v2.2)
Full-load heating hours (FLH_{heat})	1,341	Indiana TRM (v2.2) for Indianapolis
Capacity of heating system ($Btuh_{heat}$)	32,000	2016 Pennsylvania TRM
Efficiency of existing heating system (n_{heat} for electric resistance)	1	Indiana TRM (v2.2)
Efficiency of existing heating system (n_{heat} heat for pump)	2.26	Indiana TRM (v2.2)
Energy savings factor for heating (ESF_{heat})	0.068	Indiana TRM (v2.2)

Savings Summary for Programmable Thermostats

Table L-15 shows *ex ante* deemed savings and resulting *ex post* per-measure savings for programmable thermostats.

Table L-15. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Programmable Thermostats

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Programmable Thermostat (Electric Heat + Central AC)	774.88	0	969.20	0
Programmable Thermostat (ASHP)	507.29	0	492.39	0
Programmable Thermostat (Electric Heat Only)	897.56	0	855.22	0
Programmable Thermostat (Natural Gas Heat + Central AC)	113.97	0	113.97	0

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For the *ex ante* analysis, CLEAResult cited a deemed savings value, while the evaluation team used equations from the Indiana TRM (v2.2) to calculate savings and used the Indiana TRM (v2.2) and the 2016 Pennsylvania TRM for Btuh cooling values.

Smart Thermostats

Algorithms and Variable Assumptions

The evaluation team used thee equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings for smart thermostats:

$$kWh\ savings_{PStat} = kWh\ savings_{AC\ cooling} + kWh\ savings_{Elec\ htg}$$

$$kWh\ savings_{AC\ cooling} = \frac{1}{n_{cool}} * FLH_{cool} * \frac{BTUh_{cool}}{1000} * ESF_{cool}$$

$$kWh\ savings_{Elec\ htg} = FLH_{heat} * \frac{BTUh_{heat}}{n_{heat} * 3{,}412} * ESF_{heat}$$

Where:

n_{cool}	=	Efficiency of existing cooling system controlled by programmable thermostat (in SEER units)
FLH_{cool}	=	Full-load cooling hours for Indianapolis
$Btuh_{cool}$	=	Capacity of cooling system (Btu/hour)
ESF_{cool}	=	Energy savings factor for cooling
FLH_{heat}	=	Full-load heating hours for Indianapolis
Btu_{cool}	=	Capacity of cooling system (Btu/hour)
$Btuh_{heat}$	=	Capacity of heating system (Btu/hour)

n_{cool} = Efficiency of existing cooling system controlled by programmable thermostat (in SEER units)

n_{heat} = Efficiency of existing heating system controlled by programmable thermostat (in coefficient of performance units)

ESF_{heat} = Energy savings factor for heating

Table L-16 shows *ex post* assumptions and sources for installed smart thermostats.

Table L-16. 2019 Whole Home Program *Ex Post* Variable Assumptions for Smart Thermostats

Variable	Value	Source
Efficiency of existing cooling system (n_{cool})	11.15	Indiana TRM (v2.2)
Full-load cooling hours (FLH_{cool})	487	Indiana TRM (v2.2) for Indianapolis
Capacity of cooling system ($Btuh_{cool}$)	28,994	Indiana TRM (v2.2)
Energy savings factor for cooling (ESF_{cool})	0.049 if replacing programmable in use, else 0.139	Vectren 2015 report
Full-load cooling hours (FLH_{heat})	1,341	Indiana TRM (v2.2) for Indianapolis
Capacity of heating system ($Btuh_{heat}$)	32,000	2016 Pennsylvania TRM
Efficiency of existing heating system (n_{heat} for electric resistance)	1	Indiana TRM (v2.2)
Efficiency of existing heating system (n_{heat} for heat pump)	2.26	Indiana TRM (v2.2)
Energy savings factor for heating (ESF_{heat})	0.057 if replacing programmable in use, else 0.125	Vectren 2015 report

Savings Summary for Smart Thermostats

Table L-17 shows *ex ante* deemed savings and resulting *ex post* per-measure savings for smart thermostats.

Table L-17. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Smart Thermostats

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Smart Thermostat with enrollment (Electric Heat + Central AC)	1,544.56	0	1,339.59	0
Smart Thermostat with enrollment (ASHP)	700.00	0	638.91	0
Smart Thermostat (Natural Gas Heat + Central AC)	136.17	0	117.50	0
Smart Thermostat without enrollment (Electric Heat + Central AC)	2,033.86	0	1,755.16	0
Smart Thermostat without enrollment (ASHP)	605.42	0	568.06	0
Smart Thermostat without enrollment (Electric Heat Only)	1,829.87	0	1,579.13	0
Smart Thermostat (Natural Gas Heat + Central AC)	126.94	0	109.54	0

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Btuh assumptions:*** CLEAResult referred to actual equipment capacities. Since the evaluation team did not receive equipment capacity information, we leveraged the Indiana TRM (v2.2) and the 2016 Pennsylvania TRM for equipment capacities to calculate *ex post* savings.

Duct Sealing

Algorithms and Variable Assumptions

The evaluation team used four equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for duct sealing.

$$kWh\ savings_{PStat} = kWh\ savings_{heat} + kWh\ savings_{cool}$$

$$kWh\ Savings_{heat} = \frac{\left(DE_{After} - DE_{Before}\right)}{DE_{after}} * \frac{FLH_{heat} * Btuh_{heat}}{n_{heat} * 3{,}412}$$

$$kWh\ Savings_{cool} = \frac{\left(DE_{After} - DE_{Before}\right)}{DE_{After}} * \frac{FLH_{cool} * Btuh_{cool}}{SEER * 1{,}000}$$

$$kW\ Savings = \frac{\left(DE_{After} - DE_{Before}\right)}{DE_{After}} * \frac{Btuh_{cool}}{EER * 1{,}000} * CF$$

Where:

DE_{After}	=	Distribution system efficiency after duct sealing
DE_{Before}	=	Distribution system efficiency before duct sealing
FLH_{heat}	=	Full-load cooling hours for Indianapolis
$Btuh_{heat}$	=	Capacity of heating system (Btu/hour)
n_{heat}	=	Efficiency of existing heating system controlled by programmable thermostat (in coefficient of performance units)
FLH_{cool}	=	Full-load heating hours for Indianapolis
$Btuh_{cool}$	=	Capacity of cooling system (Btu/hour)
Btu_{heat}	=	Capacity of heating system (Btu/hour)
SEER	=	Seasonal average efficiency of AC equipment
EER	=	Peak efficiency of AC equipment (in EER units); if unknown, EER = SEER * 0.9
CF	=	Coincidence factor

Table L-18 shows *ex post* assumptions and sources for duct sealing.

Table L-18. 2019 Whole Home Program *Ex Post* Variable Assumptions for Duct Sealing

Variable	Value	Source
Distribution system efficiency after duct sealing (DE_{After} for cool)	Actual	Participant data
Distribution system efficiency after duct sealing (DE_{After} for heat)	Actual	Participant data
Distribution system efficiency after duct sealing (DE_{Before} for cool)	Actual	Participant data
Distribution system efficiency after duct sealing (DE_{Before} for heat)	Actual	Participant data
Full-load heating hours (FLH_{heat})	1,341	Indiana TRM (v2.2)
Capacity of heating system ($Btuh_{heat}$)	Actual	Participant data
Efficiency of existing heating system (n_{heat})	2.26	Indiana TRM (v2.2), heat pump after 2006
Efficiency of existing heating system (n_{heat})	1	Indiana TRM (v2.2), electric resistance
Full-load cooling hours (FLH_{cool})	487	Indiana TRM (v2.2)
$Btuh_{heat}$	Actual	Participant data
Capacity of cooling system ($Btuh_{cool}$)	Actual	Participant data
Seasonal average efficiency (SEER)	11.15	Indiana TRM (v2.2)
Peak efficiency (EER)	10.035	Indiana TRM (v2.2), EER = SEER * 0.9
Coincidence factor (CF)	0.88	Indiana TRM (v2.2)

Savings Summary for Duct Sealing

Table L-19 shows *ex ante* deemed savings and resulting *ex post* per-measure savings for duct sealing.

Table L-19. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Duct Sealing

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Duct Sealing (ASHP)	379.30	0.143	379.30	0.143
Duct Sealing (Electric Heat and Central AC)	1,026.23	0.094	1,026.23	0.094

Air Sealing

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for air sealing measures.

$$kWh\ savings_{Air\ Sealing} = \left(CFM50_{existing} - CFM50_{air\ sealed}\right) * \frac{\left(\frac{\Delta kWh}{cfm}\right)}{N_{factor}}$$

$$kW\ reduction_{Air\ Sealing} = \left(CFM50_{existing} - CFM50_{air\ sealed}\right) * \frac{\left(\frac{\Delta kW}{CFM}\right)}{N_{factor}} * CF$$

Where:

$CFM50_{existing}$	=	Initial blower door results measured in cubic feet per minute, pressurized at 50 pascal, of the home air leakage amount prior to air-sealing measures
$CFM50_{air\ sealed}$	=	Blower door results measures in cubic feet per minute, pressurized at 50 pascal, of the home air leakage amount after installing air-sealing measures
ΔkWh/CFM	=	Energy savings for each cfm reduction (varies by HVAC equipment)
N_{factor}	=	Constant used to convert 50-pascal airflow to natural airflow, dependent on exposure levels
ΔkW/CFM	=	Demand reduction for each cfm reduction (varies by HVAC equipment)
N_{factor}	=	Constant used to convert 50-pascal air flow to natural air flow, dependent on exposure levels
CF	=	Coincidence factor; a number between 0 and 1 indicating the ratio of cooling equipment expected to be in use and saving energy during the peak summer demand period

Table L-20 shows *ex post* assumptions and sources for the air sealing measure.

Table L-20. 2019 Whole Home Program *Ex Post* Variable Assumptions for Air Sealing

Variable	Value	Source
Initial blower door results ($CFM50_{existing}$)	Actual	Program data
Blower door results after air sealing ($CFM50_{air\ sealed}$)	Actual	
N-factor	16.3	Indiana TRM (v2.2) for unknown number of stories and exposure
Energy savings (ΔkWh/CFM for Electric Heat and Central AC)	50.1	Indiana TRM (v2.2)
Energy savings (ΔkWh/CFM for ASHP)	30.9	
Energy savings (ΔkWh/CFM for Electric Heat Only)	48.2	
Airflow conversion constant (N-factor)	16.3	Indiana TRM (v2.2) for unknown number of stories and exposure
Demand reduction (ΔkW/CFM for Electric Heat and Central AC)	0.006	Indiana TRM (v2.2)
Demand reduction (ΔkW/CFM for ASHP)	0.003	
Demand reduction (ΔkW/CFM for Electric Heat Only)	0	
Coincidence factor (CF)	0.88	Indiana TRM (v2.2)

Savings Summary for Air Sealing

CLEAResult and the evaluation team calculated savings using similar approaches, where we leveraged project-specific information where available (such as pre- and post-installation cfm). Table L-21 shows a comparison of average savings per participant for *ex ante* and *ex post*.

Table L-21. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Air Sealing

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Air Sealing (Electric Heat with Central AC)	1,082.04	0.114	1,105.27	0.116
Air Sealing (Heat Pump)	521.40	0.045	532.59	0.046
Air Sealing (Electric Heat Only)	280.80	0	280.80	0

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Exposure factor:*** CLEAResult applied a deemed exposure value and the evaluation team used the Indiana TRM (v2.2) value for an unknown number of stories and normal exposure.

Central Air Conditioning

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for replacing an existing, inefficient central AC unit with an ENERGY STAR unit.

$$kWh\ savings\ = EFLH_{cool} * Btuh * \frac{\left(\frac{1}{SEER_{existing}} - \frac{1}{SEER_{ee}}\right)}{1{,}000}$$

$$kW\ savings\ = EFLH_{cool} * Btuh * \frac{\left(\frac{1}{EER_{existing}} - \frac{1}{EER_{ee}}\right)}{1{,}000} * CF$$

Where:

$EFLH_{cool}$	=	Full-load cooling hours for Indianapolis
Btuh	=	Size of equipment in Btuh
$SEER_{existing}$	=	Seasonal average efficiency of existing unit
$SEER_{ee}$	=	Seasonal average efficiency of ENERGY STAR unit
$EER_{existing}$	=	Energy efficiency of existing unit
EER_{ee}	=	Energy efficiency of ENERGY STAR unit
CF	=	Summer peak coincident factor

Table L-22 shows *ex post* assumptions and sources for the central AC measure.

Table L-22. 2019 Whole Home Program *Ex Post* Variable Assumptions for Central Air Conditioning

Variable	Value	Source
Full-load cooling hours ($EFLH_{cool}$)	487	Indiana TRM (v2.2) for Indianapolis
Size of equipment (Btuh)	28,994	Indiana TRM (v2.2)
Seasonal average efficiency of existing unit ($SEER_{existing}$)	11.15	Indiana TRM (v2.2)
Seasonal average efficiency of ENERGY STAR unit ($SEER_{ee}$)	16, 17, or 18	Program data
Energy efficiency of existing unit ($EER_{existing}$)	10.035	EER = SEER * 0.9
Energy efficiency of ENERGY STAR unit (EER_{ee})	SEER * 0.9	Indiana TRM (v2.2)
Coincidence factor (CF)	0.88	Indiana TRM (v2.2)

Savings Summary for Central Air Conditioning

Table L-23 shows *ex ante* deemed savings and resulting *ex post* per-measure savings for the central AC measure.

Table L-23. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Central Air Conditioning

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Central AC 16 SEER	249.43	0.406	383.87	0.788
Central AC 17 SEER	313.00	0.509	435.78	0.892
Central AC 18 SEER	369.52	0.601	481.93	0.983

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Btuh and SEER values:*** Since the evaluation team did not receive existing unit SEER or equipment cooling capacity, we calculated *ex post* measure savings using the Indiana TRM (v2.2) values for baseline SEER and cooling capacity.

Central Air-Source Heat Pump

Algorithms and Variable Assumptions

The evaluation team used two equations from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings and demand reduction for replacing an existing, inefficient central heat pump with an ENERGY STAR unit:

$$kWh\ savings = EFLH_{cool} * Btuh_{cool} * \frac{\left(\frac{1}{SEER_{existing}} - \frac{1}{SEER_{ee}}\right)}{1{,}000} + EFLH_{heat} * Btuh_{heat} * \frac{\left(\frac{1}{HSPF_{existing}} - \frac{1}{HSPF_{ee}}\right)}{1{,}000}$$

$$kW\ savings = EFLH_{cool} * Btuh_{cool} * \frac{\left(\frac{1}{EER_{existing}} - \frac{1}{EER_{ee}}\right)}{1{,}000} * CF$$

Where:

$EFLH_{cool}$	=	Full-load cooling hours for Indianapolis
$Btuh_{cool}$	=	Size of cooling equipment in Btuh
$SEER_{existing}$	=	Seasonal energy efficiency of existing unit
$SEER_{ee}$	=	Seasonal energy efficiency of ENERGY STAR unit
$EFLH_{heat}$	=	Full-load heating hours, Indianapolis
$Btuh_{heat}$	=	Size of heating equipment in Btuh
$HSPF_{existing}$	=	Heating seasonal performance factor of existing ASHP
$HSPF_{ee}$	=	Heating seasonal performance factor of efficient ASHP
$EER_{existing}$	=	Energy efficiency of existing unit
EER_{ee}	=	Energy efficiency of ENERGY STAR unit
CF	=	Summer peak coincident factor

Table L-24 shows *ex post* assumptions and sources for the central ASHP measure.

Table L-24. 2019 Whole Home Program *Ex Post* Variable Assumptions for Air-Source Heat Pumps

Variable	Value	Source
Full-load cooling hours ($EFLH_{cool}$)	487	Indiana TRM (v2.2) for Indianapolis
Size of cooling equipment ($Btuh_{cool}$)	36,000	Indiana TRM (v2.2)
$Btuh_{heat}$	36,000	Indiana TRM (v2.2)
Seasonal energy efficiency of existing unit ($SEER_{existing}$)	13	Indiana TRM (v2.2), baseline SEER
Seasonal energy efficiency of ENERGY STAR unit ($SEER_{ee}$)	16, 17, or 18	Program data
Full-load heating hours ($EFLH_{heat}$)	1,341	Indiana TRM (v2.2)
Size of heating equipment ($Btuh_{heat}$)	36,000	Indiana TRM (v2.2)
Heating seasonal performance factor of existing ASHP ($HSPF_{existing}$)	7.7	Indiana TRM (v2.2), baseline SEER
Heating seasonal performance factor of efficient ASHP ($HSPF_{ee}$)	9.5	ENERGY STAR database
Energy efficiency of existing unit ($EER_{existing}$)	11.7	Indiana TRM (v2.2)
Energy efficiency of ENERGY STAR unit (EER_{ee})	SEER * 0.9	Indiana TRM (v2.2)
Coincident factor (CF)	0.88	Indiana TRM (v2.2)

Savings Summary for Heat Pumps

Table L-25 shows *ex ante* deemed savings and resulting *ex post* per-measure savings for the central ASHP measure.

Table L-25. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Air-Source Heat Pumps

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Heat Pump 16 SEER	528.75	0.227	1,440.79	0.508
Heat Pump 17 SEER	686.31	0.294	1,505.25	0.637
Heat Pump 18+ SEER	1,018.67	0.437	1,562.54	0.752

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Btuh and HSPF values:*** Since the evaluation team did not receive HSPF or equipment cooling capacity data, we calculated *ex post* measure savings using the Indiana TRM (v2.2) values for baseline SEER, HSPF, and cooling capacity.

LED Night-Lights

Algorithms and Variable Assumptions

The evaluation team used an equation from the Indiana TRM (v2.2) to calculate *ex post* per-measure energy savings for LED night-lights:

$$kWh\ savings = \frac{\left(W_{base} - W_{Night-light}\right) * (Hrs/day * 365)}{1{,}000}$$

Where:

W_{base} = Baseline wattage of existing night-light replaced with a LED night-light (= 5 watts)

$W_{Night\text{-}Light}$ = Actual wattage of installed LED night-light (= 0.33 watts)

Hrs/day = Average number of hours per day that the night-light remains in use

Table L-26 shows *ex post* assumptions and sources for LED night-lights.

Table L-26. 2019 Whole Home Program *Ex Post* Variable Assumptions for LED Night-Lights

Variable	Value	Source
Baseline wattage (W_{base})	5	Indiana TRM (v2.2)
LED night-light wattage ($W_{Night\text{-}Light}$)	0.33	Indiana TRM (v2.2)
Hours per day (Hrs/day)	8	Indiana TRM (v2.2)

Savings Summary for LED Night-Lights

Table L-27 shows *ex ante* deemed savings and the resulting *ex post* per-measure savings for LED night-lights provided in the kits.

Table L-27. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for LED Night-Lights

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
LED Night-Lights	13.64	0	13.64	0

The differences between *ex ante* and *ex post* savings resulted for one reason:

- ***Deemed versus Indiana TRM (v2.2) calculated savings:*** For *ex ante* analysis, CLEAResult applied a deemed savings value. To calculate *ex post* LED night-light savings, the evaluation team used the Indiana TRM (v2.2).

Filter Whistle

Algorithms and Variable Assumptions

The evaluation team used four equations from the 2016 Pennsylvania TRM to calculate *ex post* per-measure energy savings and demand reduction for filter whistles:

$$kWh\ savings_{Filter\ Whistle} = \Delta\mathrm{kWh}/yr_{heat} + \Delta\mathrm{kWh}/yr_{cool}$$

$$\Delta\mathrm{kWh}/yr_{heat} = \mathrm{kW}_{motor} * FLH_{heat} * EI * ISR$$

$$\Delta\mathrm{kWh}/yr_{cool} = \mathrm{kW}_{motor} * FLH_{cool} * EI * ISR$$

$$kW\ reduction_{Filter\ Whistle} = \frac{\Delta\mathrm{kWh}/yr_{cool}}{FLH_{cool}} * \mathrm{CF}$$

Where:

kW_{motor}	=	Average motor full load electric demand
FLH_{heat}	=	Full-load heating hours
FLH_{cool}	=	Full-load cooling hours
EI	=	Efficiency improvement
ISR	=	In-service rate
FLH_{cool}	=	Full-load cooling hours
CF	=	Coincidence factor
ISR	=	In-service rate

Table L-28 shows *ex post* assumptions and sources for the filter whistles.

Table L-28. 2019 Whole Home Program *Ex Post* Variable Assumptions for Filter Whistles

Variable	Value	Source
Average motor full load electric demand (kW_{motor})	0.5	2016 Pennsylvania TRM
Full-load heating hours (FLH_{heat})	1,341	Indiana TRM (v2.2) for Indianapolis
Efficiency improvement (EI)	0.15	2016 Pennsylvania TRM
In-service rate (ISR)	1	Assumed for *ex post* analysis
Full-load cooling hours (FLH_{cool})	487	Indiana TRM (v2.2) for Indianapolis
Coincidence factor (CF)	0.647	2016 Pennsylvania TRM

Savings Summary for Filter Whistles

Table L-29 shows *ex ante* deemed savings and resulting *ex post* per-measure savings for filter whistles provided in the kits.

Table L-29. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Filter Whistles

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Filter Whistle	64.17	0.098	137.05	0.049

The differences between *ex ante* and *ex post* savings resulted for two reasons:

- ***In-service rate for filter whistles:*** For the *ex ante* analysis, CLEAResult applied the embedded 2016 Pennsylvania TRM ISR of 0.474. The evaluation team applied an ISR of 1.0 for the *ex post* analysis and applied the actual ISR after the *ex post* calculations. This resulted in *ex post* per-measure savings being higher than *ex ante* savings.
- ***Demand reduction calculation:*** CLEAResult included heating and cooling energy savings to calculate demand reduction. The evaluation team only included cooling energy savings.

Audit Recommendations

Algorithms and Variable Assumptions

The evaluation team applied an *ex post* audit recommendation value for energy savings from the 2014 *Energizing Indiana Statewide Core Program Report*, consistent with CLEAResult's approach.

Savings Summary for Audit Recommendations

Table L-30 shows a comparison of *ex ante* and *ex post* per-measure savings for the audit recommendations:

Table L-30. 2019 Whole Home Program *Ex Ante* and *Ex Post* Per-Measure Savings for Audit Recommendations

Measure	*Ex Ante* Savings		*Ex Post* Savings	
	kWh	kW	kWh	kW
Audit Recommendations	187.5	0	187.5	0

As a participant survey of the audit was not conducted in 2019, the evaluation team recommends that future assessments include a follow-up survey with program participants to determine the number of participants implementing one or more of the audit recommendations. Survey results will be used with a per-measure Indiana TRM (v2.2) evaluation to inform and estimate savings that more closely reflect the implementation of audit measures.

Appendix M. Commercial and Industrial Measures, Assumptions, and Algorithms

Gross Impact Methodology

The evaluation team used several algorithms to determine *ex post* savings for measures where primary on-site data, metered trends, or custom *ex ante* calculations were unavailable. In general, these algorithms aligned with *ex ante* methodologies, though we updated some site-specific inputs in our *ex post* calculations based on evaluation findings.

Lighting Retrofit Algorithms

The evaluation team used two algorithms from the Indiana TRM (v2.2), page 283, to calculate energy savings and demand reduction for lighting retrofit measures:

$$\Delta kWh = (Watts_{base} - Watts_{ee}) * HOURS * \frac{1 + WHF_e}{1{,}000}$$

$$\Delta kW_{peak\ coincident} = (Watts_{base} - Watts_{ee}) * CF * \frac{1 + WHF_d}{1{,}000}$$

Where:

$Watts_{base}$	=	Wattage of existing fixture[74]
$Watts_{ee}$	=	Wattage of new energy-efficient fixture (= from application)
HOURS	=	Annual operating hours (= from application)
WHF_e	=	Energy waste heat factor (= from look-up value in Table M-1)
1/1,000	=	Constant to convert watts to kilowatts or watt-hours to kilowatt-hours
CF	=	Summer coincidence peak factor (= from look-up value in Table M-2)
WHF_d	=	Demand waste heat factor (= from look-up value in Table M-1)

The evaluation team used assumed fixture wattages where *ex ante* baselines or efficient wattages were nominal and had not accounted for the ballast factor.

Table M-1 lists the waste heat factors for energy savings (WHFe) and demand reduction (WHFd) by building type and city.

[74] The evaluation team sources inputs from program applications or used claimed algorithm assumptions if the bulb was EISA-exempt; otherwise, the team referenced Table M-3 through Table M-12.

Table M-1. Waste Heat Factor Assumptions in Indianapolis by Building Type and HVAC Technology

Building	AC with Natural Gas Heat		Heat Pump		AC with Electric Heat		Electric Heat Only		Natural Gas Heat Only or Exterior Space	
	WHFe	WHFd	WHFe	WHFd	WHFe	WHFd	WHFe	WHFd	WHFe	WHFd
Assembly	0.155	0.2	-0.174	0.2	-0.434	0.2	-0.591	0	0	0
Big-Box Store	0.146	0.2	-0.086	0.2	-0.193	0.2	-0.318	0	0	0
Elementary School	0.096	0.2	-0.278	0.2	-0.605	0.2	-0.743	0	0	0
Fast Food	0.109	0.2	-0.023	0.2	-0.53	0.2	-0.661	0	0	0
Full Service Restaurant	0.108	0.2	-0.023	0.2	-0.556	0.0	-0.872	0	0	0
Grocery	0.146	0.2	-0.086	0.2	-0.193	0.2	-0.318	0	0	0
Light Industrial	0.096	0.2	-0.145	0.2	-0.332	0.2	-0.433	0	0	0
Small Office	0.119	0.2	-0.027	0.2	-0.182	0.2	-0.182	0	0	0
Small Retail	0.124	0.2	-0.083	0.2	-0.315	0.2	-0.437	0	0	0
Warehouse	0.096	0.2	-0.145	0.2	-0.332	0.2	-0.433	0	0	0
Other	0.115	0.2	-0.15	0.2	-0.357	0.185	-0.487	0	0	0

Table M-2 lists the coincidence factors associated with various commercial and industrial building types.

Table M-2. Coincidence Factor by Building Type

Building Type	Coincidence Factor
Food Sales	0.92
Food Service	0.83
Health Care	0.78
Hotel/Motel Guest Room	0.37
Hotel/Motel Common Area	0.90
Office	0.76
Assembly	0.65
Public Services (non-food)	0.64
Retail	0.84
Warehouse	0.79
School	0.50
College	0.68
Industrial	0.76
Garage	1.00 [a]
Exterior	0.00 [b]
Other	0.65

[a] This value assumes 8,760 operating hours.

[b] This value assumes that no exterior lighting is operating during the summer on-peak demand period.

Table M-3 lists baseline wattage assumptions for generic, screw-base light bulbs, distinguished by lumen range, application, and shape.

Table M-3. Baseline Wattage for General Service Medium Screw-Base Lamps

Efficient Bulb Lumen Range			Baseline Wattage
General Service Bulb	Decorative Shape Bulb	Globe Shape Bulb	
1,600-2,600	--	650-1,300	72
1,100-1,599	--	575-649	53
800-1,099	500-699	500-574	43
450-799	300-499	350-499	29
0-449	150-299	250-349	25
--	90-149	--	15
--	70-89	--	10

Source: National Renewable Energy Laboratory. February 2015. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* "Chapter 21: Residential Lighting Evaluation Protocol." https://www.energy.gov/sites/prod/files/2015/02/f19/UMPChapter21-residential-lighting-evaluation-protocol.pdf

Table M-4 lists baseline wattage assumptions for EISA-exempt bulb types (such as three-way lights and post lamps), categorized by lumen range.

Table M-4. EISA-Exempt Lumen Bins

Lumen Range	Baseline Wattage
0-309	25
310-449	25
450-799	40
800-1,099	60
1,100-1,599	75
1,600-1,999	100
2,000-2,600	150
2,601-3,300	150
3,301-4,815	200

Table M-5 lists baseline wattage assumptions for reflector lamp types with diameters less than 2.5 inches, categorized by lumen range.

Table M-5. Baseline Wattage Assumptions by Lumen Range for Reflectors with a Diameter Greater than 2.5 inches

Lumen Range	Baseline Wattage
200-299	20
300-639	30
640-739	40
740-849	45
850-1,179	50
1,180-1,419	65
1,420-1,789	75
1,790-2,049	90
2,050-2,579	100
2,580-3,429	120
3,430-4,270	150

See Table M-6 and Table M-7 for baseline wattage assumptions for BR30, BR40, ER30, and ER40 lamp types.

Table M-6 lists baseline wattage assumptions for BR30, BR40, and ER40 lamp types, categorized by lumen range.

Table M-6. Baseline Wattage Assumptions by Lumen Range for BR30, BR40, and ER40 Lamps

Lumen Range	Baseline Wattage
200-299	20
300-399	30
400-449	40
450-499	45
500-649	50
650-1,179	65
1,180-1,419	65
1,420-1,789	75
1,790-2,049	90
2,050-2,579	100
2,580-3,429	120
3,430-4,270	150

Table M-7 lists baseline wattage assumptions for ER30 lamp types, categorized by lumen range.

Table M-7. Baseline Wattage Assumptions by Lumen Range for ER30 Lamps

Lumen Range	Baseline Wattage
200-299	20
300-399	30
400-449	40
450-499	45
500-639	50
640-739	40
740-849	45
850-1,179	50
1,180-1,419	65
1,420-1,789	75
1,790-2,049	90
2,050-2,579	100
2,580-3,429	120
3,430-4,270	150

Table M-8 lists baseline wattage assumptions for reflector lamp types with diameters between 2.25 and 2.5 inches, categorized by lumen range.

Table M-8. Baseline Wattage Assumptions by Lumen Range for Reflectors with Diameter between 2.25 and 2.5 Inches

Lumen Range	Baseline Wattage
200-299	20
300-539	30
540-629	40
630-719	45
720-999	50
1,000-1,199	65
1,200-1,519	75
1,520-1,729	90
1,730-2,189	100
2,190-2,899	120
2,900-3,850	150

See Table M-9 for baseline wattage assumptions for R20 lamp types.

Table M-9 lists baseline wattage assumptions for R20 lamp types, categorized by lumen range.

Table M-9. Baseline Wattage Assumptions by Lumen Range for R20 Lamps

Lumen Range	Baseline Wattage
200-299	20
300-399	30
400-449	40
450-719	45
720-999	50
1,000-1,199	65
1,200-1,519	75
1,520-1,729	90
1,730-2,189	100
2,190-2,899	120
2,900-3,850	150

Table M-10 lists baseline wattage assumptions for reflector lamp types with diameters under 2.25 inches, categorized by lumen range.

Table M-10. Baseline Wattage Assumptions by Lumen Range for Reflectors with Diameter Equal to or Smaller than 2.25 inches

Lumen Range	Baseline Wattage
200-299	20
300-399	30
400-449	40
450-499	45
500-649	50
650-1,199	65

Table M-11 lists baseline wattage assumptions for exterior wall packs and flood lamps, categorized by lumen range.

Table M-11. Baseline Wattage Assumptions by Lumen Range for Exterior Wall Pack and Flood Lamps

Bulb Type	Baseline Wattage
Small (≤ 50W)	139.3
Medium (50 < Watts ≤ 80)	245.9
Large (80 < Watts ≤ 165)	444.4

Table M-12 lists baseline efficacy assumptions for T8 lamps, categorized by bulb type and lumen range.

Table M-12. Baseline Wattage Assumptions by Lumen Range for T8 Lamps

Bulb Type	Minimum Efficacy (lm/W)
4-Foot Medium Bi-pin ≤ 4,500 K Lumens	92.4
4-Foot Medium Bi-pin 4,500 K < Lumens ≤ 7,500 K	88.7
2-Foot U-Shaped ≤ 4,500 K Lumens	85.0
2-Foot U-Shaped 4,500 K < Lumens ≤ 7,500 K	83.3

Lighting Controls Algorithms

The evaluation team used two algorithms from the Indiana TRM (v2.2), page 267, to calculate energy savings and demand reduction for lighting control measures:

$$\Delta kWh = kW_{controlled} * HOURS * (1 + WHF_e) * ESF$$

$$\Delta kW_{peak\ coincident} = kW_{controlled} * (1 + WHF_d) * CF$$

Where:

$kW_{controlled}$	=	Total lighting load connected to the control in kilowatts (= from application or Table M-13)
HOURS	=	Annual operating hours (= from application)
WHF_e	=	Energy waste heat factor (= from look-up value in Table M-1)
ESF	=	Energy-savings factor (= from look-up value in Table M-13)
WHF_d	=	Demand waste heat factor (= from look-up value in Table M-1)
CF	=	Summer coincidence peak factor (= from look-up value in Table M-13)

Table M-13 lists the energy-savings factors and coincidence factors for various control types.

Table M-13. Energy-Savings Factors and Coincidence Factors by Control Type

Lighting Control Type	Energy-Savings Factor	Coincidence Factor
Wall- or Ceiling-Mounted Occupancy Sensors	0.30	0.15
Fixture-Mounted Occupancy Sensors	0.30	0.15
Remote-Mounted Daylight Dimming Sensors	0.30	0.90
Fixture-Mounted Daylight Dimming Sensors	0.30	0.90
Switching Controls for Multi-Level Lighting	0.30	0.77
Central Lighting Controls (Time Clocks)	0.10	0.00

Variable Frequency Drive Algorithms for HVAC Supply and Return Fans

The evaluation team used several algorithms from the Illinois TRM (v7.0), Section 4.4.26, to calculate energy savings and demand reduction associated with installations of VFDs on supply and return HVAC fans.

Electric Energy Savings:

$$kWh_{Base} = \left(0.746 \times HP \times \frac{LF}{\eta_{motor}}\right) \times RHRS_{Base} \times \sum_{0\%}^{100\%} (\%FF \times PLR_{Base})$$

$$kWh_{Retrofit} = \left(0.746 \times HP \times \frac{LF}{\eta_{motor}}\right) \times RHRS_{Base} \times \sum_{0\%}^{100\%} (\%FF \times PLR_{Retrofit})$$

$$\Delta kWh_{fan} = kWh_{Base} - kWh_{Retrofit}$$

$$\Delta kWh_{total} = \Delta kWh_{fan} \times (1 + IE_{energy})$$

Summer Coincident Peak Demand Reduction:

$$kW_{Base} = \left(0.746 \times HP \times \frac{LF}{\eta_{motor}}\right) \times PLR_{Base,FFpeak}$$

$$kW_{Retrofit} = \left(0.746 \times HP \times \frac{LF}{\eta_{motor}}\right) \times PLR_{Retrofit,FFpeak}$$

$$\Delta kW_{fan} = kW_{Base} - kW_{Retrofit}$$

$$\Delta kW_{total} = \Delta kW_{fan} \times (1 + IE_{demand})$$

Where:

kWh_{base} = Baseline annual energy consumption (kWh/yr)

0.746 = Conversion factor for horsepower to kilowatt-hours

HP = Nominal horsepower of controlled motor

LF = Load factor; motor load at fan design cfm (default = 65%)

η_{motor} = Installed nominal/nameplate motor efficiency (= from look-up value in Table M-14)[75]

$RHRS_{base}$ = Annual operating hours for fan motor based on building type (= from look-up value in Table M-15)

%FF = Percentage of run-time spent within a given flow fraction range

PLR_{Base} = Part-load ratio for a given flow fraction range based on the baseline flow control type

$kWh_{Retrofit}$ = Retrofit annual energy consumption (kWh/yr)

$PLR_{Retrofit}$ = Part-load ratio for a given flow fraction range based on the retrofit flow control type

ΔkWh_{fan} = Fan-only annual energy savings (kWh/yr)

ΔkWh_{total} = Total project annual energy savings (kWh/yr)

IE_{energy} = HVAC interactive effects factor for energy (default = 15.7%)

kW_{Base} = Baseline summer coincident peak demand (kW)

$PLR_{Base,FFpeak}$ = Part-load ratio for the average flow fraction between the peak daytime hours during the weekday peak time period based on the baseline flow control type (default average flow fraction during peak period = 90%)

$kW_{Retrofit}$ = Retrofit summer coincident peak demand (kW)

$PLR_{Retrofit,FFpeak}$ = Part-load ratio for the average flow fraction between the peak daytime hours during the weekday peak time period based on the retrofit flow control type (default average flow fraction during peak period = 90%)

ΔkW_{fan} = Fan-only summer coincident peak demand impact (kW)

ΔkW_{total} = Total project summer coincident peak demand impact (kW)

IE_{demand} = HVAC interactive effects factor for summer coincident peak demand (default = 15.7%)

Table M-14 lists National Electrical Manufacturers Association Premium default motor efficiencies, categorized by horsepower, motor type, number of poles, and operational rpms.

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75 The default motor is a National Electrical Manufacturers Association Premium Efficiency, open drip proof, 4-pole, 1,800 rpm fan motor.

Table M-14. National Electrical Manufacturers Association Premium Default Motor Efficiency

Size (horsepower)	Open Drip Proof (# of Poles / Speed in rpm)			Totally Enclosed Fan Cooled (# of Poles / Speed in rpm)		
	6 / 1,200	4 / 1,800 (Default)	2 / 3,600	6 / 1,200	4 / 1,800 (Default)	2 / 3,600
1	0.825	0.855	0.770	0.825	0.855	0.770
1.5	0.865	0.865	0.840	0.875	0.865	0.840
2	0.875	0.865	0.855	0.885	0.865	0.855
3	0.885	0.895	0.855	0.895	0.895	0.865
5	0.895	0.895	0.865	0.895	0.895	0.885
7.5	0.902	0.910	0.885	0.910	0.917	0.895
10	0.917	0.917	0.895	0.910	0.917	0.902
15	0.917	0.930	0.902	0.917	0.924	0.910
20	0.924	0.930	0.910	0.917	0.930	0.910
25	0.930	0.936	0.917	0.930	0.936	0.917
30	0.936	0.941	0.917	0.930	0.936	0.917
40	0.941	0.941	0.924	0.941	0.941	0.924
50	0.941	0.945	0.930	0.941	0.945	0.930
60	0.945	0.950	0.936	0.945	0.950	0.936
75	0.945	0.950	0.936	0.945	0.954	0.936
100	0.950	0.954	0.936	0.950	0.954	0.941
125	0.950	0.954	0.941	0.950	0.954	0.950
150	0.954	0.958	0.941	0.958	0.958	0.950
200	0.954	0.958	0.950	0.958	0.962	0.954
250	0.954	0.958	0.950	0.958	0.962	0.958
300	0.954	0.958	0.954	0.958	0.962	0.958
350	0.954	0.958	0.954	0.958	0.962	0.958
400	0.958	0.958	0.958	0.958	0.962	0.958
450	0.962	0.962	0.958	0.958	0.962	0.958
500	0.962	0.962	0.958	0.958	0.962	0.958

Table M-15 lists annual HVAC fan run-time hours, categorized by building type.

Table M-15. Annual HVAC Fan Run Hours by Building Type

Building Type	Total Fan Run Hours
Assembly	7,235
Assisted Living	8,760
College	6,103
Convenience Store	7,004
Elementary School	7,522
Garage	7,357
Grocery	7,403
Healthcare Clinic	6,345
High School	7,879
Hospital – Variable Air Volume Economizer	8,760
Hospital – Continuous Air Volume Economizer	8,760
Hospital – Continuous Air Volume No Economizer	8,760
Hospital – Fan Coil Unit	8,760
Manufacturing Facility	8,706
Multifamily - High Rise	8,760
Multifamily - Mid-Rise	8,760
Hotel/Motel - Guest	8,760
Hotel/Motel - Common	8,760
Movie Theater	7,505
Office - High Rise - Variable Air Volume Economizer	6,064
Office - High Rise - Continuous Air Volume Economizer	5,697
Office - High Rise - Continuous Air Volume No Economizer	5,682
Office - High Rise – Fan Coil Unit	6,163
Office - Low Rise	6,288
Office - Mid-Rise	6,856
Religious Building	7,380
Restaurant	7,809
Retail - Department Store	7,155
Retail - Strip Mall	6,846
Warehouse	6,832
Unknown	7,100

Table M-16 lists default fan duty cycles, categorized by flow fraction percentage.

Table M-16. Default Fan Duty Cycle

Flow Fraction (% of design cfm)	Percentage of Time at Flow Fraction
0% to 10%	0.000
10% to 20%	0.010
20% to 30%	0.055
30% to 40%	0.155
40% to 50%	0.220
50% to 60%	0.250
60% to 70%	0.190
70% to 80%	0.085
80% to 90%	0.030
90% to 100%	0.005

Table M-17 lists VFDs' part-load ratios for various control types.

Table M-17. Part-Load Ratios for Variable Frequency Drive of Given Control Types

Control Type	Flow Fraction Percentage									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
No Control or Bypass Damper	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Discharge Dampers	0.46	0.55	0.63	0.70	0.77	0.83	0.88	0.93	0.97	1.00
Outlet Damper, Bi and Airfoil Fans	0.53	0.53	0.57	0.64	0.72	0.80	0.89	0.96	1.02	1.05
Inlet Damper Box	0.56	0.60	0.62	0.64	0.66	0.69	0.74	0.81	0.92	1.07
Inlet Guide Vane, Bi and Airfoil Fans	0.53	0.56	0.57	0.59	0.60	0.62	0.67	0.74	0.85	1.00
Inlet Vane Dampers	0.38	0.40	0.42	0.44	0.48	0.53	0.60	0.70	0.83	0.99
Outlet Damper, Forward Curved Fans	0.22	0.26	0.30	0.37	0.45	0.54	0.65	0.77	0.91	1.06
Eddy Current Drives	0.17	0.20	0.25	0.32	0.41	0.51	0.63	0.76	0.90	1.04
Inlet Guide Vane, Forward Curved Fans	0.21	0.22	0.23	0.26	0.31	0.39	0.49	0.63	0.81	1.04
VFD with Duct Static Pressure Controls	0.09	0.10	0.11	0.15	0.20	0.29	0.41	0.57	0.76	1.01
VFD with Low/No Duct Static Pressure	0.05	0.06	0.09	0.12	0.18	0.27	0.39	0.55	0.75	1.00

Table M-18 lists resultant values for the final terms of the algorithms, calculating kWh_{Base} and $kWh_{Retrofit}$ based on the flow fraction percentage and part-load ratio for various control types.

Table M-18. Resultant Values of Percentage Flow Fraction and Part-Load Ratios for Given Control Types

Control Type	$\sum_{0\%}^{100\%} (\%FF \times PLR)$
No Control or Bypass Damper	1.00
Discharge Dampers	0.80
Outlet Damper, Bi and Airfoil Fans	0.78
Inlet Damper Box	0.69
Inlet Guide Vane, Bi and Airfoil Fans	0.63
Inlet Vane Dampers	0.53
Outlet Damper, Forward Curved Fans	0.53
Eddy Current Drives	0.49
Inlet Guide Vane, Forward Curved Fans	0.39
VFD with Duct Static Pressure Controls	0.30
VFD with Low/No Duct Static Pressure	0.27

Variable Frequency Drive Algorithms for HVAC Pumps and Cooling Tower Fans

The evaluation team used two algorithms from the Illinois TRM (v7.0), Section 4.4.26, to calculate energy savings and demand reduction associated with VFD installations on HVAC pumps and cooling tower fans:

$$\Delta kWh = \left(\frac{BHP}{EFF_i}\right) \times Hours \times ESF$$

$$\Delta kW = \left(\frac{BHP}{EFF_i}\right) \times DRF$$

Where:

ΔkWh	=	Annual electric energy savings (kWh/yr)
BHP	=	Brake horsepower (= nominal motor horsepower x motor load factor; with 65% motor load factor if unknown)
EFF_i	=	Currently installed motor efficiency (= actual percentage, or from look-up value in Table M-14)
Hours	=	Hours of use (= actual hours; default hours provided for HVAC applications in Table M-19, by HVAC application and building type)
ESF	=	Energy savings factor (kW/horsepower; = from look-up value in Table M-21)
ΔkW	=	Summer coincident peak demand reduction (kW)
DRF	=	Demand reduction factor (kW/horsepower; = from look-up value in Table M-22, based on typical peak loads for the listed application)

Table M-19 lists heating and cooling annual run hours for HVAC equipment, categorized by building type.

Table M-19. Building Type Annual Hours of Use for Heating and Cooling for HVAC Equipment

Building Type	Heating Run Hours	Cooling Run Hours
Assembly	4,888	2,150
Assisted Living	4,711	4,373
College	3,990	1,605
Convenience Store	4,136	2,084
Elementary School	5,105	3,276
Garage	4,849	2,102
Grocery	4,200	2,096
Healthcare Clinic	5,481	1,987
High School	5,480	3,141
Hospital – Variable Air Volume Economizer	3,718	2,788
Hospital - Continuous Air Volume Economizer	7,170	2,881
Hospital - Continuous Air Volume No Economizer	7,139	8,760
Hospital – Fan Coil Unit	5,844	8,729
Manufacturing Facility	3,821	2,805
Multifamily - High Rise	4,522	4,237
Multifamily - Mid-Rise	5,749	2,899
Hotel/Motel - Guest	4,480	4,479
Hotel/Motel - Common	3,292	8,712
Movie Theater	5,063	2,120
Office - High Rise - Variable Air Volume Economizer	4,094	2,038
Office - High Rise - Continuous Air Volume Economizer	5,361	4,849
Office - High Rise - Continuous Air Volume No Economizer	5,331	5,682
Office - High Rise – Fan Coil Unit	3,758	3,069
Office - Low Rise	3,834	2,481
Office - Mid-Rise	6,155	3,036
Religious Building	5,199	2,830
Restaurant	4,579	3,350
Retail - Department Store	4,249	2,528
Retail - Strip Mall	4,475	2,266
Warehouse	4,606	770
Unknown	4,649	2,718

Table M-20 lists the conditioning type (heating or cooling) associated with three primary VFD applications.

Table M-20. Heating and Cooling Hour Type Reference for Variable Frequency Drive Applications

Application	Hours Type
Hot Water Pump	Heating
Chilled Water Pump	Cooling
Cooling Tower Fan	Cooling

Table M-21 lists the energy savings factors for VFDs by relevant application.

Table M-21. Energy Savings Factors for Variable Frequency Drive Applications

Application	Energy Savings Factor
Hot Water Pump	0.424
Chilled Water Pump	0.411
Cooling Tower Fan	0.126

Table M-22 lists the demand reduction factors for VFDs by relevant application.

Table M-22. Demand Reduction Factors for Variable Frequency Drive Applications

Application	Demand Reduction Factor
Hot Water Pump	0
Chilled Water Pump	0.299
Cooling Tower Fan	0.378

Single-Package and Split System Unitary Air Conditioners Algorithm

The evaluation team used two algorithms from Indiana TRM (v2.2), page 224, and from ASHRAE 90.1-2013, Section 6: Heating, Ventilating, and Air Conditioning, to calculate energy savings and demand reduction for unitary HVAC measures:

$$\Delta kWh = Capacity * EFLH * \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{EE}}\right)$$

$$\Delta kW_{peak\ coincident} = Capacity * \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{EE}}\right) * CF$$

Where:

Capacity = Cooling capacity (kBtu/hour; = from application)

EFLH = Equivalent full-load hours (= from look-up value in Table M-23)

$SEER_{base}$ = Baseline SEER rating (= from look-up value in Table M-24)

$SEER_{EE}$ = Installed SEER rating (= from application or equipment documentation)

CF = Summer coincidence peak factor (= 0.74 per CLEAResult assumption)

Table M-23 lists the equivalent full-load hours, by building type and location, for use with air conditioning equipment.

Table M-23. Equivalent Full-Load Cooling Hours by Building Type and Location

Building	Location				
	Indianapolis	South Bend	Evansville	Fort Wayne	Terre Haute
Assembly	810	721	1,047	716	955
Auto Repair	538	484	721	431	675
Big-Box Retail	1,123	1,006	1,422	1,056	1,251
Fast Food Restaurant	798	738	1,066	694	905
Full Service Restaurant	729	641	967	633	837
Grocery	1,123	1,006	1,422	1,056	1,251
Light Industrial	690	598	842	642	760
Primary School	514	456	573	454	503
Religious Worship	401	360	516	357	444
Small Office	1,096	1,015	1,299	1,035	1,151
Small Retail	1,032	906	1,294	977	1,142
Warehouse	690	598	842	642	760
Other	795	711	1,001	725	886

Table M-24 lists baseline SEER ratings for various types of air conditioning equipment and capacity ranges.

Table M-24. Baseline SEER Rating by Air Conditioner Type and Capacity

Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency
< 65,000 Btu/h	All	Split system	13.0 SEER
		Single package	14.0 SEER
≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split system and single package	11.2 EER and 12.9 IEER
	All other	Split system and single package	11.0 EER and 12.7 IEER
≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split system and single package	11.0 EER and 12.4 IEER
	All other	Split system and single package	10.8 and 12.2 IEER
≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)	Split system and single package	10.0 EER and 11.6 IEER
	All other	Split system and single package	9.8 EER and 11.4 IEER

Source: October 21, 2004. *Electronic Code of Federal Regulations*. Title 10, Chapter II, Subchapter D, Part 431—Energy Efficiency Program for Certain Commercial and Industrial Equipment. "Subpart F—Commercial Air Conditioners and Heat Pumps." 69 FR 61969. https://www.ecfr.gov/cgi-bin/text-idx?SID=f6cc1be4ece3f2b179c0d8ea7ee09d7d&mc=true&node=pt10.3.431&rgn=div5#sp10.3.431.f

Pre-Rinse Spray Valve Algorithms

The evaluation team used algorithms from the Indiana TRM (v2.2), page 190, to calculate energy savings and demand reduction for pre-rinse spray valves:

$$\Delta kWh = \Delta Water * HOT_{\%} * 8.33 * (T_{OUT} - T_{IN}) * \left(\frac{1}{EFF_E * 3{,}412}\right)$$

$$\Delta MMBtu = \Delta Water * HOT_{\%} * 8.33 * (T_{OUT} - T_{IN}) * \frac{1}{EFF_G} * 10^{-6}$$

$$\Delta Water = (FLO_{BASE} - FLO_{EFF}) * 60 * \mathrm{H} * 365$$

Where:

ΔWater	=	Water savings (gallons)
$HOT_{\%}$	=	Retrofit annual energy consumption (kWh/yr)
8.33	=	Specific weight of water (8.3 lbs/gal) multiplied by the specific heat of water (1.0 Btu/(lb∗°F))
T_{OUT}	=	Water heater setpoint (= actual, otherwise assume 130°F)
T_{IN}	=	Cold water temperature entering the domestic hot water system (= from look-up value in Table M-25)
EFF_E	=	Electric water heater thermal efficiency (= actual, otherwise assume 97%)
1/3,412	=	Conversion factor (kWh/Btu)
EFF_G	=	Natural gas water heater thermal efficiency (= actual, otherwise assume 58%, which was the baseline submitted to the Ohio Public Utility Commission (case no. 09-512-GE-UNC) in the natural gas utilities' 2009 proposed predetermined values and protocols)
10^{-6}	=	Conversion factor (Btu to MMBtu)
FLO_{BASE}	=	Flow rate of baseline spray nozzle (= assume 3 gallons per minute)
FLO_{EFF}	=	Flow rate of efficient equipment (= assume 1.6 gallons per minute)
60	=	Minutes per hour
H	=	Usage hours per day (= from look-up value in Table M-26)
365	=	Days per year

Table M-25 lists groundwater temperature assumptions (T_{IN}) by location.

Table M-25. Groundwater Temperature (T_{IN}) by Location

City	Groundwater Temperature (°F)
Indianapolis	58.1
South Bend	57.4
Terre Haute	60.5
Evansville	62.8
Fort Wayne	55.6

Table M-26 lists estimates for the number of hours of use per day for pre-rinse spray valves, based on facility type.

Table M-26. Pre-Rinse Spray Valve Hours Per Use by Facility Type

Facility Type	Hours of Pre-Rinse Spray Valve Use per Day
Full Service Restaurant	4
Other	2
Limited Service (Fast Food) Restaurant	1

Retro-Commissioning Utility Bill Analysis

The evaluation team used utility bill analysis of several 2019 projects (since measure-level analysis was not available for these projects). CLEAResult also used utility bill analysis; however, their method and data periods differed from those used by the evaluation team.

The evaluation team employed a regression-based utility bill analysis, using daily actual weather data from the National Oceanic and Atmospheric Administration[76] and hourly TMY3 weather data from the National Renewable Energy Laboratory[77] specific to each project site location. This required monthly utility data from the project, pre- and post-implementation. Ideally, the baseline period consists of 12 months of utility data and the post-implementation period consists of at least three months of utility data, preferably spanning both the heating and cooling seasons.

Given the utility data inputs, the evaluation team analyzed monthly utility data and normalized that data to actual weather data at each location. We calculated the monthly kilowatt-hour consumption based on the average daily temperature in each month. The team graphed this data to determine energy use characteristics, including the heating balance point (when energy use increases in cold temperatures) and the cooling balance point (when energy use increases in warmer temperatures). In most cases, a single balance point is appropriate, and is typically 55-degrees Fahrenheit, unless the project-specific data and location indicate a better correlation to a different balance point. The analysis workbook uses the balance point(s) to generate two regression models—one based on all points greater than the

[76] National Oceanic and Atmospheric Administration. “Data Tools: Local Climatological Data.” https://www.ncdc.noaa.gov/cdo-web/datatools/lcd

[77] National Renewable Energy Laboratory. “National Solar Radiation Data Base.” 1991-2005 Update: Typical Meteorological Year 3. https://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/

balance point, representing the CDDs, and one based on all points lower than the balance point, representing the HDDs. When the balance point is difficult to identify, both regression models look similar, resulting in a minimal impact on the analysis. The team applied these regression models to the actual weather year data to calculate monthly savings during that year, and to the TMY3 weather data to calculate monthly savings during a typical weather year. The evaluation team used the TMY3 savings results for all the 2019 analysis.

Several K-12 educational facilities participated in the Retro-Commissioning portion of the Custom Incentives program in 2019. For these projects, the evaluation team deemed it most appropriate to create two separate analysis models—one for months in the typical school year (August through May) and one for months in the typical non-school year (June and July). Occupancy and usage patterns differ greatly between these two models, and including them together in one regression model would likely result in a skewed and poorly correlated regression. The results of each model provided savings only for the affected months, and the evaluation team summed the savings of both models to determine annual savings for a typical weather year.

Strategic Energy Management

To estimate facility savings for SEM, the evaluation team used a forecast regression model to estimate the adjusted baseline consumption for each facility, generating *ex post* gross savings. As a final step we subtracted savings from capital projects rebated through other IPL programs. The forecast model approach is the analysis approach recommended for estimating facility savings in IPMVP Option C and in the U.S. DOE's Uniform Methods Project Strategic Energy Management Program Evaluation Protocols (NREL, 2017), and is the same approach used by the implementation team.

Table M-27 through Table M-37 present the evaluation team's final baseline model specifications for all evaluated facilities that participated in the Strategic Energy Management portion of IPL's Custom Incentives program. For all facilities, the team used the same data frequency as CLEAResult (either weekly or monthly data). We selected individual HDDs and CDDs for each facility, as shown in the tables. For each model, the evaluation team tested holiday indicators, occupation indicators (such as school days), weather impacts, and any changes at the site (as indicated by CLEAResult or in the extracts provided to the evaluation team, discussed below), which we regressed on average daily consumption. For the two school districts, the team interacted weather and occupancy with school fixed effects to allow impacts to differ by school. We selected the final model based on the specification with the lowest Bayesian information criterion. We also reviewed the coefficients to ensure that the model estimates were logical and to confirm that the residuals were well-behaved.

To ensure that we only accounted for savings due to the Strategic Energy Management portion of the Custom Incentives program, the evaluation team reviewed the extracts of all Strategic Energy Management participation. If the extracts indicated that, during the baseline, a facility installed an incentivized capital project, the team created an indicator that began on the install date and included it for selection. If a project from the extract was not selected in the model, we subtracted the savings from the baseline consumption in order to account for the project's impact. The one exception was for IU Health Methodist; due to its size and number of meters and buildings, the team tested all projects, but did not subtract any non-selected projects since these could have only impacted other meters or buildings.

Table M-27. Regression Estimates and Parameters for Pike School District Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	950.69	432.02	2.20	0.0311
Holiday	92.97	50.43	1.84	0.0695
Deer Run Elementary	-119.25	534.81	-0.22	0.8242
Eagle Creek Elementary	245.25	619.66	0.40	0.6935
Fishback Creek Academy	77.62	488.52	0.16	0.8742
Guion Creek Elementary	491.01	478.35	1.03	0.3083
New Augusta North	3,674.83	566.09	6.49	<0.0001
Snacks Crossing Elementary	295.07	535.63	0.55	0.5835
Transportation and Facilities Center	611.88	465.69	1.31	0.1932
College Park x CDD 73°F	75.63	105.55	0.72	0.4760
Deer Run Elementary x CDD 51°F	64.63	7.44	8.68	<0.0001
Eagle Creek Elementary x CDD 43°F	22.60	10.42	2.17	0.0335
Fishback Creek Academy x CDD 48°F	30.35	6.37	4.76	<0.0001
New Augusta North x CDD 53°F	75.43	9.36	8.06	<0.0001
Snacks Crossing Elementary x CDD 68°F	224.93	29.79	7.55	<0.0001
College Park x HDD 73°F	10.80	9.15	1.18	0.2419
Eagle Creek Elementary x HDD 42°F	91.74	33.57	2.73	0.0080
Guion Creek Elementary x HDD 50°F	20.73	11.84	1.75	0.0844
Transportation and Facilities x Center x HDD 50°F	53.50	11.46	4.67	<0.0001
College Park x School Days	696.74	201.23	3.46	0.0009
Deer Run Elementary x School Days	1,261.04	240.02	5.25	<0.0001
Eagle Creek Elementary x School Days	451.95	245.40	1.84	0.0698
Fishback Creek Academy x School Days	1,244.13	344.07	3.62	0.0006
Guion Creek Elementary x School Days	744.42	226.24	3.29	0.0016
New Augusta North x School Days	2,216.38	276.28	8.02	<0.0001
Snacks Crossing Elementary x School Days	2,112.72	519.24	4.07	0.0001
Transportation and Facilities Center x School Days	3.76	391.19	0.01	0.9924

Table M-28. Regression Estimates and Parameters for Wayne School District Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	1,842.88	631.56	2.92	0.0051
Operation Center x HDD 67°F	64.54	3.18	20.30	<0.0001
Days in Month	-25.79	19.58	-1.32	0.1933
North Wayne Elementary	728.52	250.84	2.90	0.0053
Operation Center	-238.69	228.85	-1.04	0.3016
Rhoades Elementary	138.54	224.19	0.62	0.5392
Sanders School	-228.84	265.39	-0.86	0.3923
Wayne Enrichment Center	-704.99	262.05	-2.69	0.0095
Main Office Building x School Days	80.34	286.08	0.28	0.7799
North Wayne Elementary x School Days	644.33	265.95	2.42	0.0188
Operation Center x School Days	129.77	263.59	0.49	0.6245
Rhoades Elementary x School Days	436.49	235.04	1.86	0.0688
Sanders School x School Days	175.60	290.67	0.60	0.5483
Wayne Enrichment Center x School Days	60.59	280.69	0.22	0.8299
Main Office Building x CDD 71°F	61.82	21.48	2.88	0.0057
North Wayne Elementary x CDD 51°F	53.61	4.24	12.65	<0.0001
Sanders School x CDD 56°F	33.58	5.64	5.95	<0.0001
Wayne Enrichment Center x CDD 45°F	5.89	3.57	1.65	0.1044

Table M-29. Regression Estimates and Parameters University High School Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	979.07	143.13	6.84	0.0001
HDD 33°F	82.74	21.09	3.92	0.0044
School Days	301.30	173.71	1.73	0.1211
CDD 51°F	28.04	4.31	6.50	0.0002

Table M-30. Regression Estimates and Parameters for Ivy Tech Glick Technology Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	1,986.25	172.90	11.49	<0.0001
Temperature	51.25	2.42	21.19	<0.0001
HDD 38°F	67.77	11.13	6.09	<0.0001
HVAC Indicator (July 8, 2018)	-378.43	71.10	-5.32	<0.0001
School Days	419.2	121.96	3.44	0.0012

Table M-31. Regression Estimates and Parameters for Ivy Tech Illinois Fall Creek Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	8,186.08	160.99	50.85	<0.0001
HDD 43°F	67.08	11.17	6.01	<0.0001
CDD 76°F	244.09	64.83	3.77	<0.0001
HVAC Indicator (July 8, 2018)	-1,891.22	194.60	-9.72	<0.0001
Holiday	-3,115.75	1,520.99	-2.05	0.046
School Days	428.40	239.35	1.79	0.080

Table M-32. Regression Estimates and Parameters for IU Health Clinical Labs Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	19,781.33	122.76	161.13	<0.0001
HDD 37°F	131.11	14.87	8.82	<0.0001
Lab Reconfiguration (May 14, 2018)	-1,655.29	139.29	-11.88	<0.0001

Table M-33. Regression Estimates and Parameters for IU Health Fairbanks Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	4,260.33	20.03	212.67	<0.0001
Building Management System HVAC Adjustment (March 19, 2018)	-83.37	27.10	-3.08	0.0027
Building Management System HVAC Adjustment (August 20, 2018)	-171.70	31.18	-5.51	<0.0001
Major Holidays (Thanksgiving, Christmas)	-517.15	53.51	-9.66	<0.0001
Minor Holidays (Memorial Day, Independence Day, New Years' Day)	-261.53	43.48	-6.01	<0.0001
Building Management System Overrides	151.22	54.00	2.80	0.0062
HDD 56°F	15.15	1.27	11.90	<0.0001
CDD 69°F	40.58	4.29	9.47	<0.0001

Table M-34. Regression Estimates and Parameters for IU Health Gateway Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	11,153.30	99.72	111.85	<0.0001
HDD 57°F	270.71	5.02	53.98	<0.0001
Holiday	-4,558.26	867.63	-5.25	<0.0001
CDD 58°F	-53.45	7.78	-6.87	<0.0001
HVAC Improvements (June 28, 2018)	6,704.90	579.16	11.58	<0.0001

Table M-35. Regression Estimates and Parameters for IU Health North Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	33,793.46	342.96	98.53	<0.0001
Holiday	-6,089.72	3,803.51	-1.60	0.1159
CDD 37°F	372.76	59.22	6.29	<0.0001
CDD 37°F ^ 2	4.62	1.43	3.24	0.0022

Table M-36. Regression Estimates and Parameters for IU Health West Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	30,450.34	135.53	224.68	<0.0001
CDD 45°F	481.57	7.14	67.49	<0.0001

Table M-37. Regression Estimates and Parameters for IU Health Methodist Baseline Model

Term	Estimate	Standard Error	t-Statistic	p-Value
Intercept	160,889.70	2,332.53	68.98	<0.0001
HVAC Improvements (November 6, 2017)	-8,054.03	1,234.85	-6.52	<0.0001
Holiday	-15,240.25	7,444.14	-2.05	0.0434
Humidity x Temp above 55°F Dummy	-1,785.62	98.94	-18.05	<0.0001
Temperature x Temp above 55°F Dummy	139.69	73.57	1.90	0.0606
Temperature x Temp below 55°F Dummy	197.48	51.17	3.86	0.0002
Humidity x Temp x Temp above 55°F Dummy	33.34	1.59	21.02	<0.0001
March 2018 Capital Projects	-3,526.14	1,287.94	-2.74	0.0074
July 2018 Capital Projects	-2,621.87	1,033.86	-2.54	0.0128

Evaluation Summary

The evaluation team made adjustments based on results from on-site EM&V and engineering desk reviews in each program's evaluation sample. This included all measures that received a realization rate other than 100%.

Custom Incentives Program

In 2019, the Custom Incentives program comprised Custom, Retro-Commissioning, and Strategic Energy Management components. The sections below provide measure tables for the Custom and Retro-Commissioning components.

Custom

Table M-38 outlines energy-savings analysis results for measures in the Custom evaluation sample receiving realization rates other than 100%.

Table M-38. Custom Analysis Sample Adjustment Summary for Energy Savings

Measure Type	Energy Savings (kWh)		Realization Rate	Reasons for Discrepancy
	Ex Ante	*Ex Post*		
Process Equipment	154,382	34,197	22%	The evaluation team used a day-type analysis methodology, which compared the performance of the air compressor during each day of the week.
Compressed Air	43,657	56,035	128%	
Lighting	155,379	106,208	68%	The team used ASHRAE 90.1.2007 Table 9.5.1 lighting power density values.
Lighting	817,627	598,770	73%	The team adjusted the annual operating hours (AOH) and WHFe based on facility type and documentation of electric heating.
HVAC	483,577	439,099	91%	The team reduced the fan load factor from 90 to 85 and adjusted return enthalpy based on trend data.

Measure Type	Energy Savings (kWh)		Realization Rate	Reasons for Discrepancy
	Ex Ante	*Ex Post*		
Lighting	62,416	60,041	96%	The team adjusted the efficient wattage based on manufacturer specifications.
Lighting	1,218,543	990,680	81%	The team adjusted AOH and WHFe based on our on-site observations.
Whole Building	92,861	96,790	104%	The team adjusted the AOH and equivalent full-load hours for the data center using Wisconsin TRM values and used an Indiana TRM (v2.2) equations to estimate efficient EER from the SEER value.
Lighting	2,130,757	2,162,108	101%	The team adjusted AOH based on our on-site observations.
Lighting	1,739,186	1,246,240	72%	The team applied AOH for each space type rather than using one representative value and incorporated lighting metering findings.
HVAC	454,727	227,657	50%	The team adjusted the AOH for the air-handling units based on trend data analysis.
Lighting	7,265	9,187	126%	The team applied a WHFe for refrigerated case lighting instead of using the "Other" facility type.
Whole Building	1,529,121	622,973	41%	The team adjusted lighting AOH based on our on-site observations and light metering data.
Lighting	250,759	255,403	102%	The team adjusted the baseline fixtures based on information in the project files.

Table M-39 outlines demand reduction analysis results for measures in the Custom evaluation sample that received realization rates other than 100%.

Table M-39. Custom Analysis Sample Adjustment Summary for Demand Reduction

Measure Type	Demand Reduction (kW)		Realization Rate	Reasons for Discrepancy
	Ex Ante	*Ex Post*		
Process Equipment	0.0	3.9	--	The evaluation team used a day-type analysis, which showed demand reduction not claimed by CLEAResult.
Miscellaneous	31.0	5.0	16%	The team applied the demand reduction value from the same model CLEAResult used to estimate energy savings.
Lighting	30.9	21.5	70%	The team used ASHRAE 90.1.2007 Table 9.5.1 lighting power density values.
Lighting	94.1	81.2	86%	The team adjusted the WHFd based on the facility type.
Lighting	10.9	10.6	97%	The team adjusted the efficient wattage based on manufacturer specifications.
Lighting	154.8	142.4	92%	The team adjusted coincidence factors and WHFd based on our on-site observations.
Compressed Air	5.0	6.7	133%	The team used a day-type analysis methodology, which compared the performance of the air compressor during each day of the week.
Whole Building	14.9	15.8	106%	The team adjusted the equivalent full-load hours for the data center using Wisconsin TRM values and used an Indiana TRM (v2.2) equation to estimate efficient EER from the SEER value.
Lighting	362.9	364.9	101%	The team adjusted coincidence factors based on our on-site observations.

Measure Type	Demand Reduction (kW)		Realization Rate	Reasons for Discrepancy
	Ex Ante	*Ex Post*		
Lighting	189.6	224.9	119%	The team increased the coincidence factor for hallway lighting based on light metering findings.
Lighting	1.0	1.6	166%	The team used the coincidence factor and WHFd for refrigerated case lighting instead of using the "Other" facility type.
Whole Building	115.3	66.7	58%	The team adjusted lighting coincidence factors based on our on-site observations and light metering data.

Retro-Commissioning

Table M-40 outlines energy-savings analysis results for measures in the Retro-Commissioning evaluation sample receiving realization rates other than 100%.

Table M-40. Retro-Commissioning Sample Adjustment Summary for Energy Savings

Ex Ante Savings (kWh)	*Ex Post* Savings (kWh)	Realization Rate	Reasons for Discrepancy
217,214	182,401	84%	The evaluation team performed utility bill analysis using TMY3 weather data and using a longer performance period than CLEAResult used for the EM&V utility bill analysis, and used a different analysis methodology.
102,116	0	0%	
33,455	11,891	36%	
63,313	0	0%	
-61,013	24,435	-40%	
47,667	0	0%	
150,420	97,619	65%	
103,729	93,435	90%	
138,972	67,036	48%	
-51,105	35,134	-69%	
-46,607	125,238	-269%	
131,637	134,887	102%	
130,680	70,192	54%	The evaluation team performed utility bill analysis using TMY3 weather data and using a longer performance period than CLEAResult used for the EM&V utility bill analysis, as well as a different analysis methodology, and separate models for the school year versus non-school year months.
598,172	500,990	84%	
64,171	141,340	220%	
113,463	122,209	108%	
163,776	211,737	129%	
149,868	113,777	76%	
109,774	103,793	95%	
99,525	106,981	107%	
92,892	178,287	192%	
63,359	184,489	291%	
420,262	727,415	173%	
197,391	244,104	124%	
247,684	158,218	64%	
264,418	532,986	202%	
314,213	215,405	69%	
68,877	56,184	82%	
1,080,311	407,600	38%	

Ex Ante Savings (kWh)	*Ex Post* Savings (kWh)	Realization Rate	Reasons for Discrepancy
33,926	30,622	90%	
21,848	111,004	508%	
103,499	62,142	60%	
23,861	69,441	291%	
127,487	143,069	112%	
55,030	90,502	164%	
174,547	180,891	104%	
24,654	43,312	176%	
38,887	57,051	147%	
290,626	378,425	130%	
681,354	630,277	93%	
255,246	307,033	120%	
118,046	125,792	107%	
85,871	107,254	125%	
263,239	258,638	98%	
53,318	65,998	124%	
143,305	159,522	111%	
30,721	250,033	814%	
73,175	95,593	131%	
50,993	53,426	105%	
127,865	127,279	100%	
227,735	417,620	183%	
89,379	128,668	144%	
100,045	138,225	138%	
112,379	155,706	139%	
88,955	233,968	263%	
214,892	191,804	89%	
168,084	263,997	157%	
289,810	430,926	149%	

Table M-41 outlines demand reduction analysis results for measures in the Retro-Commissioning evaluation sample that received realization rates other than 100%.

Table M-41. Retro-Commissioning Analysis Sample Adjustment Summary for Demand Reduction

Ex Ante Demand Reduction (kW)	*Ex Post* Demand Reduction (kW)	Realization Rate	Reasons for Discrepancy
-12.6	0	0.0%	The evaluation team determined that the data provided did not support any claim to demand reduction
37.5	0	0.0%	
-14	0	0.0%	
-42.4	0	0.0%	
8.8	0	0.0%	
56.2	0	0.0%	
86.6	0	0.0%	
56.5	0	0.0%	
26.9	0	0.0%	
4.8	0	0.0%	

Prescriptive Rebates Program

Table M-42 outlines energy-savings analysis results for measures in the Prescriptive Rebates program evaluation sample receiving realization rates other than 100%.

Table M-42. Prescriptive Rebates Program Analysis Sample Adjustment Summary for Energy Savings

Measure Type	Energy Savings (kWh)		Realization Rate	Primary Reasons for Discrepancy
	Ex Ante	*Ex Post*		
Midstream Delivery Channel				
TLED	12,315	7,275	59%	The evaluation team updated AOH and WHFe based on our on-site observations.
TLED	222,644	282,168	127%	
TLED	36,425	27,614	76%	
TLED	19,259	8,170	42%	
TLED	17,925	8,908	50%	
LED - Other	51,303	48,166	94%	The team adjusted the baseline wattage to the EISA value.
LED - GS	65,849	37,422	57%	
LED - GS	55,792	49,395	89%	
LED - GS	11,344	10,044	89%	
LED - Exterior	96,394	94,779	98%	
TLED	425,514	521,795	123%	The team adjusted the efficient wattage based on our on-site observations.
TLED	56,603	69,411	123%	
LED - GS	176,697	158,541	90%	The team adjusted the baseline and efficient wattage.
TLED	112,157	109,843	98%	The team adjusted the WHFe to the Indiana TRM (v2.2) value.
TLED	67,355	155,724	231%	The team increased the AOH to 8,760 based on our on-site observations.
TLED	38,090	88,065	231%	
LED - GS	26,425	15,974	60%	The team adjusted AOH and WHFe based on facility type and adjusted the baseline wattage to the EISA value.
LED - GS	15,569	9,072	58%	
LED - Reflector	8,909	7,689	86%	
LED - GS	82,770	192,808	233%	
TLED	28,749	19,299	67%	The team adjusted AOH and WHFe based on facility type.
TLED	27,067	14,883	55%	
TLED	3,157	2,013	64%	
TLED	65,154	47,120	72%	

Measure Type	Energy Savings (kWh)		Realization Rate	Primary Reasons for Discrepancy
	Ex Ante	*Ex Post*		
TLED	48,717	57,640	118%	The team adjusted the efficient wattage based on manufacturer specifications.
TLED	20,028	23,537	118%	
LED - Exterior	34,051	34,707	102%	
TLED	179,768	16,372	9%	The team observed that all but 47 of the reported 824 lamps were in storage.
LED - Reflector	46,666	51,772	111%	The team verified that the lamps were installed in exterior fixtures and adjusted AOH and removed WHFe for exterior locations.
LED - GS	36,587	2,064	6%	The team adjusted AOH and WHFe based on our on-site observations and adjusted the baseline wattage to the EISA value.
LED - Exterior	26,649	19,230	72%	The team observed that five of the reported 18 lamps were in storage and adjusted AOH based on our on-site observations.
TLED	5,339	2,470	46%	The team adjusted AOH and WHFe based on posted hours and the facility type.
TLED	20,595	11,870	58%	
LED - GS	3,905	3,458	89%	The team adjusted the baseline and efficient wattages based on EISA values and manufacturer specifications.
LED - GS	243,089	53,853	22%	The team verified that some lamps were not on 24/7 and applied an electric heating WHFe based on our on-site observations.
LED - GS	128,417	28,449	22%	
Non-Midstream Delivery Channel				
TLED	10,187	14,029	138%	The evaluation team adjusted AOH and WHFe based on posted hours and the facility type.
TLED	18,456	10,468	57%	
TLED	35,089	11,754	33%	
TLED	33,744	38,891	115%	
TLED	178,178	131,011	74%	The team adjusted AOH and WHFe based on facility type.
TLED	38,375	24,496	64%	
TLED	84,199	109,711	130%	
LED - Low Bay	172,152	110,208	64%	The team adjusted AOH and WHFe based on our on- site observations.
LED - High-Bay	51,934	40,220	77%	
TLED	143,678	127,055	88%	
LED - Low Bay	343,265	479,741	140%	
TLED	239,154	266,353	111%	The team adjusted AOH, WHFe, and the efficient wattage based on our on-site observations.
Controls	122,921	257,570	210%	The team increased the AOH to 8,760 and removed WHFe based on our on-site observations.
LED - Exterior	15,838	16,082	102%	The team adjusted the efficient wattage based on manufacturer specifications.
TLED	363,417	248,687	68%	
TLED	53,837	55,712	103%	
TLED	21,463	21,033	98%	
LED - High-Bay	261,020	269,823	103%	
LED - High-Bay	192,693	100,575	52%	The team adjusted AOH and removed WHFe based on our on-site observations.
Heating and Cooling Equipment	32,652	33,657	103%	The team adjusted AOH and efficient equipment capacity based on our on-site observations and manufacturer specifications.

Measure Type	Energy Savings (kWh)		Realization Rate	Primary Reasons for Discrepancy
	Ex Ante	*Ex Post*		
TLED	97,399	127,045	130%	The team determined that the fixtures had been incorrectly identified as external and adjusted AOH and WHFe to reflect an internal location.
LED - High-Bay	443,740	410,259	92%	The team observed that 304 of 324 reported fixtures were installed and observed six fixtures in storage.
TLED	15,367	15,050	98%	The team adjusted WHFe to the Indiana TRM (v2.2) value.
LED - High-Bay	87,064	77,799	89%	The team eliminated the WHFe for these warehouse fixtures based on project notes.
LED - High-Bay	68,754	67,335	98%	The team adjusted WHFe to the Indiana TRM (v2.2) value.
LED - High-Bay	446,871	127,263	28%	The team verified that fixtures were not on 24/7, adjusted the WHFe, and reduced the fixture count from 148 to 145 based on our on-site observations.
Controls	64,419	18,346	28%	
LED - Low Bay	319,761	446,893	140%	The team adjusted AOH, based on project notes.

Table M-43 outlines demand reduction analysis results for the measures in the Prescriptive Rebates program evaluation sample that received realization rates other than 100%.

Table M-43. Prescriptive Rebates Program Analysis Sample Adjustment Summary for Demand Reduction

Measure Type	Demand Reduction (kW)		Realization Rate	Primary Reasons for Discrepancy
	Ex Ante	*Ex Post*		
Midstream Delivery Channel				
TLED	2.2	2.4	108%	The evaluation team used a lower efficient lamp wattage based on our on-site observations.
LED - Other	8.1	7.6	94%	The team adjusted the baseline wattage to the EISA value.
LED - GS	10.4	5.9	57%	
LED - GS	8.8	7.8	89%	
LED - GS	2.5	2.2	90%	
LED - Reflector	1.4	1.8	129%	
LED - GS	13.1	23.7	181%	
LED - GS	5.8	2.3	39%	
TLED	1.0	0.9	97%	
LED - GS	1.8	1.6	89%	
LED - GS	4.2	3.8	90%	
TLED	52.3	64.4	123%	The team adjusted the efficient wattage based on our on-site observations.
TLED	7.0	8.6	123%	
LED - GS	21.7	19.6	90%	
TLED	16.9	21.9	130%	The team used a coincidence factor of 1.0 based on our on-site observations.
TLED	9.5	12.4	130%	
TLED	6.0	7.1	119%	The team adjusted the efficient wattage based on manufacturer specifications.
TLED	4.4	5.3	120%	
TLED	6.0	7.1	119%	
TLED	35.0	2.0	6%	The team verified that all but 47 of 824 lamps were in storage based on our on-site observations.

Measure Type	Demand Reduction (kW)		Realization Rate	Primary Reasons for Discrepancy
	Ex Ante	*Ex Post*		
LED - Reflector	7.4	0.0	0%	The team verified that the lamps were in exterior fixtures and do not achieve peak coincident demand reduction.
TLED	2.4	2.2	94%	The team adjusted the efficient lamp wattage based on our our-site observations.
LED - GS	0.6	0.5	89%	The team adjusted the baseline and efficient wattages based on EISA values and manufacturer specifications.
TLED	3.3	2.8	83%	The team adjusted coincidence factors based on facility type.
TLED	3.2	3.0	91%	The team calculated savings for two different fixtures based on our on-site observations.
TLED	3.7	3.4	90%	The team adjusted coincidence factors based on posted hours.
LED - GS	29.8	17.2	58%	That team adjusted coincidence factors based on our on-site observations and adjusted the baseline wattage to the EISA value.
LED - GS	15.7	9.1	58%	
TLED	0.5	0.5	95%	The team observed that 38 of 40 reported lamps were installed and two were in storage.
Non-Midstream Delivery Channel				
TLED	1.6	2.3	142%	The team adjusted coincidence factors based on posted hours.
Other	4.0	3.9	98%	The team adjusted the efficient wattage based on manufacturer specifications.
TLED	2.9	2.9	98%	
TLED	44.7	30.7	69%	
TLED	9.7	10.0	103%	
TLED	5.4	5.3	98%	
LED - High-Bay	57.8	61.0	106%	
TLED	53.9	48.4	90%	The team adjusted the efficient wattage based on our on-site observations.
Controls	17.2	14.7	85%	The team adjusted the coincidence factor and removed WHFd based on our on-site observations.
LED - High-Bay	33.2	28.1	85%	
Heating and Cooling Equipment	5.6	5.9	106%	The team adjusted the efficient equipment capacity based on manufacturer specifications.
TLED	0.0	22.9	--	The team determined that the fixtures had been incorrectly identified as external and applied a coincidence factor and WHFd appropriate for the interior location.
LED - High-Bay	98.3	92.8	94%	The team observed that 304 of 324 reported fixtures were installed and observed six fixtures in storage.
TLED	15.2	13.8	90%	The team adjusted the coincidence factor based on the facility type.
LED - High-Bay	19.3	16.1	83%	The team eliminated the WHFd for these warehouse fixtures based on project notes.
TLED	5.5	3.9	71%	The team adjusted the coincidence factor based on posted hours.
LED - High-Bay	54.7	42.3	77%	The team adjusted the coincidence factor and reduced fixture quantity from 148 to 145 based on our on-site observations.
Controls	3.9	3.9	98%	The team adjusted quantity from 148 to 145 based on our on-site observations.
LED - High-Bay	8.2	10.9	133%	

Measure Type	Demand Reduction (kW)		Realization Rate	Primary Reasons for Discrepancy
	Ex Ante	*Ex Post*		
TLED	26.0	24.8	96%	The team adjusted the coincidence factor based on our on- site observations.
LED - Low Bay	62.0	73.9	119%	The team used a coincidence factor of 1.0 based on our on-site observations.
LED - Low Bay	57.8	68.8	119%	The team adjusted the coincidence factor based on project notes.

Small Business Direct Install Program

Table M-44 outlines energy-savings analysis results for measures in the SBDI program evaluation sample that received realization rates that did not equal 100%.

Table M-44. Small Business Direct Install Program Analysis Sample Adjustment Summary for Energy Savings

Measure Type	Energy Savings (kWh)		Realization Rate	Primary Reasons for Discrepancy
	Ex Ante	*Ex Post*		
Controls	12,286	10,952	89%	The team updated AOH based on our on-site observations.
TLED	4,328	6,290	145%	
LED - Reflector	18,266	13,107	72%	
LED General Service	10,514	5,509	52%	The team updated AOH and WHFe based on posted hours and the facility type.
TLED	9,865	4,701	48%	
LED General Service	9,673	5,045	52%	
TLED	3,961	1,868	47%	
LED - Reflector	1,908	3,003	157%	
TLED	9,638	6,268	65%	
LED General Service	4,416	5,190	118%	
TLED	9,281	6,057	65%	
LED General Service	9,299	7,890	85%	The team updated AOH and WHFe based on the facility type.
LED - Reflector	1,983	1,331	67%	
Controls	12,209	8,536	70%	
TLED	6,425	4,193	65%	
TLED	15,685	12,135	77%	
LED - Reflector	1,303	895	69%	
LED - Reflector	10,860	7,456	69%	
TLED	3,473	2,331	67%	
TLED	2,053	1,397	68%	
LED - Reflector	5,816	3,994	69%	
TLED	4,972	3,338	67%	
LED - Reflector	2,606	1,789	69%	
Controls	1,110	745	67%	
LED - Reflector	1,096	587	54%	
TLED	7,340	4,927	67%	
LED General Service	8,369	5,618	67%	
LED General Service	22,914	8,508	37%	
LED General Service	739	373	50%	

Measure Type	Energy Savings (kWh)		Realization Rate	Primary Reasons for Discrepancy
	Ex Ante	*Ex Post*		
TLED	5,841	3,921	67%	
TLED	947	636	67%	
LED General Service	3,719	2,497	67%	
LED General Service	11,530	7,740	67%	
TLED	10,263	6,093	59%	
TLED	4,194	2,681	64%	The team updated AOH and reduced lamp count based on our on-site observations.
TLED	9,331	5,813	62%	
TLED	11,293	3,617	32%	
Pre-Rinse Spray Valve	7,629	6,521	85%	The team updated AOH based on posted hours.
LED - Reflector	12,924	13,172	102%	The team updated WHFe based on facility type.
LED - Reflector	4,847	605	12%	The team updated AOH and reduced the lamp quantity based on our on-site observations.
LED General Service	5,257	3,044	58%	
LED - Reflector	10,916	11,125	102%	The team adjusted the efficient wattage based on values provided by CLEAResult.
Pre-Rinse Spray Valve	15,258	20,708	136%	The team used a lower gallons per minute for the efficient spray valve.
LED General Service	18,479	4,169	23%	The team verified that the lamps were not on 24/7 and applied an electric heating WHFe based on our on-site observations.
TLED	13,332	3,704	28%	
LED - Reflector	4,495	1,285	29%	
LED - Reflector	20,548	9,600	47%	The team verified that lamps were not on 24/7 based on our on-site observations.
TLED	11,423	7,455	65%	The team updated AOH and WHFe based on our on-site observations.
TLED	7,893	4,832	61%	
TLED	7,182	4,655	65%	
Pre-Rinse Spray Valve	15,258	0	0%	The team determined the water heater is not electric based on our on-site observations.
Faucet Aerators	1,135	1,160	102%	The team adjusted AOH and other values based on posted hours and the facility type.

Table M-45 outlines the demand reduction analysis results for measures in the SBDI program evaluation sample that received realization rates that did not equal 100%.

Table M-45. Small Business Direct Install Program Analysis Sample Adjustment Summary for Demand Reduction

Measure Type	Demand Reduction (kW)		Realization Rate	Primary Reasons for Discrepancy
	Ex Ante	*Ex Post*		
Controls	0.6	2.0	333%	CLEAResult's calculations incorrectly applied an energy-savings factor to the demand reduction calculation.
Controls	0.4	1.5	333%	
Controls	0.0	0.1	333%	
LED General Service	1.9	1.7	90%	The evaluation team updated the coincidence factor based on posted hours.
LED General Service	1.7	1.6	90%	
LED - Reflector	0.5	0.5	113%	
TLED	1.7	1.6	90%	
LED General Service	0.8	0.9	110%	
TLED	1.7	1.5	90%	

Measure Type	Demand Reduction (kW)		Realization Rate	Primary Reasons for Discrepancy
	Ex Ante	*Ex Post*		
TLED	1.2	1.1	90%	The team updated the coincidence factor based on the facility type.
TLED	1.9	1.5	78%	
LED General Service	2.8	2.1	76%	
LED General Service	0.1	0.1	65%	
LED General Service	0.6	0.6	96%	
LED - Reflector	0.2	0.2	102%	The team adjusted the efficient wattage based on values provided by CLEAResult.
LED - Reflector	1.7	1.8	102%	
LED - Reflector	2.0	2.1	102%	
LED - Reflector	0.9	0.9	102%	
LED - Reflector	0.4	0.4	102%	
LED - Reflector	0.2	0.2	102%	
LED - Reflector	1.3	1.4	102%	
TLED	1.1	0.9	89%	The team reduced lamp count based on our on-site observations.
TLED	1.7	1.5	87%	
TLED	1.4	0.8	58%	
LED - Reflector	3.3	3.5	105%	The team adjusted the efficient wattage based on our on-site observations.
LED General Service	1.0	0.9	99%	
LED - Reflector	0.8	0.4	53%	The team reduced the lamp quantity based on our on-site observations.
LED General Service	2.3	1.7	76%	The team updated the coincidence factor based on our on-site observations.
LED - Reflector	2.5	0.6	23%	
TLED	2.1	1.9	90%	
TLED	1.6	1.3	78%	
LED - Reflector	0.6	0.4	80%	
TLED	1.2	1.3	107%	The team adjusted the coincidence factor and WHFd based on our on-site observations.
TLED	1.1	1.3	117%	
TLED	1.9	1.4	77%	The team updated the coincidence factor based on the facility type.
Faucet Aerators	0.1	0.2	112%	The team adjusted equation inputs based on facility type.