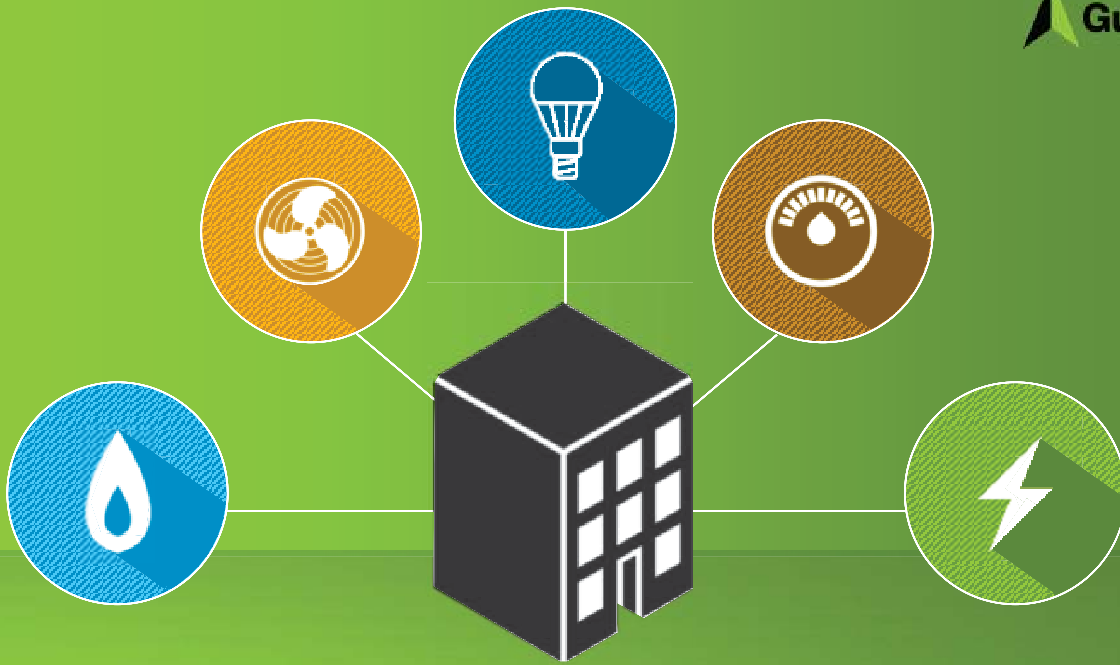
APPENDIX J

Guidehouse



Efficient Products for Business

2019 Impact Evaluation Report

AEP OHIO

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Content of Report

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April 22, 2020

Table of Contents

01

Introduction

Program Summary

The Efficient Products for Business program (EP4B)[1] offers incentives on pre-qualified equipment to non-residential customers installing eligible high-efficiency electric equipment. The EP4B program is marketed, administered, and delivered as a single program by AEP Ohio. 2019 is the eleventh year of operation for this program.

The program is delivered by AEP Ohio, with the support of a program implementer. The customer outreach and application support is provided by AEP directly. This in-house recruitment and support is provided by AEP's team of Energy Advisors, who have strong knowledge of the program offerings, measures, process, and meet directly with customers. Application support entails identification of potential measures and the compilation and review of supporting documentation. Once a completed application is ready for submittal, AEP's Energy Advisors pass the application and supporting documentation to the implementation contractor for final processing, savings analysis, data tracking, and payment of incentives on behalf of AEP Ohio.

AEP Ohio's Bid4efficiency Program (B4E) is an alternate path for participation in the EP4B and Process Efficiency Programs. The B4E measures are identical to those offered via the standard EP4B approach; the primary difference between the alternate track is the magnitude of the projects. B4E is a reverse auction for projects with energy efficiency improvement incentives above $25,000. Projects accepted into the B4E program are otherwise processed and tracked in parallel with their standard track counterparts.

During 2019, the EP4B program delivery channels were expanded through the addition of a midstream delivery model operating in parallel with the standard and B4E tracks. Midstream intervention delivers incentives directly to distributors, which lowers the upfront cost of energy efficiency measures. This model simplifies and streamlines participation and helps reach customers that might not otherwise participate through the standard tracks.

1. https://www.aepohio.com/save/business/programs/prescriptiveprogram.aspx

Evaluation Objectives

The 2019 evaluation objectives include:

01 Quantify energy and peak demand savings impacts at the meter from the program during 2019.

02 Sample enough projects to achieve a 90 percent evaluation confidence and a +/-10 percent relative precision for both the program energy and peak demand savings.

03 Determine program cost-effectiveness.

04 Determine key strengths and weaknesses in how the program calculates impacts and identify ways the program can be improved.

02 Methodology

Evaluation Methodology

Guidehouse evaluates the EP4B program at the project level. Through a review of the tracking data, the evaluation team stratifies projects based on the magnitude of energy savings. A statistically representative, random sample of projects is selected from each stratum.

The evaluation team's engineers conduct desk reviews of all projects sampled, checking to ensure a complete set of supporting documents is available and assuring consistency between: the final ex ante analysis, product specification sheets, invoices, and key project details captured in the program database. The desk review also confirms the participant's assigned business segment and any additional, relevant details available from the supporting documents and internet.

If uncertainties in the savings calculations are identified, the project is flagged for additional data collection and deeper review to ensure accuracy in the evaluation.

Additional data collection may include a combination of telephone interviews, billing data analysis, and site visits. During site visits, the evaluation team interviews the participant, then visually confirms: equipment specifications, measure quantities, operation schedules, control methods, and any other data necessary to verify savings. Onsite data collection may also include electrical spot measurements, export of energy management system trends, and/or installation temporary data logging equipment.

The most common update for lighting projects are due to corrections in hours of use. If the verified hours of use are based on logged data; then a site specific peak coincidence factor (CF) is also used to true up demand impacts. If hours of use are based on participant interview or other secondary source (not logged); then the prescriptive CF values are used based on the verified business type. This approach is applied consistently across projects; even when lights are found to be in constant use. This consistency is applied to preserve the applicability of an average CF and avoid skewing results due to a unidirectional correction. (i.e., only revising some CFs upward without the ability to make similar corrections in the opposite direction.)

Evaluation Methodology

(continued)

Verified project realization rates (RR) from the sampled projects are extrapolated to the entire population of projects to determine ex post savings. The equations used and additional context for this process are provided below.

Realization rates for each stratum are calculated using the following equation:

$$RR_i = \frac{\sum_{sampled} E_{ex\ post}}{\sum_{sampled} E_{ex\ ante}}$$

Where *E* = the electric energy savings or summer peak demand reduction for each project in the stratum and i refers to the stratum.

The stratum realization rate is then applied back to the project population of that stratum with the following equation:

$$E_{i,ex\ post} = RR_i * E_{i,ex\ ante}$$

Finally, the program population savings are the sum of all stratum savings:

$$E_{population,ex\ post} = \sum_i E_{i,ex\ post}$$

Data Collection Activities

DATA COLLECTION TYPE	
Project File Review	**Onsite/Telephone Verification**
Targeted Population	Targeted Population
Sample of completed projects	**Projects with uncertainties or inconsistencies in ex ante savings calculations, ambiguities or conflicts in equipment details or HOU, and a sample of projects with particularly large impacts on savings**
1	2

Sample Design

Guidehouse stratified at the project level and designed the sample to target 90 percent confidence and 10 percent relative precision for both energy and demand savings, resulting in the following sample.

Strata	Project Savings Criteria	Population (Project Count)	Strata Weight by Energy (kWh)	Number of Desk Reviews	Number of Onsite and Telephone Interviews[2]
Large	> 300 MWh or > 70 kW demand	61	28,038,756	33	26
Medium	100 < 300 MWh	238	40,501,598	27	19
Small	10 < 100 MWh	1,000	37,418,596	28	11
Midstream Medium	> 25 MWh	80	4,443,372	80[1]	0
Midstream Small	1 < 25 MWh	816	4,400,689	816[1]	0
Excluded	bottom 2% of cumulative total	896	2,341,072	0	0
Total		**3,091**	**117,144,083**	**984**	**56**

1. Midstream projects have very little data available. Therefore, the desk review for this part of the program was an engineering review of the information available in the program database; and a confirmation of consistency within the analysis inputs and process.
2. Onsite and Telephone reviews are conducted on a subset of desk reviews.

Sample includes 31 percent of the EP4B projects and 19 percent of the ex ante kWh.

Excluding the midstream projects, the sample includes five percent of the remaining projects and 12 percent of the remaining savings.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

03

Evaluation Findings

Savings Results – Program Level

The 2019 EP4B program evaluation verified that actual program energy impacts (kWh) are ten percent above the ex ante estimate. Peak demand (kW) savings are lower than reported with an 0.88 RR. The program exceeded its energy savings goal by 30 percent, but missed the peak demand savings goal by 20 percent.

Additional context regarding this evaluation:

- Statistical precision is well within the evaluation objective of 90 percent confidence that the results represent the actual program performance to within +/- 10 percent.
- Precision bounds are tighter than previous evaluations because the sample size was increased by 60 percent compared to 2018.
- Five percent of the total demand reduction is attributed to a single site that is adjusted due to a correction to a typo in data entry.

	Program Goals[1] (a)	Ex Ante Savings[2] (b)	Ex Post Savings[3] (c)	Realization Rate (c / b)	Percent to Goal (c / a)	Relative Precision (at 90% Confidence)
Energy Savings (MWh)	99,053	117,144	128,537	1.10	130%	8.0%
Demand Savings (kW)	25,551	23,222	20,341	0.88	80%	7.8%

Sources:

1. AEP Ohio Volume 1: 2017 TO 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016
2. AEP Ohio tracking data
3. Ex post savings and remaining three columns sourced from Guidehouse evaluation analysis

Savings Results – Program Level

The two primary drivers of program level RR are lighting projects with adjusted HOU and/or corrected wattage inputs.

- The verified lighting HOU are, on average, 1.22 times the reported values. Note this is the simple average across the sample providing perspective on how the implementation contractor's (IC) Appendix A: AEP Ohio Prescriptive Measures Protocols (Appendix A) perform independent of project size.
- Large sites, particularly large retail, are a key driver of the HOU adjustments because these often operate 24/7, while the Appendix A is a 50/50 average of DEER 2011 estimates for Department Store (3,380) and Big Box Retail (4,270). This blended HOU estimate does not account for market share, nor does this reflect subsequent revisions to DEER's suggested HOU for Large Retail sites.
- Adjustments to wattage (both baseline and efficient wattages) are generally minor in terms of impact on savings, but occur for multiple reasons and across a significant portion of the sample. The two most common adjustments to wattage are correcting omitted or incorrectly entered fixture wattage, and adjustments to fixture quantity.

The ex ante analysis files are largely based on templates that draw savings inputs from the 2018 version of Appendix A. However, Appendix A was updated in late 2019. The impact on savings estimates for the most common measures is marginal, with the primary update for 2019 focused on incremental measure costs.

Savings Results – Program Level

Guidehouse's evaluation identified unique strengths and relative performance for each of EP4B tracks:

- **Standard Track:** most commonly used and with reported energy savings generally on target. The largest adjustment to ex post demand savings is from a single project that was reported with over one MW of demand reduction due to incorrect units assignment in Appendix A (0.15 kW savings per Watt reduced); with multiple smaller adjustments necessary due to incomplete ex ante analysis workbooks.
- **B4E Track:** typically used for the largest projects. The large stratum is where savings are often revised upward due to extended hours of use at large sites relative to the average for their building segment.
- **Midstream:** The primary adjustment is due to finding measures reported with no demand savings for the given measure row. These measures do have associated per unit demand savings; but the reported total impact for the given row is zero (treated as though the quantity is zero).

Program Delivery Path	Savings Metric	Ex Ante Savings (b)	Ex Post Savings (c)	Realization Rate (c / b)
Standard	Energy Savings (MWh)	85,430	88,072	1.03
	Demand Savings (kW)	16,116	14,094	0.87
B4E	Energy Savings (MWh)	22,691	31,572	1.39
	Demand Savings (kW)	4,312	3,781	0.88
Midstream	Energy Savings (MWh)	9,024	8,893	0.99
	Demand Savings (kW)	2,794	2,466	0.88
Total	Energy Savings (MWh)	117,144	128,537	1.10
	Demand Savings (kW)	23,222	20,341	0.88

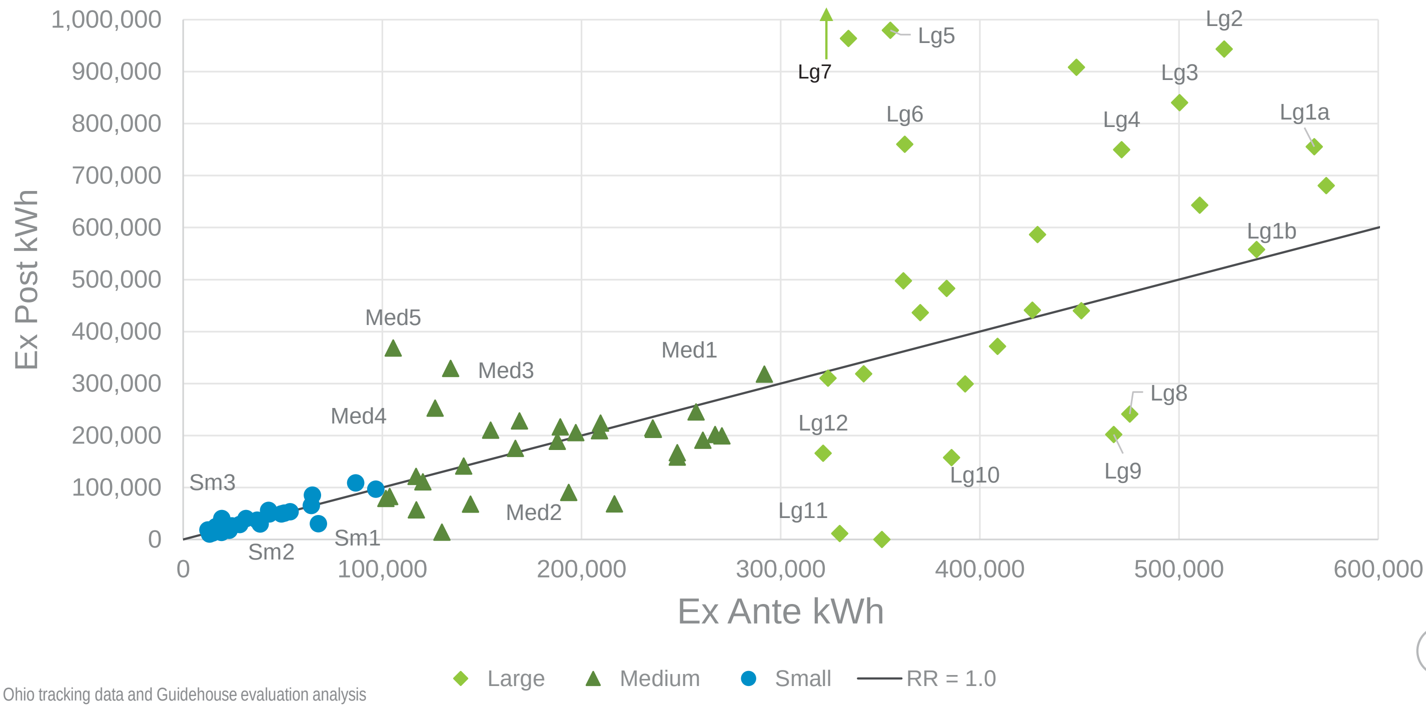
Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Energy Savings Results – Site Summary

The figure below is a graphical representation of the site level ex ante versus ex post energy savings. The diagonal line represents where reported and verified savings are equal (RR = 1.0). Points above and to the left of the line represent sites with verified savings in excess of the reported value, while those points below and to the right are sites with RR less than one.

Sites with significantly higher or lower RR are discussed in the site-level detail slides that follow. Note, not all of the projects are covered in the detailed discussion slides; instead, the evaluation team selected a cross-section of projects that represent the most common or notable adjustments.

ENERGY SAVINGS RESULTS



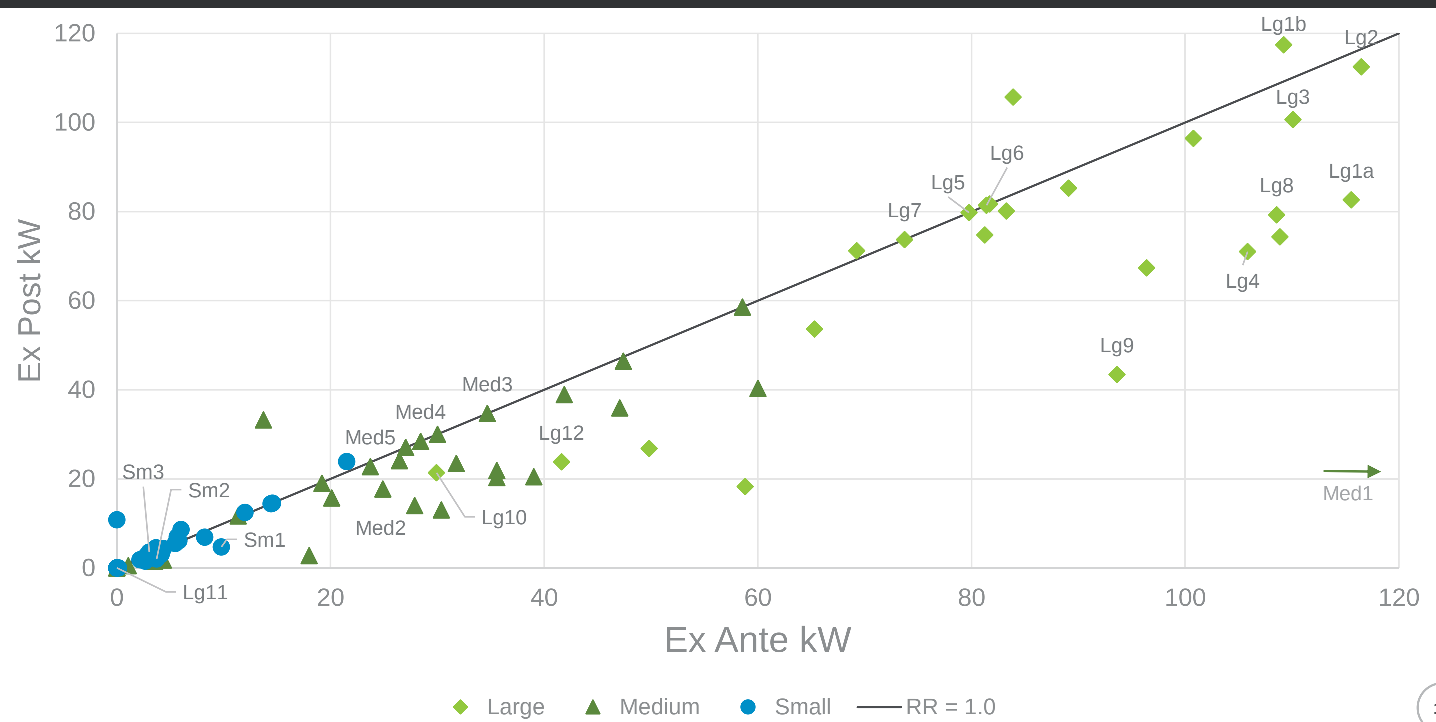
Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Peak Demand Savings Results – Site Summary

This figure represents coincident peak demand savings, where the diagonal line represents a perfect match between reported and verified savings (RR = 1.0).

Sites with significantly higher or lower RR are discussed in the following slides. Sites with demand RR close to one are flagged here only for consistency with the preceding energy savings RR plot.

PEAK DEMAND SAVINGS RESULTS



Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

Site Lg1a & Lg1b – This pair of projects occurred at a single, large retail site and were submitted through the B4E program track.

This pair of projects cover two phases of a whole building lighting retrofit implemented in two distinct parts of the site. Verified savings for Project Lg1b are very close to reported.

For project Lg1a, the verified HOU for approximately half of the measures was 160 percent of the Appendix A estimate for this building type. However, the final RR is tempered by the balance of measures experiencing the expected HOU. The combined impact results in kWh savings 33 percent above the ex ante value.

Fixture wattage for Lg1a is corrected with verified fixture wattage from on-site observation; resulting in a 15 percent reduction in demand savings. Demand savings are reduced by another 15 percent due to updates in the verified coincidence factor (CF).

RR for Site Lg1a:	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	567,823	755,402	1.33
Demand Savings (kW)	115.56	82.59	0.71

RR for Site Lg1b:	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	538,860	557,730	1.04
Demand Savings (kW)	109.23	117.42	1.08

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

Site Lg2 – Industrial / Manufacturing facility.

A telephone interview with this participant confirmed that there are three different HOU that are applicable to the different zones within this site.

This correction to HOU includes adjustments to exterior fixtures that were assigned interior HOU. The energy impact from HOU adjustments alone is 250 percent. However, in correcting savings components for the exterior fixtures, the HVAC interactive factors for those fixtures dropped from 1.39 to 1.00; bringing the overall energy RR to 181 percent.

Review of the demand savings for exterior fixtures corrected peak CF to zero; while CF for other parts of the plant were increased per customer self reported occupancy profiles. Overall impact on demand savings from the combined updates is marginal.

The remaining three percent reduction in demand savings occurred because the ex ante savings analysis for this site is missing wattage information for multiple new fixtures. The evaluation team corrected the omission using data available in the product specification sheets included with the project's supporting documentation.

RR for Site Lg2:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	522,644	943,680	1.81
Demand Savings (kW)	116.50	112.49	0.97

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

Site Lg3 & Lg4 – Lighting system upgrades for two similar medical facilities.

These two projects are at separate sites, but have similar participants and adjustments. Therefore, the following comments are combined for simplicity.

Prescriptive HOU for the hospital building type is 5,260. However, Guidehouse noted that the majority of rebated lights for these two projects are in common areas operating 8,760 hours per year. A smaller portion of program fixtures are in patient rooms and controlled by occupancy sensors (consistent with ex ante analysis). The variance between reported and verified HOU varies slightly by site, but the weighted average adjustment for both is approximately 165 percent.

Demand savings for both projects is lower than expected because the ex ante calculations lack a lamp wattage for the screw-in LED portion of the projects. The evaluation team sourced the necessary wattage data from product specification sheets, leading to a seven percent decrease in demand savings.

RR for Site Lg3:	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	500,183	840,381	1.68
Demand Savings (kW)	110.11	100.66	0.91

RR for Site Lg4:	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	471,084	749,856	1.59
Demand Savings (kW)	105.86	71.05	0.67

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

Site Lg5 – Lighting retrofit at an unconditioned warehouse.

The large kWh RR is due to a correction to the lighting system's HOU.

Appendix A suggested HOU for an unconditioned warehouse is 3,420, while the ex ante analysis workbook appears to use 3,110 hours per year.

However, during a telephone interview with the participant, Guidehouse confirmed that the actual occupancy for this site is 8,600 hours per year.

The difference between the ex ante and ex post HOU is 276 percent.

RR for Site Lg5:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	354,985	979,828	2.76
Demand Savings (kW)	79.77	79.77	1.00

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

RR for Site Lg6:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	362,268	760,568	2.10
Demand Savings (kW)	81.41	81.41	1.00

RR for Site Lg7:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	328,551	2,791,108	8.50
Demand Savings (kW)	73.75	73.69	1.00

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Sites Lg6 & Lg7 – Large retail and large hotel lighting retrofits.

These two projects occurred at very different building types, but have similar findings and directionality within the RRs.

For Lg6, the ex ante calculation used the reported building type HOU of 3,825 from Appendix A. However, during the telephone interview it was found that this site operates 24/7 with limited holidays, which is a 228 percent increase from the reported HOU. Savings estimates for the lighting controls and kWh Interactive Factors were also updated due to the telephone interview.

Evaluation of Lg7 is also supported by a telephone interview and areas impacted by this project are also identified as operating 24/7. However, the building type for this project was mischaracterized as Unknown. The Appendix A prescribed HOU for hotel/motel is 6,842, which is only 28 percent lower than verified. However, the ex ante analysis use the Unknown building type, applying 1,205 HOU; 690 percent lower than verified.

However, for both of these projects, drivers of the atypically large kWh RR cannot be determined beyond the HOU corrections mentioned above. This lack of further insight is due to ex ante savings method that is based on with a single, per-unit savings multiplier.

Demand RR for both projects is very close to 1.0.

Savings Results – Site Level

RR for Site Lg8:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	475,221	241,166	0.51
Demand Savings (kW)	108.58	79.27	0.73

RR for Site Lg11:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	329,551	11,364	0.03
Demand Savings (kW)	0.00	0.00	1.0

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Sites Lg8 and Lg11 – Sports complex lighting system upgrades.

Project Lg8 took place at a large sport complex where upgrades encompass stadium lighting, offices, training space, common areas, and locker rooms. Project Lg11 is more limited in scope, only impacting a school sports field.

Both projects have significant downward revision to reported kWh savings; however, only Lg 11 can be directly linked to HOU adjustments. Lg11 ex ante HOU is 4,160 based on the school building type. The Outdoors Sport Complex building type (640 HOU) is a better preliminary match; however, the participant interview and subsequent on-site follow-up confirmed that the actual light use profile for Lg11 is just 140 hours per year.

Lg8 has a similar downward calibration of the stadium lights, however this is largely offset by an increase in HOU for other measures. The stadium provides two-thirds of the wattage reduction for the site, and the HOU for these fixtures is reduced by roughly 90 percent (from 2,385 to 208.) However, the remaining one-third of fixtures operate 5,640 hours per year, a 236 percent increase over Appendix A. The weighted HOU adjustment is therefore only a 7 percent decrease.

Ten percent of the adjustment for Lg8 is due to an update in fixture quantities where the project documentation is very through and complete; on-site counts support this revision. Lg8's demand savings are reduced by another 18 percent due to the verification process finding that efficient wattage information for nine measures is not entered in to the ex ante savings analysis. The remaining 20 percent decrease in kWh RR for Lg8 cannot be explained given the limited ex ante context; CF does not apply to kWh and the HVAC IF are theoretically the same.

Demand RR for site Lg11 is 1.0 because both ex ante and ex post have zero demand savings.

Savings Results – Site Level

Site Lg9 – Large office lighting retrofit project.

With this large office site, several adjustments are interacting with each other, compounding to drive the low RR.

The largest adjustment is to the peak CF, which was reported as 0.71, but confirmed to be 0.42. This correction causes a 41 percent decrease in the demand RR.

Verified HOU are 14 percent lower than average for this segment.

Guidehouse also found that the ex ante analysis has the wrong wattage per lamp for some of the LEDs. Changing this Wattage input from 39 to 37.5 watts for some of the efficient lamps leads to an additional 4 percent savings for both kWh and demand.

The remainder of the adjustments to savings cannot be traced to specific causes due to the limited transparency in the ex ante analysis workbook.

RR for Site Lg9:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	467,168	202,106	0.43
Demand Savings (kW)	93.63	43.43	0.46

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

Site Lg10 – Restaurant lighting retrofit.

This project is located at a site that contains a variety of end-uses; therefore, the project was submitted under the Miscellaneous building type. However, the measures upgrades occurred only within areas used for food service; and therefore the verification team treats the area of interest as a Restaurant.

Logged lighting use is used to update the HOU and CF for this site; while the updated building type informs the HVAC interactive impacts (WHFe & WHFd).

- Logged HOU for the fixtures are 21 percent lower than the prescriptive HOU for a Miscellaneous building. (verified 2,675 vs. reported of 3,819)
- Appendix A specifies a WHFe of 1.5 for a Miscellaneous building, while ex post calculations use the restaurant WHFe of 1.14; a 24 percent decrease.
- Appendix A's WHFe for Misc. buildings is the highest of any building and appears to be an error where 1.5 is entered for both energy and demand.
- Appendix A specifies a WHFd of 1.5 for a Miscellaneous building, while ex post calculations use the restaurant WHFe of 1.31; a 13 percent decrease.
- The reported Coincidence Factor is 0.65 while the logged use profile confirms the CF is 0.67; a difference of 3.5 percent.

The evaluation team also noted that some of the fixtures were missing wattage data in the ex ante calculations. These omissions were corrected in the equipment specification sheets. The wattage update leads to an eight percent decrease in savings.

RR for Site Lg10:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	385,727	157,619	0.41
Demand Savings (kW)	29.91	21.38	0.71

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

Site Lg12 – Industrial manufacturing site lighting retrofit.

The difference seen between the ex ante and the ex post savings is primarily attributed to the evaluation team's use of actual metered HOU. Other minor updates included corrections to the quantities (from on-site counts), updated wattages (per product specification sheets), and corrections to the interactive effects based on confirmed space type.

The reported HOU is 6,724, consistent with Appendix A's estimate for three shift Industrial Manufacturing sites. A weighted average of the logged schedule found site occupancy is 4,933 hours per year; a 27 percent decrease. The logged data also leads to a lower peak CF, from 0.89 down to a weighted average of 0.63, a difference of 29 percent.

System wattage received minor adjustments for two reasons. The first adjustment impacted 24 fixtures verified as 576 Watts each; but reported as 744 Watts each. The second wattage adjustment occurred because one of the measures is missing a wattage input in the ex ante calculations. The missing value applies only to a single lamp and is only notable in that it is consistent with a similar error found with the same measure in other projects. Verified wattages are sourced from the specification sheets. Correcting this omission leads to a minor (two percent) impact on total savings.

Updates to HOU and CF account for the final Demand RR. However the remaining differences between reported and verified kWh savings is unclear because the analysis workbook has hardcoded values for both the measure base savings as well as the "savings multiplier", and these fundamental inputs are compiled outside of Appendix A.

RR for Site Lg12:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	321,340	165,926	0.52
Demand Savings (kW)	41.63	23.80	0.57

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

Site Med1 – Parking garage lighting system retrofit.

The RR for this site is very near the 1.0 benchmark. Therefore, this project would be unremarkable except for the adjustment to the demand savings. Site Med1 has the most significant ex ante demand savings in the program which appears to be a data entry error. The confirmed demand impact is roughly two orders of magnitude lower.

RR for Site Med1 :

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	257,438	245,282	0.95
Demand Savings (kW)	1,132.65	17.84	0.02

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Energy Considerations – Site Level

Site Med2 and Sm1 – Multi-family residential building lighting retrofit.

The reported savings for this pair of projects cite Multi-Family HOU; however, the ex ante lighting analysis tool does not differentiate between common areas vs dwellings, nor does the ex ante analysis account for distinctions between interior and exterior lighting HOU. Both sites received a site visit that confirmed interior fixtures are placed in dwelling space. Verified HOU for the interior lighting 1,095 and the exterior HOU is 4,161. The project realization rates suggest that the multi-family residential HOU documented in Appendix A (845 for dwelling space and 5950 for common areas) may be averaged to create a single, hybrid building type for use in the ex ante analysis.

Additional site specific augments include:

- Med2: The verified savings also use the equipment specification sheets to fill a missing wattage value that is missing in the ex ante savings.
- Sm1: Measure counts from the site visit decreased the measure quantity from 1,692 to 1,644, a three percent difference.

RR for Site Med2:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	193,512	90,724	0.47
Demand Savings (kW)	27.89	13.99	0.50

RR for Site Sm1:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	67,834	30,417	0.45
Demand Savings (kW)	9.77	4.72	0.48

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

RR for Site Med3:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	154,356	210,255	1.36
Demand Savings (kW)	34.69	34.69	1.00

RR for Site Med4:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	126,524	252,570	2.00
Demand Savings (kW)	28.43	28.43	1.00

RR for Site Med5:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	105,467	368,598	3.49
Demand Savings (kW)	23.73	22.71	0.96

Sites Med3, Med 4, & Med5 – Lighting system upgrades for two large retail sites and an educational site

These projects all have significant HOU updates but demand RR near 1.0.

Med3: The store hours are verified as 5,671 and are approximately 50 percent higher than Appendix A for the Large Retail building type (3,825).

Med4: The verified kWh savings for this project are double the reported savings. Appendix A indicates 4,910 HOU for grocery segment. However, the customer reported store hours are at least 40 percent higher, and data from the advanced lighting controls place actual baseline use closer to 60 percent higher than the segment average. The addition of occupancy sensors and networked lighting controls generate further savings by decreasing the new HOU relative to the baseline

Med5: Reported HOU is 2,385 (per college/university building segment) but this is corrected to 8,760 based on site visit; boosting kWh savings by 367 percent.

The demand RR is then reduced slightly due to a "Screw in LED" measure that is missing lamp wattage in the ex ante calculations. This correction decreases both demand and energy savings by eight percent.

The significant change in HOU is further amplified by updates to the coincidence factor and an HVAC interactive impacts.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

Site Sm2 – Restaurant lighting retrofit.

The verified savings for screw-in lamps uses the site specific HOU, rated wattages for the LEDs, and the prescriptive baseline wattage.

Appendix A suggests annual restaurant HOU of 4,100 while the verified operation is 6,200 hours, a 50 percent increase.

The ex ante calculations use per unit savings of 197.54 kWh and 0.03671 kW. These values are not defined in Appendix A; therefore more detailed comments regarding the drivers of this project's RR are not possible.

RR for Site Sm2:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	19,287	13,650	0.71
Demand Savings (kW)	3.71	2.01	0.54

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Site Level

Site Sm3 – Office building lighting measures.

The building is in the government/municipal segment, with expected 2,640 HOU; and verified HOU is 3,022. The higher than expected HOU pushes the project-level kWh savings up 15 percent.

However, the increased occupancy profile reduces opportunities for occupancy sensors to turn off lights. Therefore, kWh savings from the occupancy sensor measure are approximately 40 percent lower; offsetting more savings than are gained by the updated HOU.

The demand RR of 1.18 is also the result of compounding updates for both fixtures and controls. However the CF is the key difference with demand savings versus the kWh impacts. Revising the CF for both measures upward (due to the increased occupancy profile) leads to an overall positive shift in the demand RR.

RR for Site Sm3 :

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	14,801	12,541	0.85
Demand Savings (kW)	3.04	3.58	1.18

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Energy Considerations – Midstream Delivery Track

RR for Midstream:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (MWh)	9,024	8,893	0.99
Demand Savings (MW)	2,794	2,466	0.88

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Midstream measures are not included on the scatter plots shown at the beginning of this section. However, this group of measures was reviewed *en masse* with the following comments applicable to the midstream track in general.

The application process for Midstream projects is fundamentally different than the standard or B4E delivery tracks. This difference in delivery methodology significantly reduces transparency. Only minimal measure details are included in the program database and no project specific documentation is available for review.

The majority of the inputs necessary to reproduce the reported savings are available through a combination of the project and measure level databases. However, the database only includes the wattage difference between baseline and installed equipment (delta Watts). Therefore the evaluation team is unable to confirm the wattage of the equipment installed. Similarly, the measure data is also insufficient to allow assignment of baseline wattage assumptions per Appendix A.

Due to the limited amount of supporting context for the midstream measures, the evaluation team confirmed savings by using the ex ante wattage reduction, then applied other factors (HOU, IF, CF) from Appendix A based on building type.

The primary adjustment for midstream measures is due to inconsistencies within the reported savings. Specifically, the program database has several rows with partial measure data (lamp type, quantity, incentive, etc.) and these measures are assigned kWh savings; in some instances an otherwise complete row lacks demand savings even when a demand savings is shown at the "per unit" level. This is unusual because these measures are located in building types that have non-zero CF and similar measures do include this detail.

Further comment on the reason for other discrepancies is not possible given the limited level of context available from the program database. However, the overall realization rates for this portion of the program are comparable to the EP4B program as a whole; so assignment of measure savings appear consistent across delivery tracks.

Savings Results – Common Themes

Guidehouse identified the following common themes as regular drivers of RR adjustments:

1. **Major HOU adjustments:** A disproportionate number of sites in the Large stratum were adjusted by more than 50 percent. The most common reason for these changes are updates to HOU that can drive RR either up or down. The most common HOU update applies to facilities that operate 24/7, and sites where the measures were installed only in a specific portion of the site that has an occupancy profile distinct from the building average.

   - Examples of this type of adjustment are large “big box” retail that is open 24/7; factories that operates 24/7 but that have offices that are occupied on a standard workday schedule; and sports/training venues that may be heavily occupied for extended hours each day, significantly above the average use profile for the assembly building type.

   - Guidehouse corrected HOU for exterior fixtures in multiple projects where these measures are included as part of a larger project and therefore have ex ante savings based on interior HOU. This error is due to a limitation of the ex ante analysis tool as it is currently designed; which applies HOU based on Building Segment, allowing only one HOU per project. (Exterior is a separate segment in Appendix A.)

2. **Minor HOU adjustments:** The most common reason for savings adjustments on lighting projects is the evaluation team’s use of site specific HOU and CF. These are determined though the use of temporary data loggers, customer self-reported hours of operation, or posted schedules. The impact from occupancy sensors is also regularly revised to reflect site specific context. These types of adjustment are normal and to be expected.

3. **Wattage adjustments:** Updates to the baseline and efficient wattage cause small, yet frequent changes to project savings estimates. The two most common drivers for this adjustment are changes due to verified fixture counts and LED wattage updates where the lighting analysis workbooks have incomplete data entry. The fixture count adjustments typically lower total installed quantity and are attributed to participants ordering a small surplus of lamps for storage. Ex ante savings submitted with missing LED wattage information inflates savings because the analysis workbook treats the empty cell as zero Watts.

(continued on next slide)

Savings Results – Common Themes (Continued)

4. **Business type assignments:** Three sites in the sample are identified as having an incorrect business segment. This correction impacts HOU, CF, and HVAC interactive impacts. These updates include shifting from multifamily to a conditioned warehouse, from a large retail to a small retail, and from a large office to large retail.

5. **Midstream:** Eighteen percent of the Midstream projects are reported as having no demand savings while the same measure row does have savings entered for demand savings per unit. Many of these rows also suggest coincident peak demand savings. Similarly, 11 percent of the midstream measure rows record zero kWh savings; many of these rows do contain lifetime savings estimates. Verified savings correct these omissions.

6. **IC lighting analysis workbook:** The implementer's lighting analysis workbook only has one place to enter lamps per fixture, which is linked to the efficient equipment. This makes it necessary for users to modify their data entry approach in instances where multi-lamp fixtures are retrofit with integrated LED fixtures that have a fixed fixture wattage. This limitation leads to variations in how individual users deploy the analysis tool. Multiple versions of the lighting analysis workbooks are used in the 2019 supporting documents.

7. **Variable speed drives:** Ex ante calculations for variable speed drives (VSD) continue to have an error identified in previous evaluations. The average savings from those projects has a 20 percent derating factor applied to the supporting analysis. In the 2019 version of Appendix A the wattage savings estimates for this measure are reduced even further. Aside from being overly conservative, the current prescriptive approach to VSD analysis fundamentally limits the IC's ability to make site specific adjustments to input values, such as HOU or load factors, that are inherently unique to each VSD installation.

Effective Useful Life Review

Effective Useful Lifetimes (EUL) are estimated on an individual measure basis using the implementer’s Appendix A in combination with the California DEER database. The ex post EUL is determined by calculating the ex post lifetime savings and dividing by the ex post annual savings.

Overall, ex post EUL mirrors ex ante EUL values.

EUL REVIEW

Ex Ante EUL (a)	Ex Post EUL (b)
14	14

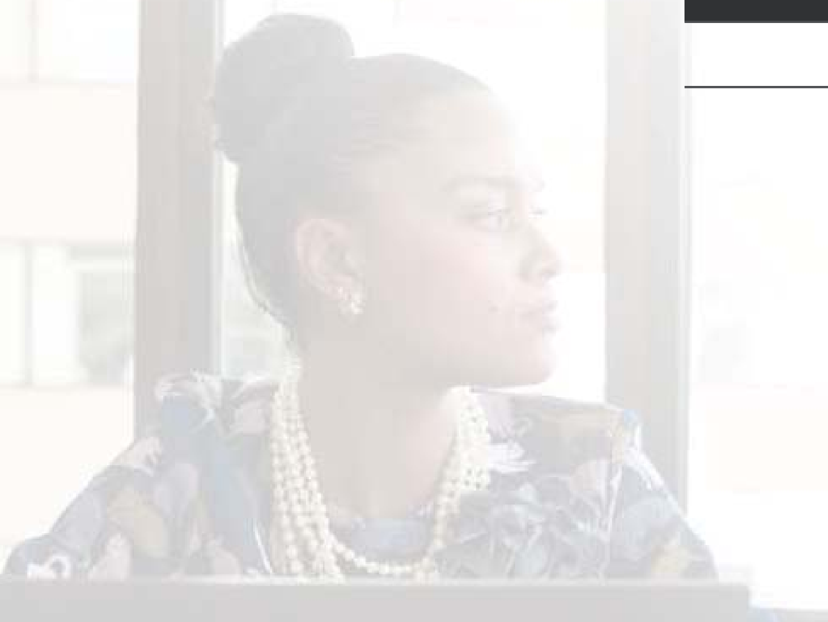
Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Incremental Measure Cost Review

Guidehouse evaluated Incremental Measure Costs (IMC) for all program measures based on verified quantity and watts reduced, multiplied by IMC values sourced from the 2019 Appendix A.

Adjustments to verified IMC reflect a slight reduction in verified quantity and watts reduced for lighting measures.

IMC REVIEW	
Ex Ante IMC (a)	**Ex Post IMC (b)**
$32,826,743	$32,301,365



Source: AEP Ohio tracking data, IC's Appendix A, and Guidehouse evaluation analysis

Cost-Effectiveness Review

The following tables address the cost-effectiveness of the 2019 EP4B program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Average Measure Life	14
Premises	2,319
Unique Projects	3,091
Ex Post Annual Energy Savings (kWh)	128,536,652
Ex Post Coincident Peak Savings (kW)	20,341
Third Party Implementation Costs	$3,409,496
Utility Administration Costs	$2,224,029
Utility Incentive Costs	$7,893,527
Incremental Measure Costs	$32,301,365

Based on the inputs shown above, the TRC ratio is 1.2, confirming that the program passes the TRC test.

COST-EFFECTIVENESS RESULTS	
Benefit-Cost Ratio–Test Results	**Ratio**
Total Resource Cost	1.2
Participant Cost Test	3.3
Ratepayer Impact Measure	0.5
Utility Cost Test	4.1

Additional benefits related to the reduction of societal benefits (such as greenhouse gas emissions) have not been quantified in the calculation of the TRC.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

04

Recommendations

Recommendations

FINDING #1

The IC's approach to lighting HOU limits inputs to a single HOU per site regardless of fixture location (interior vs. exterior; factory floor vs. office; stadium vs. gym). And the HOU for some Building Types (particularly large retail) are likely too low.

The savings average out across the span of many projects, but the current approach overly simplifies and therefore leads to significant swings in RR on a project basis; particularly for the largest sites but also across smaller projects.

The RR for the B4E path is significantly higher than the standard path (1.39 vs 1.03 for energy).

RECOMMENDATION #1

Several options are available for improving the accuracy of HOU driving kWh savings estimates.

- Adding further subdivisions to key market segments (e.g. Continuous Operation).
- Consider criteria (e.g. B4E projects) where HOU are custom to the project; while below the fixed limit, the average HOU are used in line with the IC's Appendix A.

FINDING #2

A limited number of projects are submitted with savings based on incorrect building types. In other instances, the building types used in the ex ante analysis workbook do not match those documented in Appendix A. Similarly, for several sampled projects interior HOU are applied to exterior fixtures. These inputs are critical in that drive the application of HOU, CF, and HVAC interactive impacts.

RECOMMENDATION #2

Wattage data, building type, and measure placement (interior v. exterior) must receive additional internal QC review. The analysis tool must be able to apply different HOU for interior versus exterior fixtures that are part of a single project. IC is encouraged to improve transparency by replacing singular savings index with a reference able per input variable and ensure consistency between measure characterization documents and the analysis tool.

FINDING #3

Projects submitted in 2019 include a mix of at least five versions of the ex ante savings analysis tool, with version IDs spanning from v5 to v12. The unit level measure savings appears to be consistent across many of the workbooks. A deep dive review of all assumptions in all versions is outside of the evaluation scope for 2019, however at least one project was noted to have savings coefficients inconsistent with the 2019 version of Appendix A, and versions of the lighting analysis workbook referencing the 2018 IMC are also noted.

RECOMMENDATION #3

Confirm the analysis template for each year is consistent with the inputs documented in the latest version of Appendix A; ensure all staff are using the current year's analysis template.

Recommendations

(continued)

FINDING #4

Guidehouse found several instances of missing data both in the tracking data and in the implementer workbooks:

- Four percent of midstream measures lack demand savings, even though 60 percent of those measures provide demand savings per unit.
- Eleven percent of midstream measures lack kWh savings but note lifetime kWh savings.
- The lighting analysis workbooks for multiple projects in the standard track are lacking wattage inputs for a portion of the measures.

RECOMMENDATION #4

The database appears to lack an automated QC process that would flag missing or incorrectly entered data. The lighting analysis workbook needs a more comprehensive internal review and QC process to ensure that all required inputs are populated.

FINDING #5

The Midstream measure database lacks some details necessary to confirm the input assumptions and verify reported project context. Details provided in other similar programs but not included in this dataset include: measure model number, both efficient and baseline measure wattage, participant organization name, participant contact information, and the invoice number associated with the sale. Comprehensive records are fundamental and necessary to fully validate savings.

RECOMMENDATION #5

Installed measure wattage and applicable baseline assumptions should be captured in addition to the product measure number. Contractors should submit copies of invoices covering sale of incentivized measures, or be prepared to do so upon request. Basic participant data should be captured in the program database.

FINDING #6

Appendix A cites California DEER 2008 as the source for most of the lighting EULs (rated HOU for screw base lamps is sourced from the ENERGY STAR database) and DEER 2011 is noted as the source for many of the other lighting inputs.

The CPUC updates aspects of DEER on an annual basis; therefore, these key inputs to the prescriptive savings estimates are several generations out of date. As such, they lack updates to the values themselves; as well as updates that expanded the number of available business segments.

RECOMMENDATION #6

Data sourced from DEER should be reviewed and updated on a regular basis. Ideally updates would occur at least every other year or preferably on an annual basis.

Recommendations

(continued)

FINDING #7

Guidehouse attempted to recalculate lighting measure savings using data from the project and measure databases, and data sourced from App A as in previous evaluations. The attempt to replicate ex ante savings identified 1,675 measures with savings consistent with the the program database and 5,190 measure rows with mismatched savings values.

RECOMMENDATION #7

Improve transparency by indexing the key analysis inputs individually instead of combining in to a single coefficient; ensure consistency within the analysis tool throughout the program year.

FINDING #8

As noted in previous evaluations, the implementer's lighting analysis tool only has one place to enter lamps per fixture, which is linked to the efficient equipment. This makes it necessary for users to modify their data entry approach in instances where multi-lamp fixtures are retrofit with integrated LED fixtures that have a fixed fixture wattage. This limitation leads to variations in how individual users use the analysis tool and is particularly problematic given the overly complex system of coefficients and adjustments used to estimate unit level measure savings.

RECOMMENDATION #8

Update the measure inputs tab of the analysis template's "Calculation Sheet" to accommodate baseline lamps per fixture as distinct from the efficient case lamps per fixture. Integrate this with the delta watts calculation. This baseline lamps data also needs to be added to the program's measure level database.

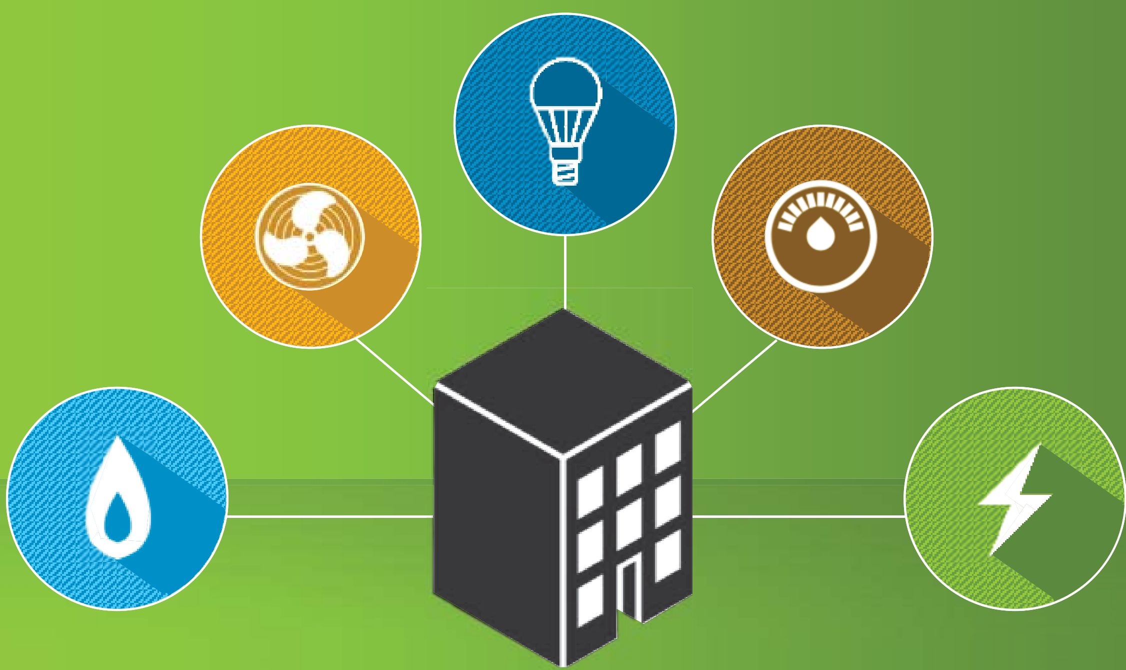
FINDING #9

Ex ante calculations for Variable Speed Drives (VSD) use deemed savings methods and multipliers from the implementer's Appendix A. Previous evaluations noted that these savings estimates are overly conservative. However, the 2019 Appendix A maintained the same kWh estimates while further reducing demand savings. Previous evaluations also noted that the approach of using simplified savings multipliers prevents for this measure prevent the IC from making any site specific adjustments to input values (such as HOU or load factors) that are applicable to a given VSD.

RECOMMENDATION #9

The preferred approach is to move away from a fixed savings per hp approach for VSD projects. Instead, develop a prescriptive VSD analysis tool that is easily updated per project to more accurately estimate savings

APPENDIX K



Process Efficiency Program

2019 Impact Evaluation Report

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Content of Report

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April 24, 2020

Table of Contents

01 Introduction

Program Summary

This document presents a summary of the findings and results from the impact evaluation of the AEP Ohio 2019 Process Efficiency Program for the period January 1, 2019 through December 31, 2019.

The Process Efficiency Program provides a streamlined incentive application and quality control process intended for non-residential customers interested in purchasing and installing efficient technologies not included on the pre-qualified list of measures employed by the Efficient Products for Business Program. 2019 is the 11th year the program has been active.

Custom equipment includes controls, injection molding machines, variable speed air compressors and other compressed air measures, cooling or heating equipment and controls replacement, custom oven replacement, process efficiency improvements and other miscellaneous measure installations.

Financial incentives are tiered and have a threshold of 50 percent of the project cost, up to $25,000. AEP Ohio’s Bid4Efficiency Program is a reverse auction for projects with incentives above $25,000. A majority of program savings are channeled through the Bid4Efficiency auction.

Process Efficiency Program applications can also include prescriptive measures receiving incentives as though these were submitted through the Efficient Products for Business Program. A small percentage of savings are from prescriptive measures submitted alongside custom measures.

https://www.aepohio.com/save/business/programs/ProcessEfficiencyProgram.aspx

Evaluation Objectives

The 2019 impact evaluation objectives include:

01 Quantify energy and summer coincident peak demand savings impacts at the meter from the program during 2019.

02 Sample enough projects to achieve a 90 percent evaluation confidence and a +/-10 percent precision for both the program energy and demand savings.

03 Determine program cost-effectiveness.

04 Determine key strengths and weaknesses in how the program calculates impacts and identify ways in which the program can be improved.

02 Methodology

Evaluation Methodology

Guidehouse created a sample of the project population with the goal of categorizing the projects into three relatively equal strata and sampling enough projects from each, to achieve a 90 percent confidence and 10 percent relative precision for both energy and demand savings.

Guidehouse requested project-specific documentation for each of the sampled projects from the implementation contractor, and conducted a detailed technical review. The assessment included a review of the tracking database, customer applications, invoices, and equipment specifications. Adjustments were made to project-specific savings wherever project documentation clearly showed different values from the database, or where calculation mistakes were present.

Engineering-based energy and demand reduction algorithms were applied in order to estimate ex post savings. Site-specific building information was leveraged when possible for adjustments to the ex ante savings. Additional metered data was obtained onsite for projects where documentation was insufficient or the project was complex in nature. Energy savings calculations were conducted in accordance with the 2019 Appendix A - AEP Ohio Prescriptive Measures Protocols, the 2010 Ohio Technical Reference Manuals (TRM), or other published methodologies, such as regional TRM's and accepted engineering approaches, as appropriate.

Realization rates (RR) for each stratum are calculated using the following equation:

$$RR_i = \frac{\sum_{sampled} E_{ex\ post}}{\sum_{sampled} E_{ex\ ante}}$$

Where *E* = the electric energy savings or peak demand reduction for each project in the stratum.

The stratum RR is then applied back the project population of that stratum with the following equation:

$$E_{i,ex\ post} = RR_i * \ E_{i,ex\ ante}$$

Sample Design

The evaluation team weighted each project individually based on both individual kWh and kW savings with respect to the total project population kWh and kW savings. These two weighted values were then averaged together into a combined weighted value and projects were sorted from largest to smallest according to this metric. This method was employed due to a few projects within the population containing relatively low kWh savings and relatively high kW savings, with the intent of increasing the precision for the demand savings. The projects were then placed into strata to achieve a relatively even distribution of cumulative standard deviation in electric energy savings between strata and minimize overall sample size.

Guidehouse stratified projects and designed the sample to target 90% confidence and 10% precision for both energy and demand savings.

Stratum by Approach and Energy Savings	Number of Projects	Strata Weight by Energy	Number of Desk Reviews	Number of Onsite/ Telephone Reviews
Large (> 7% of program savings weighted by kWh and kW)	4	25,046,672	4	2
Medium (< 7% and > 1% of program savings weighted by kWh and kW)	11	9,083,398	6	2
Small (< 1% of program savings weighted by kWh and kW)	41	5,506,875	3	0
Total	**56**	**39,636,945**	**13**	**4**

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Data Collection Activities

DATA COLLECTION TYPE

1	2
Project File Review	**Onsite/Phone Verification**
Targeted Population	Targeted Population
Sample of completed projects	**Projects with uncertainties or inconsistencies in ex ante savings calculations, ambiguities or conflicts in equipment details or hours of use (HOU), and a sample of projects with exceptionally high impacts on savings**

03 Evaluation Findings

Savings Results – Program Level

The 2019 impact evaluation of AEP Ohio's Process Efficiency program shows the program is operating below expectation for energy (kWh) with a RR of 0.79, and operating well for demand (kW) with a RR of 1.05. The variance in the energy RR is explained in detail later in the report.

The ex ante energy savings were 39,637 MWh and the ex post energy savings were 31,161 MWh; the ex ante energy savings exceeded the goal of 38,072 MWh, while the ex post energy savings fell short. The ex ante demand savings were 2,276 kW and the ex post demand savings were 2,397 kW; both fell short of the demand savings goal of 6,127 kW.

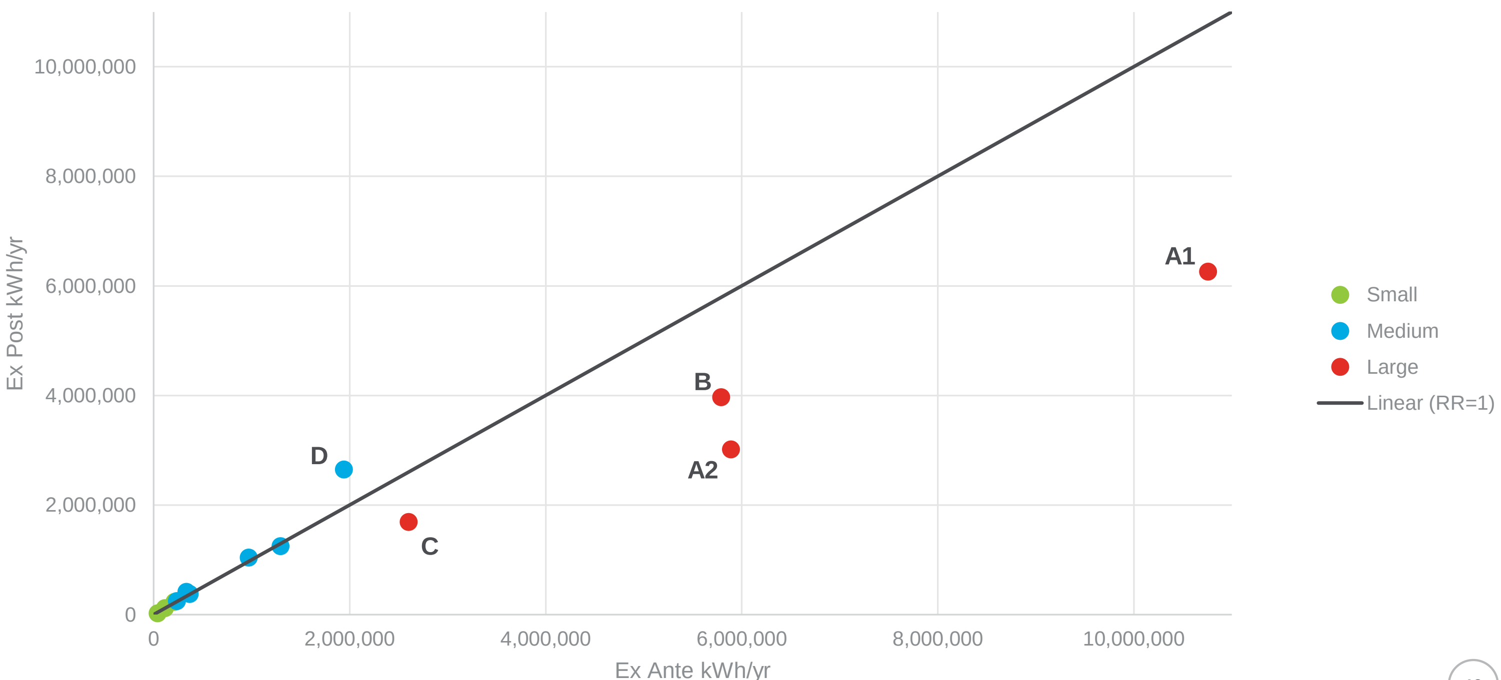
Metric	2019 Program Goals1 (a)[1]	Ex Ante (b)	Ex Post (c)	Realization Rate RR = (c) / (b)	Percent of Goal = (c) / (a)	Overall Relative Precision at 90% Confidence
Annual Energy Savings (MWh)	38,072	39,637	31,161	0.79	0.82	3.8%
Coincident Peak Reduction (kW)	6,127	2,276	2,397	1.05	0.39	15.6%

[1] AEP Ohio Volume 1: 2017 TO 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016

Energy Savings Summary

The figure below is a graphical representation of the building level ex ante versus ex post energy savings grouped by sample strata. The diagonal line represents the goal of a RR of one. Points above and to the left of the RR=1 line represent buildings with energy RRs above one, while those points below and to the right are building with RRs less than one. The most significant project RR drivers are labeled and are discussed in detail in the following slides. The overall energy RR is 0.79.

ENERGY SAVINGS SUMMARY



Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site A1|A2 – Theses two sites are industrial/manufacturing ethanol plant facilities and involve multiple process improvements at each site.

Both of these projects involved a list of improvements that were installed over a multi-year span, including fermenter additions, pump VFDs, and heat exchangers. Both facilities had multiple other prior efficiency projects that had been booked in previous evaluations both during the baseline period and during the installation period for the current 2019 projects. These savings were added to both the baseline and efficiency case on a monthly basis to effectively avoid any double counting of savings. The ex ante calculations for both of these projects included very little post production data (20-26 days for each project) from fall of 2018. The ex post analysis incorporated one full year of post production data (Jan through Dec 2019) to more accurately characterize the post production operation. Guidehouse's analysis slightly raised the energy intensity (kWh/gal) for the efficient post production values and was the primary driver for the low RR of both projects.

The ex ante calculations also excluded seven months within the two year, pre-production period for the baseline due to variance. The ex post calculations analyzed the full two year period for the baseline case. This adjustment had very little effect on the overall project RR, however.

Summary for Site A1	
Ex Ante kWh	10,759,355
Ex Post kWh	6,256,068
Energy RR	0.58
Ex Ante kW	0.0
Ex Post kW	0.0
Demand RR	N/A

Summary for Site A2	
Ex Ante kWh	5,893,190
Ex Post kWh	3,014,773
Energy RR	0.51
Ex Ante kW	0.0
Ex Post kW	0.0
Demand RR	N/A

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site B – This site is an industrial/manufacturing ethanol plant facility and involves multiple process improvements.

The ex ante calculations for both of these projects included limited post production data (26 days) during the winter of 2018. The ex post analysis incorporated one and a half years of post production data to more appropriately characterize the post production operation of the plant and further capture any potential seasonality in production. This data was further supplemented by operational data obtained through a telephone interview conducted with the site. This analysis slightly raised the energy intensity (kWh/gal) for the efficient post production values and slightly lowered the energy intensity for the baseline case and was the primary driver for the low RR of this project.

Summary for Site B

Ex Ante kWh	5,791,410
Ex Post kWh	3,967,263
Energy RR	0.69
Ex Ante kW	469.2
Ex Post kW	518.9
Demand RR	1.11

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site C – This site is an industrial/manufacturing facility and involves advanced process control improvements to refrigeration systems.

The ex ante regression calculation included 26 days of data where the compressors were not operational. This 26 day window was found to be abnormal from typical operation, therefore this time frame was excluded from the ex post regression calculations to better characterize the typical operation of the efficient equipment. This adjustment is the sole driver of the low RR.

Summary for Site C

Ex Ante kWh	2,602,717
Ex Post kWh	1,690,158
Energy RR	0.65
Ex Ante kW	317.1
Ex Post kW	205.9
Demand RR	0.65

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site D – This site is an industrial/manufacturing facility and involves compressed air upgrades.

A bin analysis was performed on the pre condition data for this analysis to determine operational hours and average demand for a cubic feet per minute (CFM) profile. Given that this project entailed reducing a high pressure system to a low pressure system and that there was no post metering data, the normalized HOU from the baseline data was used to develop trends for the efficient post data at a lower pressure. Calculations were then performed to determine how the high pressure baseline system would operate at an equivalent low pressure system to that of the efficient case. This approach provides a more accurate comparison of the baseline and efficient systems, and is the driver behind the high RRs for both energy and demand.

Summary for Site D

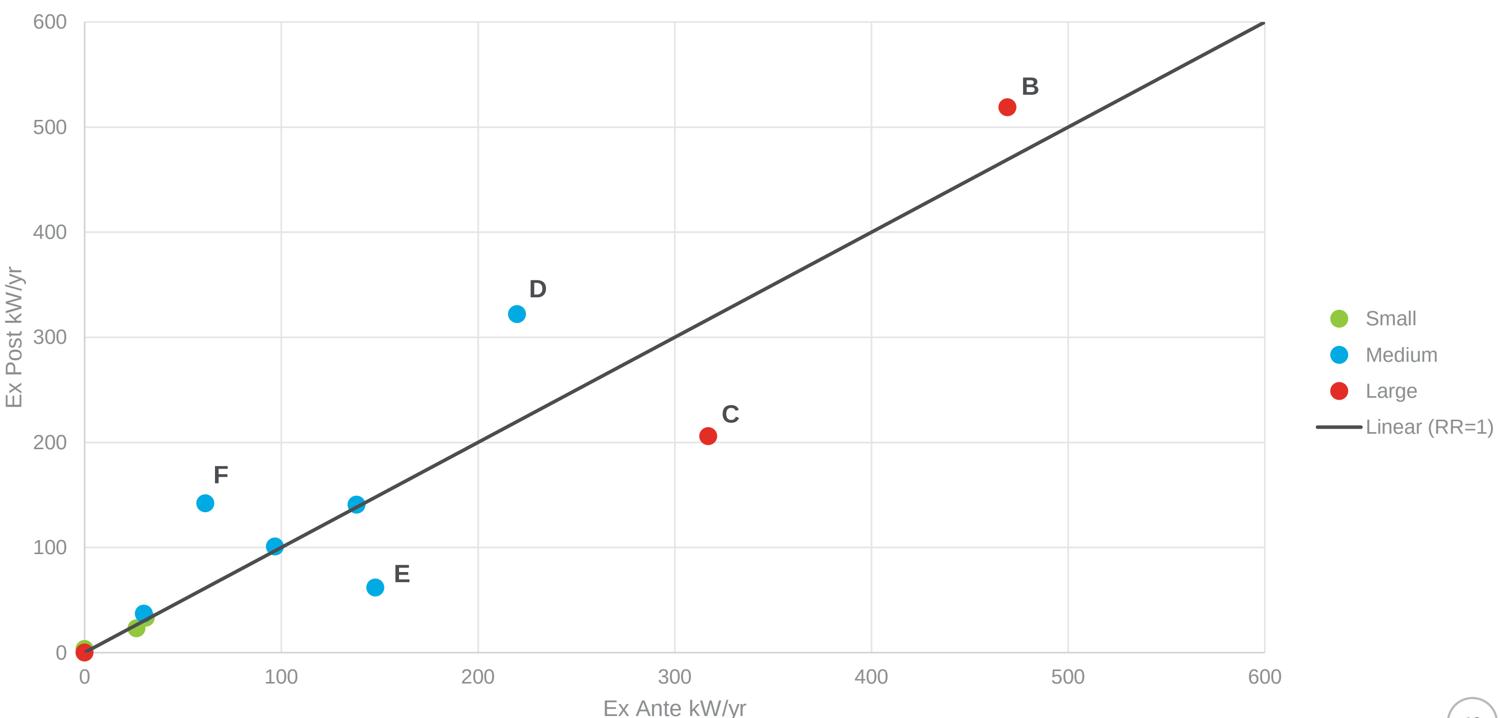
Ex Ante kWh	1,942,050
Ex Post kWh	2,646,034
Energy RR	1.36
Ex Ante kW	219.9
Ex Post kW	322.1
Demand RR	1.47

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Demand Savings Summary

The figure below is a graphical representation of the building level ex ante versus ex post demand savings grouped by sample strata. The diagonal line represents the goal of a RR of one. Points above and to the left of the RR=1 line represent buildings with demand RR above one, while those points below and to the right are building with RR less than one. The most significant project RR drivers are labeled and are discussed in detail in the following slides. The overall demand RR is 1.05.

DEMAND SAVINGS SUMMARY



Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Demand Considerations – Site Level

Site E – This site is a large office facility and involves the retro-commissioning of HVAC building systems.

The ex ante calculations derive both average equipment demand savings as well as average coincident peak demand savings. The average equipment demand savings were mistakenly reported as coincident demand savings, and in this case the two are very different. This is the primary driver behind the project RR.

The ex post calculations adjusted the ex ante equations to incorporate the actual static pressure values found, based on snapshots of the building automation system (BAS), which include values for both the control system static pressure and reset setpoints for the systems. These values were used to generate ex post savings for each of the roof-top units (RTUs) for this project. This adjustment is the only other notable driver for the RR.

Summary for Site E

Ex Ante kWh	1,295,292
Ex Post kWh	1,247,427
Energy RR	0.96
Ex Ante kW	147.9
Ex Post kW	61.9
Demand RR	0.42

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Demand Considerations – Site Level

Site F – This site is an industrial/manufacturing facility and involves compressed air upgrades.

The ex post calculations performed a bin analysis based on the calculated CFM from the metered post data, as there was no metered CFM data for this project in either the pre or post cases. This bin analysis approach provides a more comprehensive comparison between the baseline and efficient cases. A capacity vs load relationship was established for the baseline condition to calculate a more accurate baseline demand profile, which had a large impact on the adjustment made to the ex ante baseline demand values. The same bin analysis methodology was applied to both energy and demand savings, and is the primary driver behind the high RRs for both energy and demand.

The onsite visit and customer interview performed by Guidehouse informed a slightly adjusted hours of use, which was incorporated into the ex post analysis. This had little effect on the overall project savings RRs.

Summary for Site F

Ex Ante kWh	971,800
Ex Post kWh	1,041,253
Energy RR	1.07
Ex Ante kW	61.5
Ex Post kW	142.1
Demand RR	2.31

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Effective Useful Lifetime (EUL)

This section reviews the Expected Useful Lives (EULs), tracked and evaluated, and identifies issues.

The EULs are estimated on an individual measure basis using the evaluation guidance documentation, typically the implementer's workpapers. The overall program EUL is determined by calculating the ex post lifetime savings and dividing by the ex post annual savings. Guidehouse reviewed EUL for each sampled measure.

Guidehouse used the EUL of measures provided by the 2019 AEP Ohio Appendix A documentation whenever possible. When individual measures or their EUL were not documented in the 2019 AEP Ohio Appendix A documentation, Guidehouse used the 2010 Ohio TRM or other TRM documents as necessary.

The adjustment to the program EUL pertains solely to RR adjustments. Guidehouse found all measure level EULs within the sample to have correct or reasonable measure life, so no adjustments were made to the measure lives directly.

EUL REVIEW	
Ex Ante EUL (a)	**Ex Post EUL (b)**
16.7	15.8

Incremental Costs

This section reviews the Incremental Measure Costs (IMCs), tracked and evaluated, and identifies issues.

Guidehouse used the incremental measure costs of measures provided by the 2019 AEP Ohio Appendix A documentation whenever possible. When individual measures or their costs were not documented in the 2019 AEP Ohio Appendix A documentation, Guidehouse used the 2010 Ohio TRM or other TRM documents as necessary.

The driver behind the small IMC difference between ex ante and ex post stems from a single project that was adjusted based on a review of the project invoices. Overall, the ex ante incremental costs appear consistent with actual incremental customer costs.

IMC REVIEW

Ex Ante IMC (a)	Ex Post IMC (b)
$11,754,109	$11,785,962

Cost-Effectiveness Review

This section addresses the cost-effectiveness of the 2019 Process Efficiency Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS

Item	Value
Average Measure Life	15.8
Projects	56
Ex Post Annual Energy Savings (kWh)	31,161,307
Ex Post Coincident Peak Savings (kW)	2,397.3
Third Party Implementation Costs	$852,703
Utility Administration Costs	$544,161
Utility Incremental Incentive Costs	$1,602,638
Incremental Measure Costs	$11,785,962

Based on these inputs, the TRC ratio is 1.0 and the program passes the TRC test for the program in its entirety.

COST-EFFECTIVENESS RESULTS

Benefit-Cost Ratio–Test Results	Ratio
Total Resource Cost	1.0
Participant Cost Test	2.0
Ratepayer Impact Measure	0.6
Utility Cost Test	4.7

Additional benefits related to the reduction of societal benefits (such as greenhouse gas emissions) have not been quantified in the calculation of the TRC.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

04

Recommendations

Findings and Recommendations

FINDING #1

Several large industrial process improvement projects used a limited amount of data for post production and consumption for determining typical efficient conditions after the completion of a project. The variability of this data leads to uncertainty in project savings.

RECOMMENDATION #1

Ensure projects utilizing production data are leveraging adequate time frames for both the pre and post production periods. Less than one month of pre or post data is not adequate for sufficiently determining typical operating conditions for projects with significant variability day to day, or accounting for seasonality for measures that are weather or time of year dependent.

FINDING #2

Several facilities contain other prior claimed efficiency projects within the pre- and post-installation periods, as well as the period where the project was actively undergoing installation. These previous projects were difficult to track across prior years and the savings from these projects were not accurately accounted for within the current projects' evaluation.

RECOMMENDATION #2

Document prior projects installed within a facility including whether savings from the prior projects were claimed and project completion dates. Ensure all prior projects with claimed savings are appropriately backed out from the current project's ex ante savings correctly when performing whole-site billing analyses.

- Apply prior project savings to match the granularity of the data being evaluated (e.g. If monthly production data is being used, apply the previous savings at the monthly level by dividing the annual savings accordingly).
- Add all savings values from previous projects to the historical site energy consumption to achieve normalized pre- and post-consumption, which simulates an absence of any previously installed efficiency projects.

FINDING #3

Post metered data included time periods where the efficiency equipment was not operational as part of a prolonged atypical shutdown.

RECOMMENDATION #3

Ensure that time during metering periods are omitted where non-typical operation occurs for both the pre and post period to more accurately characterize the typical operation for both the baseline and efficient equipment. Extend metering periods where possible to account for atypical anomalies that might occur during pre or post metering.

Findings and Recommendations

FINDING #4

Similar to 2018, several air compressor projects had differing RRs for both energy and demand after normalizing the air profile using a CFM binning analysis. Demand savings vary substantially depending on method, especially when limited data is collected.

RECOMMENDATION #4

The ex ante estimates should be derived from HOU normalized air profiles rather than simple pre/post analysis of power consumption.

The logging period should be extended to a minimum of two weeks to better capture variable schedules.

FINDING #5

Site specific data that was previously collected was not used in lieu of assumed or default values in calculations.

RECOMMENDATION #5

Implement a system for cross-referencing all site specific collected data and ensuring it replaces previous assumptions or default values within equations or calculation methodologies. Detail the changes made to the assumed or default values in order to more transparently discern drivers for the change in energy and demand savings.

FINDING #6

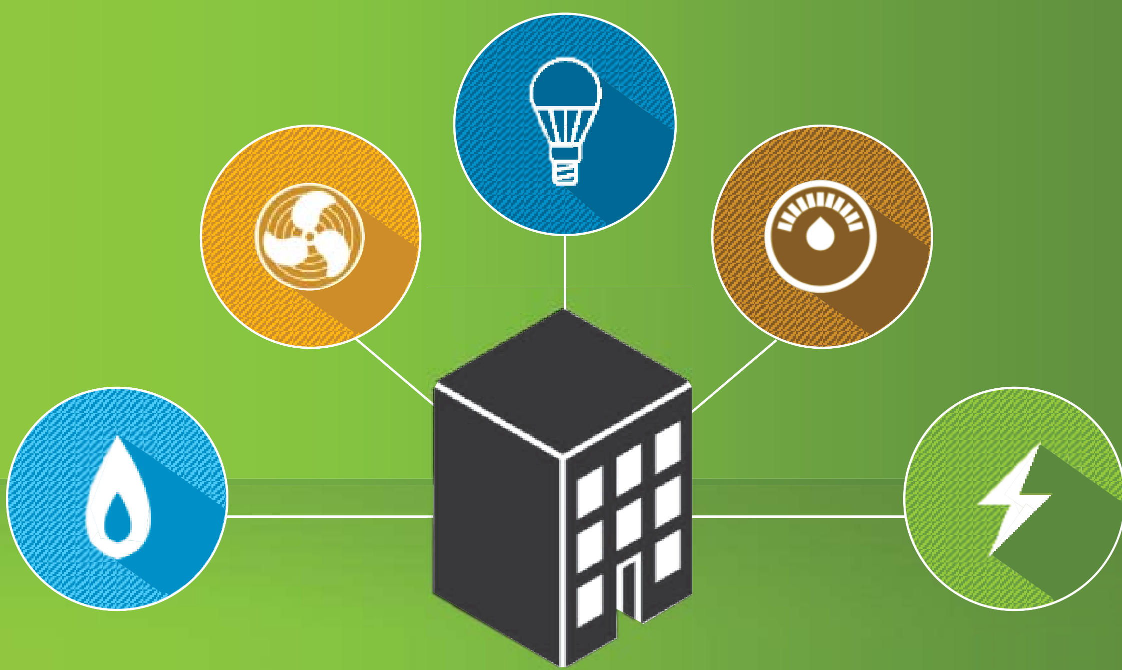
Project reported average equipment demand value in lieu of average coincident peak demand value.

RECOMMENDATION #6

Establish a process for differentiating average equipment demand from average coincident peak demand values through the verification process. Ensure that the average coincident peak demand values are checked between the final reported tracking data to the original project calculations.

APPENDIX L

Guidehouse



Self Direct Program

2019 Impact Evaluation Report

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April 17, 2020

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Content of Report

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April 17, 2020

Table of Contents

01

Introduction

Program Summary

The Self Direct Program allows qualifying business customers to commit their already completed energy efficiency and peak demand reduction resources to AEP Ohio. AEP Ohio accepts projects on a case-by-case basis, and each must be approved by rules established by the Public Utility Commission of Ohio (PUCO). Business customers are eligible if they meet one of the following criteria:

1. The customer has energy consumption greater than 700,000 kWh per year from AEP Ohio, or

2. The customer is part of a national account involving multiple facilities in one or more states.

Submitted projects for 2019 must have been completed between January 1, 2016 and the date of acceptance into the program. Each project is required to produce verifiable and persistent energy savings and/or peak demand reduction for at least five years from the date of installation. Projects are also required to have a payback period between one and seven years without the incentive applied, and pass either the total resource cost test or the utility cost-effectiveness tests as determined by AEP Ohio.

The goal of the Self Direct Program is to educate qualifying business customers on all of AEP Ohio's business sector programs. Self Direct incentives are designed to 'prime the market' for more energy efficiency projects by providing participants start-up funds to re-invest in future projects outside of the Self Direct Program.

The 2019 program year represents the eleventh year of operation for the Self Direct Program. In 2019, AEP Ohio completed 42 total projects (32 premises), which is more than the 23 projects completed in 2018, but fewer than the number of projects completed in 2017 (63 projects) and 2016 (73 projects). Program spending was close to goal, while the ex ante energy savings were less than a third of the program goal.

https://www.aepohio.com/save/business/programs/SelfDirectProgram.aspx

Evaluation Objectives

The 2019 impact evaluation objectives include:

01 Quantify energy and summer coincident peak demand savings impacts at the meter from the program during 2019.

02 Sample enough projects to achieve a 90% evaluation confidence and a +/-10% precision for both the program energy and demand savings.

03 Determine key strengths and weaknesses in how the program calculates impacts and identify ways in which the program can be improved.

04 Determine program cost-effectiveness.

02
Methodology

Evaluation Methodology

Guidehouse created a sample of the project population with the goal of categorizing the projects into three relatively equal strata and sampling enough projects from each to achieve a 90% confidence and 10% precision for both energy and demand savings.

Guidehouse requested project-specific documentation for each of the sampled projects from the implementation contractor, and conducted a detailed technical review. The assessment included a review of the tracking databases, customer applications, invoices, and equipment specifications. Adjustments were made to project-specific savings wherever project documentation clearly showed different values from the database, or where calculation mistakes were present.

Ex post savings were calculated by employing a custom engineering approach to each individual project. Additional metered data was obtained onsite for projects that were either large in stratum, documentation was insufficient, or the project was complex in nature. Energy savings calculations were conducted in accordance with the 2019 Appendix A - AEP Ohio Prescriptive Measures Protocols, the 2010 Ohio Technical Reference Manuals (TRM), or other published methodologies, such as regional TRM's and accepted engineering approaches, as appropriate. Building energy code, which is referenced as the baseline in many of these Self Direct projects, is defined by the State of Ohio.

Realization rates for each stratum are calculated using the following equation:

$$RR_i = \frac{\sum_{sampled} E_{ex\ post}}{\sum_{sampled} E_{ex\ ante}}$$

Where *E* = the electric energy savings or peak demand reduction for each project in the stratum.

The stratum realization rate is then applied back the project population of that stratum with the following equation:

$$E_{i,ex\ post} = RR_i * E_{i,ex\ ante}$$

Sample Design

The evaluation team weighted each project individually based on both individual kWh and kW savings with respect to the total project population kWh and kW savings. These two weighted values were then averaged together into a combined weighted value and projects were sorted from largest to smallest according to this metric. This method was employed due to a few projects within the population containing relatively low kWh savings and relatively high kW savings. The projects were then placed into strata, attempting to achieve a relatively even distribution of cumulative standard deviation in electric energy savings between strata and minimize overall sample size.

Guidehouse stratified projects and designed the sample to target 90% confidence and 10% precision for both energy and demand savings.

Stratum by Approach and Energy Savings	Number of Projects	Strata Weight by Energy	Number of Desk Reviews	Number of Onsite/Phone Reviews
Large (> 10% of program savings weighted by kWh and kW)	4	2,161,329	4	2
Medium (< 10% and > 2% of program savings weighted by kWh and kW)	7	1,420,915	4	1
Small (< 2% of program savings weighted by kWh and kW)	31	434,846	3	0
Total	**42**	**4,017,089**	**11**	**3**

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Data Collection Activities

DATA COLLECTION TYPE

1	2
Project File Review Targeted Population **Sample of completed projects**	**Onsite/Phone Verification** Targeted Population **Projects with uncertainties or inconsistencies in ex ante savings calculations, ambiguities or conflicts in equipment details or hours of use, and a sample of projects with exceptionally high impacts on savings**

03

Evaluation Findings

Savings Results – Program Level

The 2019 evaluation of AEP Ohio's Self Direct program shows the program is operating as expected for energy (kWh) with a realization rate at 0.98, and above expectations for demand (kW) with a realization rate at 1.20.

While the energy realization rate is very close to 1.00, there is significant variance in the project level energy realization rates, which are explained in detail later in the report.

The ex ante energy savings were 4,017 MWh and the ex post energy savings were 3,926 MWh; both fell short of the energy savings goal of 13,418 MWh. The ex ante demand savings were 747 kW and the ex post demand savings were 893 kW; both fell short of the demand savings goal of 1,890 kW. The self direct program does not entail any outreach effort in order to achieve these goals, but instead simply processes projects that are submitted.

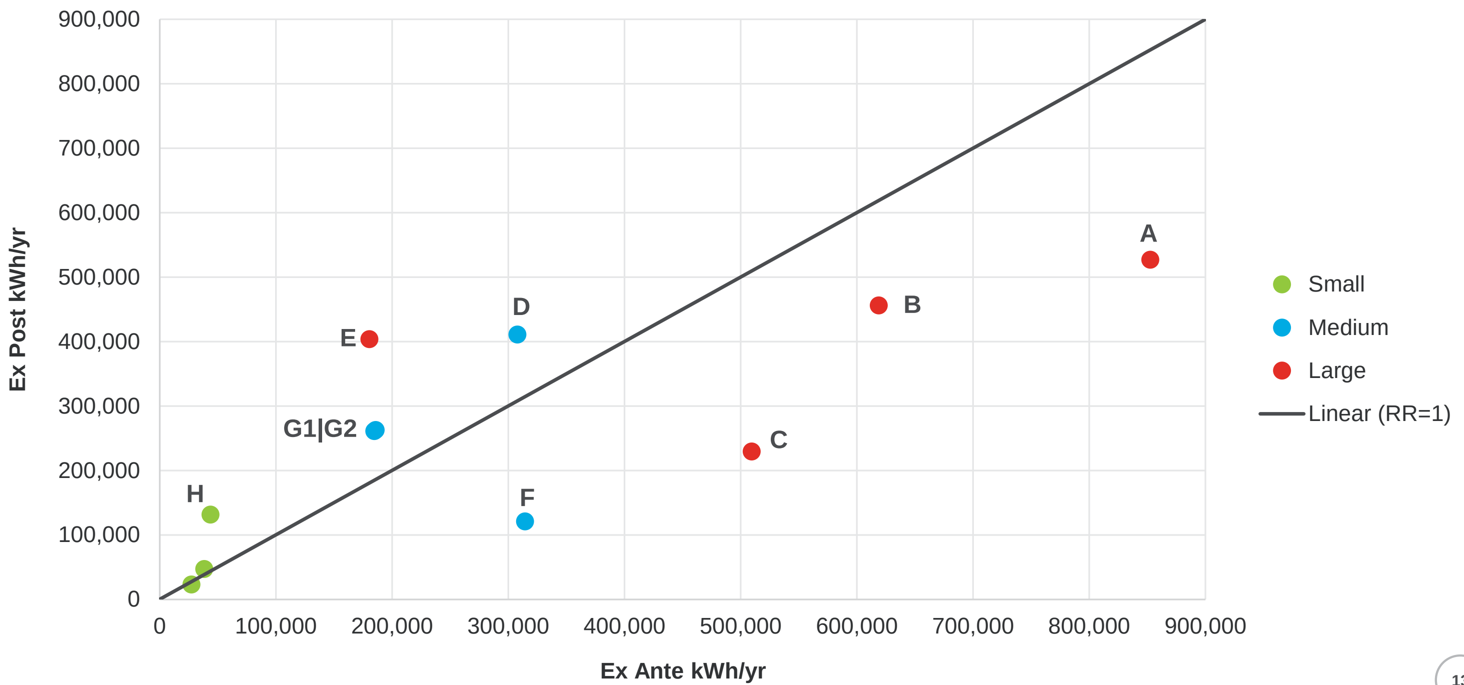
Metric	2019 Program Goals1 (a)[1]	Ex Ante (b)	Ex Post (c)	Realization Rate RR = (c) / (b)	Percent of Goal = (c) / (a)	Overall Relative Precision at 90% Confidence
Annual Energy Savings (MWh)	13,418	4,017	3,926	0.98	29%	37.8%
Coincident Peak Reduction (kW)	1,890	747.286	893.421	1.20	47%	13.1%

1. AEP Ohio Volume 1: 2017 TO 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016

Energy Savings Summary

The figure below is a graphical representation of the building level ex ante versus ex post energy savings grouped by sample strata. The diagonal line represents the goal of a realization rate of one. Points above and to the left of the RR=1 line represent buildings with energy realization rates above one, while those points below and to the right are building with realization rates less than one. The most significant project RR drivers are labeled and are discussed in detail in the following slides. While the overall program realization rate is 0.98, the large stratum projects had a realization rate of 0.75, with higher realization rates for the small and medium strata.

ENERGY SAVINGS SUMMARY

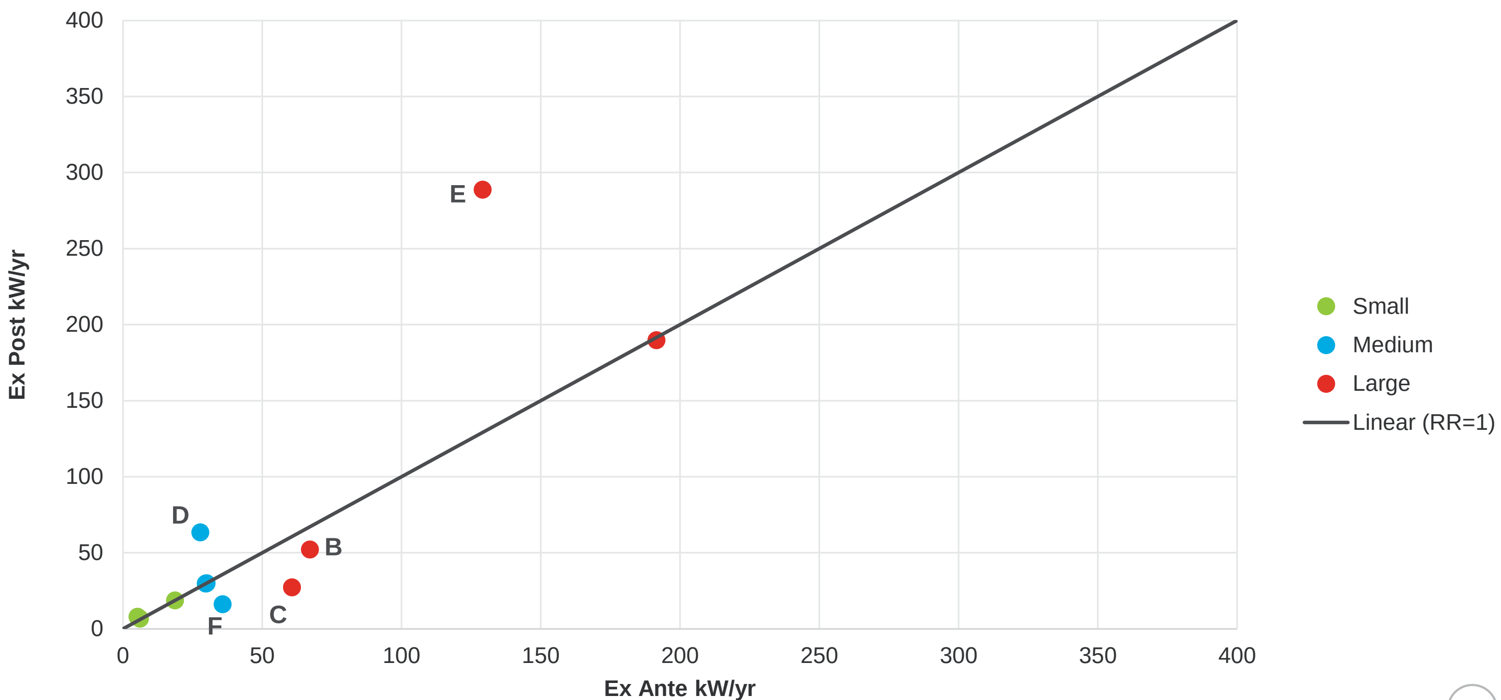


Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Demand Savings Summary

The figure below is a graphical representation of the building level ex ante versus ex post demand savings grouped by sample strata. The diagonal line represents the goal of a realization rate of one. Points above and to the left of the RR=1 line represent buildings with demand realization rates above one, while those points below and to the right are building with realization rates less than one. The most significant project realization rate drivers are labeled and are discussed in detail in the following slides. The overall demand realization rate is 1.20.

DEMAND SAVINGS SUMMARY



Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site A – This site is a single shift industrial/manufacturing facility and involves interior LED tube lighting replacing T8 fluorescent fixtures.

The ex ante calculations used deemed savings values for all fixtures instead of performing manual custom savings calculations. Furthermore, the deemed value referenced by the ex ante calculations doesn't match the 2019 AEP Ohio Appendix A. The primary realization rate driver is the discrepancy between the annual HOU contained within the ex ante deemed value and the calculated ex post HOU. The kWh savings multiplier used in the ex ante savings grossly overstates the claimed energy savings given that this facility is a single shift manufacturing facility. The lighting fixture quantities were verified from the invoices and the annual hours of use were manually calculated based on company hours and engineering assumptions. The interactive and coincidence factors were taken from the 2019 AEP Ohio Appendix A.

Summary for Site A

Ex Ante kWh	852,551
Ex Post kWh	526,963
Energy RR	0.62
Ex Ante kW	191.584
Ex Post kW	189.759
Demand RR	0.99

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site B – This site is an industrial/manufacturing facility and involves the installation of VFDs on two 125HP chilled water pumps.

The ex ante calculations collected one week of metered data for the operational pump VFD, which occurred during the month of July, which coincides with the higher end of the system demand spectrum since both cooling and process loads are being serviced. The VFD appears to reduce the system load to approximately eight percent of full capacity, which indicates the equipment is significantly oversized for the system needs. A conservative approach was used to approximate both annual usage and baseline behavior and consumption. The eight percent metered power with the VFD correlates to roughly 60 percent baseline power at the same operating capacity. Since there is no indicated documentation detailing the ratio of the system process usage vs. cooling needs, the system was considered to be process load dominated rather than HVAC dominated given the very low load metered in the month of July.

Summary for Site B

Ex Ante kWh	618,792
Ex Post kWh	456,046
Energy RR	0.74
Ex Ante kW	67.140
Ex Post kW	52.060
Energy RR	0.78

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site C – This site is an industrial/manufacturing facility and involves vacuum loader pump system replacement. Eight centralized vacuum pumps ranging from 10-25HP were replaced with thirty-five self-contained 1.3HP vacuum pumps.

The ex ante calculation assumptions for the baseline case are the primary source for realization rate variance, specifically the load factors. The assumption was made that the baseline system operates at a 100 percent load factor when operational, and a standby load factor of 60 percent when "off". Guidehouse believes these assumptions are unreasonable and adjusted to 75 percent load factor when "on" and 25 percent load factor when "off". This adjustment reduced the baseline energy consumption.

Summary for Site C

Ex Ante kWh	509,426
Ex Post kWh	229,486
Energy RR	0.45
Ex Ante kW	60.65
Ex Post kW	27.32
Energy RR	0.45

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site D – This site is a recreational center for a college campus and entails a whole building analysis modeled in Trane Trace using ASHRAE 90.1 2007 as a baseline.

An initial model run was performed (Ex Post Initial) of the unchanged model to check the claimed savings. The overall kWh savings was very close to claimed. However, it was found that the ex ante model did not apply PRM (Performance Rating Method) rules to the fan sizing for the selected ASHRAE 90.1 - 2007 baseline case, which led to an underestimated baseline fan usage. This adjustment was made in the Ex Post Final model run and is the primary driver for the high realization rate.

There was an additional small realization rate finding pertaining to a lighting fixture type. A full manual lighting takeoff was performed in the ex post calculations after discovering a fixture type was missing from the model during lighting spot checks. Guidehouse therefore found the proposed LPD to be slightly higher than the ex ante LPD overall. Both the efficient and baseline cases employ a space by space LPD within the model, so spaces for the efficient case were updated according to the ex post lighting takeoff findings, summarized on the Lighting Takeoff tab.

Summary for Site D

Ex Ante kWh	307,968
Ex Post kWh	410,645
Energy RR	1.33
Ex Ante kW	27.800
Ex Post kW	63.454
Energy RR	2.28

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site E – This site is a grocery facility and involves the replacement of old refrigeration compressors with a new refrigeration compressor.

The ex ante calculations use 1,300 for their annual HOU for the refrigeration system, which greatly underestimates operation hours for a refrigerated system. The ex ante calculations currently estimates a baseline operation at 75 percent load but did not provide any evidence of this estimate. The winter trend data that was collected for post installation operation found an operating load of 51 percent which was much smaller than the 75 percent baseline load.

The ex post calculations account for the above issues by increasing the HOU of both the pre and post case to 8,760 as this system is required to maintain a refrigerated space all year long. In order to account for the inconsistent load condition, the ex post calculation used 51 percent load for both pre and post operation as this was verified load collected by the trend data.

Summary for Site E

Ex Ante kWh	180,560
Ex Post kWh	403,541
Energy RR	2.23
Ex Ante kW	129.16
Ex Post kW	288.66
Energy RR	2.23

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site F – This site is a grocery facility and involves the installation of anti-sweat hearting controls and new refrigerated doors with LED lighting.

The ex ante heating calculations use deemed savings values, whereas the ex post calculations used equations from both the 2019 AEP Ohio Appendix A and a workpaper from Southern California Edison for more accurate savings calculations on anti-sweat heater controls. The workpaper is referenced by the 2019 AEP Ohio Appendix A (p. 152 citation number 85). The baseline conditions for the refrigerated doors were poorly documented, and several baseline condition assumptions were thought to be inappropriate for the installed efficient equipment.

The ex ante calculations assumed a baseline of 160 feet of open case LT reach-ins, which is not standard. The ex ante also counts the savings from anti-sweat heaters add measure where doors were added and then counts these savings again in the anti-sweat heater controls measure. This assumption double counted the anti-sweat heater savings for MT cases. For both instances described above, savings were zeroed out.

Summary for Site F

Ex Ante kWh	314,435
Ex Post kWh	120,681
Energy RR	0.38
Ex Ante kW	35.828
Ex Post kW	16.23
Energy RR	0.45

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site G1|G2 – These sites are grocery facilities and involve the replacement of old T8 refrigerated case lighting with a new LED refrigerated case lighting.

The ex ante calculations use deemed savings values from the 2019 AEP Ohio Appendix A, which were considered appropriate for this measure. However, equipment logging determined that the annual HOU were 8,760, which is higher than the deemed HOU provided in Appendix A. These HOU were adjusted based on the facility schedule and account for the sole realization rate discrepancy for these projects.

Summary for Site G1

Ex Ante kWh	185,985
Ex Post kWh	262,567
Energy RR	1.41
Ex Ante kW	29.77
Ex Post kW	29.77
Demand RR	1.00

Summary for Site G2

Ex Ante kWh	184,745
Ex Post kWh	260,817
Energy RR	1.41
Ex Ante kW	29.77
Ex Post kW	29.77
Demand RR	1.00

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Energy Considerations – Site Level

Site H – This is a manufacturing facility that replaced an old hydraulic press with a new hydraulic press for injection molding.

The ex ante calculations contained multiple errors when calculating the annual production, which was the primary realization rate driver for this project.

The ex ante calculations divided the efficient savings in half to account for two presses being installed, however the energy usage was normalized by part produced, which negates the need for this division. The ex ante calculations also divides their parts per year value by an additional time variable, which was not necessary. Both of these calculations were corrected in the ex post evaluation.

The ex ante calculations averaged demand savings on a daily basis for the week of consumption data provided and projected energy savings by assuming 24 hour operation. The ex post analysis discounted the annual HOU to account for times where the equipment was not operating, however this resulted in minimal differences.

Summary for Site H

Ex Ante kWh	43,770
Ex Post kWh	131,527
Energy RR	3.01
Ex Ante kW	18.686
Ex Post kW	18.686
Energy RR	1.00

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Common Realization Rate Drivers

Guidehouse found a number of discrepancies or realization rate drivers present across a number of different projects.

1. Deemed savings values are used for measures where custom calculations were more appropriate. The deemed savings values used in ex ante calculations seem to reference a document that appears to be the 2019 Appendix A, however the ex ante values often do not match the 2019 AEP Ohio Appendix A documentation.
2. Calculations incorporate baseline assumptions that are unrealistic or do not reflect previous baseline site operating conditions. For example, a baseline motor can be difficult to characterize for an already completed project. Calculations should employ conservative assumptions and take into account operational characteristics of the project site.
3. Calculations employ annual HOU that are not reflective of site operations.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Expected Useful Life Review

This section reviews the Expected Useful Lives (EULs), tracked and evaluated, and identifies issues.

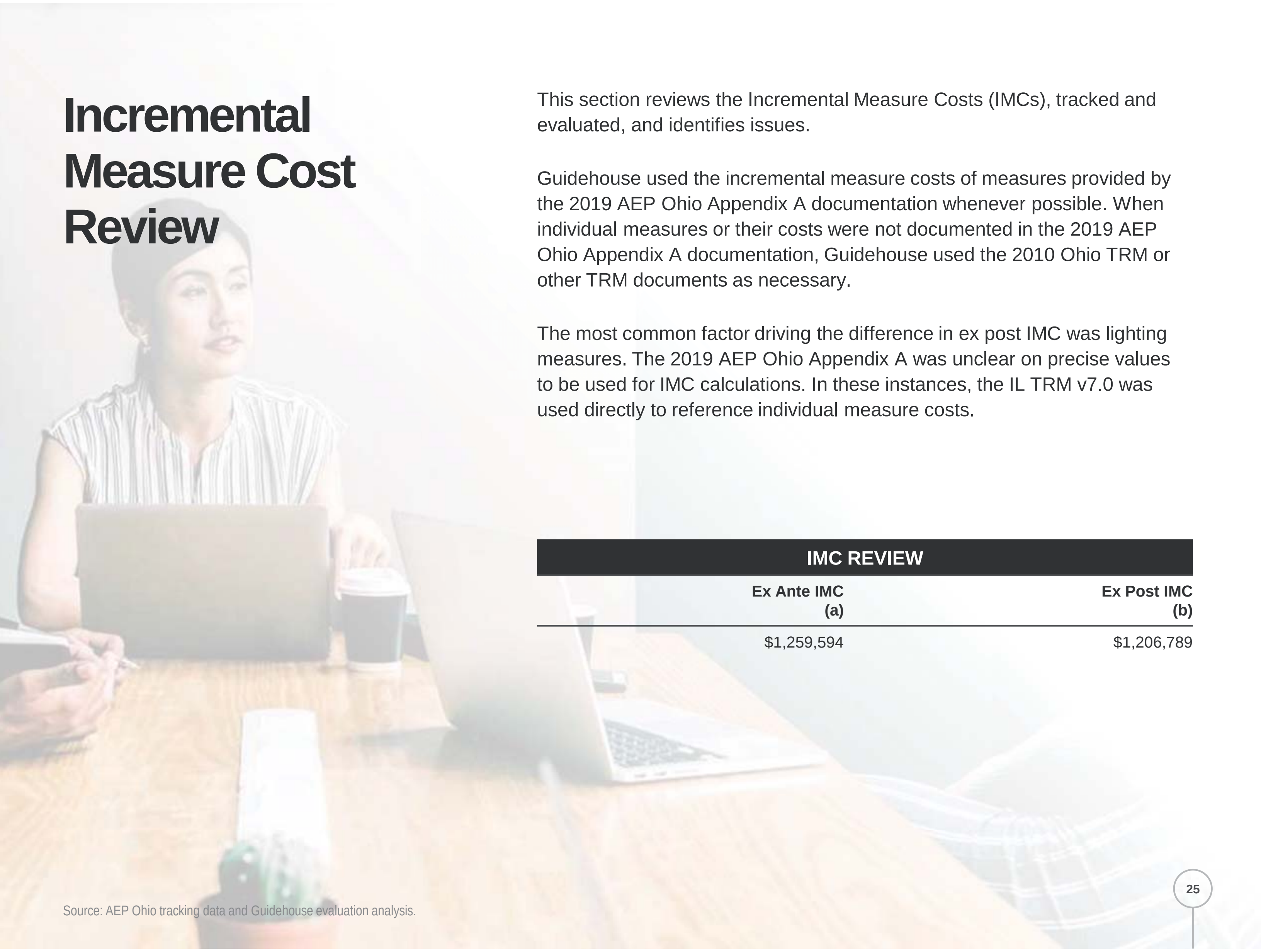
Guidehouse used the EUL of measures provided by the 2019 AEP Ohio Appendix A documentation whenever possible. When individual measures or their EUL were not documented in the 2019 AEP Ohio Appendix A documentation, Guidehouse used the 2010 Ohio TRM or other TRM documents as necessary.

Many of the measure level EULs were found to align between ex ante and ex post, however many discrepancies were found with lighting measures. Guidehouse used the 2019 AEP Ohio Appendix A for verification purposes where applicable, as well as some simple engineering calculations for lighting measures whose HOU were found to differ from the ex ante calculations.

Additionally, the ex ante calculations assigned refrigerated case lighting an EUL of 8 years, however it was found that the refrigerated cases operate at higher annual HOU than expected, which reduced the EUL to approximately 6 years. Guidehouse recommends aligning measure EUL values to Appendix A and other business program offerings.

EUL REVIEW	
Ex Ante EUL (a)	**Ex Post EUL (b)**
11.8	12.4

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.



Incremental Measure Cost Review

This section reviews the Incremental Measure Costs (IMCs), tracked and evaluated, and identifies issues.

Guidehouse used the incremental measure costs of measures provided by the 2019 AEP Ohio Appendix A documentation whenever possible. When individual measures or their costs were not documented in the 2019 AEP Ohio Appendix A documentation, Guidehouse used the 2010 Ohio TRM or other TRM documents as necessary.

The most common factor driving the difference in ex post IMC was lighting measures. The 2019 AEP Ohio Appendix A was unclear on precise values to be used for IMC calculations. In these instances, the IL TRM v7.0 was used directly to reference individual measure costs.

IMC REVIEW

Ex Ante IMC (a)	Ex Post IMC (b)
$1,259,594	$1,206,789

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

Cost-Effectiveness Review

This section addresses the cost-effectiveness of the 2019 Self Direct Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Average Measure Life	9
Projects	42
Ex Post Annual Energy Savings (kWh)	3,925,731
Ex Post Coincident Peak Savings (kW)	893.421
Third Party Implementation Costs	$127,277
Utility Administration Costs	$96,221
Utility Incremental Incentive Costs	$176,393
Incremental Measure Costs	$1,206,789

Based on these inputs, the TRC ratio is 0.7 and the program does not pass the TRC test for the program in its entirety.

COST-EFFECTIVENESS RESULTS	
Benefit-Cost Ratio–Test Results	**Ratio**
Total Resource Cost	0.7
Participant Cost Test	2.2
Ratepayer Impact Measure	0.4
Utility Cost Test	3.0

Additional benefits related to the reduction of societal benefits (such as greenhouse gas emissions) have not been quantified in the calculation of the TRC.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis.

04

Recommendations

Findings and Recommendations

FINDING #1

Deemed savings values are used for measures where custom calculations are more appropriate; the deemed savings values used often times do not match the 2019 AEP Ohio Appendix A documentation.

RECOMMENDATION #1

For prescriptive measures, require additional site information be collected to better inform the prescriptive deemed assumptions.

- Ensure a consistent reference is sourced when evaluating prescriptive measures, such as the 2019 AEP Ohio Appendix A documentation.
- Consider custom calculations for measures where deemed HOU are significantly different than actual HOU.

FINDING #2

Calculations incorporate baseline assumptions that are unrealistic or do not reflect previous baseline site operating conditions.

RECOMMENDATION #2

Incorporate a means of quality control (QC) specifically addressing the baseline equipment previously in place. Onsite verified projects should include a report that highlights all details of the baseline equipment specifications and operational schedule.

- Equipment capacity, load factor, operational hours of use, etc. should all be detailed accurately in order to adequately establish the baseline case for efficiency.
- Baseline system configurations should be accurately detailed in order to alleviate the need for baseline assumptions that would have large impacts on project savings.

FINDING #3

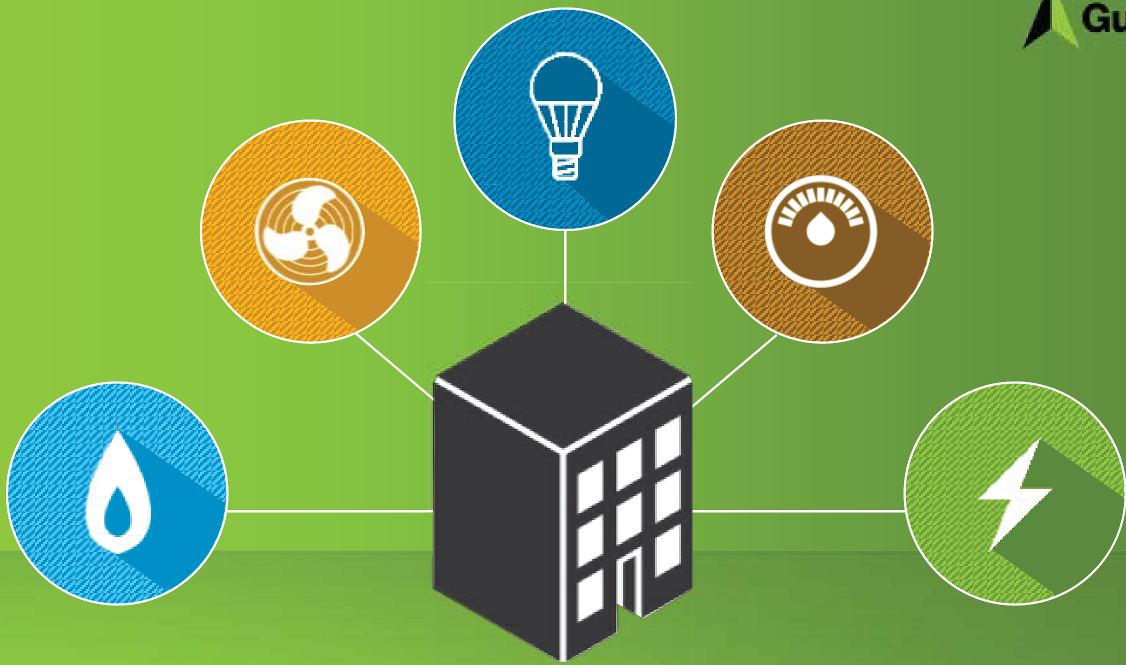
Calculations employ annual equipment operational schedules that are not reflective of site operations.

RECOMMENDATION #3

Incorporate a means of QC specifically for verifying equipment operational schedules.

- Measures where operational schedule differs from facility schedule, for example refrigeration measures that operate continuously vs. only when the facility is open.
- Measures that can not be verified, for example equipment installed in a restricted area, such as a hospital or automated manufacturing floor, should use a consistent deemed hours approach.

APPENDIX M



Non-Residential New Construction

2019 Impact Evaluation Report

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Content of Report

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January, 24 2020

Table of Contents

01
Introduction

Program Summary

The Non-Residential New Construction (NRNC) program offers financial incentives for the design, construction and installation of energy-efficient equipment and systems within new building and major renovation projects. 2019 is the ninth year the program has been active.

There are two tracks within the NRNC Program:

- The Whole Building Performance path relies on building energy modeling to estimate savings.
- Custom/Prescriptive, which includes projects focused on individual measures.
  - Prescriptive measures are evaluated similarly to the Prescriptive program.
  - Lighting savings are calculated using lighting power density (LPD) reductions relative to the Ohio Energy Code.
  - Custom measures are treated the same as in the Process Efficiency program and calculated on a measure-by-measure basis.
  - This path includes the My Solutions path, which was added in 2016 for office, retail, and restaurants under 70,000 square feet. This path assigns deemed savings to a variety of measures for small new construction projects.

https://www.aepohio.com/save/business/programs/NewConstructionProjects.aspx

Evaluation Objectives

The 2019 evaluation objectives include:

01 Quantify energy and summer coincident peak demand savings impacts at the meter from the program during 2019.

02 Sample enough projects to achieve a 90 percent evaluation confidence and +/- 10 percent precision for both the program energy and demand savings.

03 Determine program cost-effectiveness.

04 Determine key strengths and weaknesses in how the program calculates impacts and identify ways in which the program can be improved.

02 Methodology

Evaluation Methodology

Through a review of the tracking data, the evaluation team divided the completed projects into strata based on ex ante energy savings. Guidehouse selected a random sample from each stratum to be reviewed by the evaluation team, and evaluated projects at the premise level, meaning premises with multiple projects are aggregated for the purposes of sampling and evaluation.

Guidehouse conducted desk reviews on all sampled projects using methodologies prescribed in the implementer’s 2019 Workpapers with baselines documented in the appropriate code. Guidehouse reviewed modeled projects for model inputs in the code-minimum baseline and as-built models. Ohio updated its commercial building codes from ASHRAE 90.1-2007 to ASHRAE 90.1-2010 with amendments, effective January 1, 2017. Projects with permits dated prior to the transition are evaluated using ASHRAE 90.1-2007 as the baseline. Projects with permits dated after the transition are evaluated compared to ASHRAE 90.1-2010.

If uncertainties in the savings calculation existed, Guidehouse performed a site visit. Site visits inspected equipment specifications and quantities, verified hours of operation, collected energy management system data and/or metered systems where required, and answered any outstanding questions. The results of the verification of the sampled projects were applied to the population of projects to determine ex post savings.

Lighting projects are typically evaluated using the same methodology that was used in ex ante calculations. If the ex ante calculations use the Building Area Method, ex post verification also uses that method. If ex ante calculations use the Space-by-Space Method, then that is used.

Whole Building modeling projects are evaluated by comparing modeling parameters to as-built documentation. Building models are then run, and savings calculated based on model results. Exterior lighting savings are calculated separately from the models.

Evaluation Methodology

(continued)

Realization rates for each stratum are calculated using the following equation:

$$RR_i = \frac{\sum_{sampled} E_{ex\ post}}{\sum_{sampled} E_{ex\ ante}}$$

Where *E* = the electric energy savings or summer peak demand reduction for each project in the stratum and i refers to the stratum.

The stratum realization rate is then applied back to the project population of that stratum with the following equation:

$$E_{i,ex\ post} = RR_i * E_{i,ex\ ante}$$

Finally the program population savings are the sum of all stratum savings:

$$E_{population,\ ex\ post} = \sum_i E_{i,\ ex\ post}$$

Data Collection Activities

DATA COLLECTION TYPE	
Project File Review	**Onsite Verification**
Targeted Population	Targeted Population
Random sample of completed projects within each stratum.	**Projects with uncertainties or inconsistencies in ex ante savings calculations, ambiguities or conflicts in equipment details or hours of use, and a sample of projects with exceptionally high impacts on savings.**
1	2

Sample Design

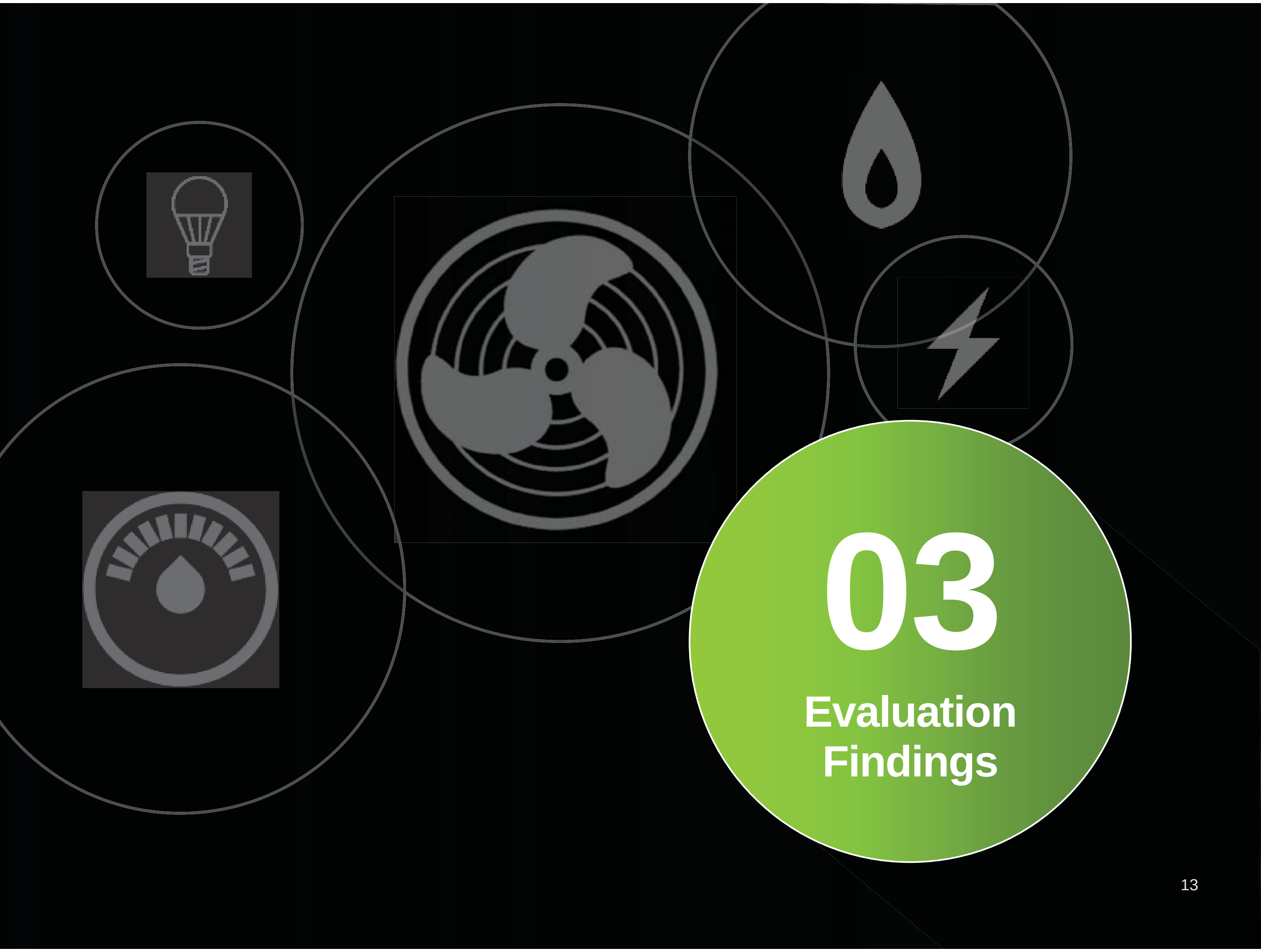
Guidehouse stratified tracked projects at the premise level and designed the sample to target 90 percent confidence and 10 percent precision for both energy and demand savings, resulting in the following sample.

Strata	Criteria	Population	Strata Weight by Energy[1]	Number of Desk Reviews	Number of Onsite Reviews[2]
Extra-Large	≥ 5 GWh/yr	1	16%	1	1
Whole Building Large	WB ≥ 500 MWh/yr	5[3]	18%	5[3]	1
Whole Building Small	WB < 500 MWh/yr	8[3]	5%	3[3]	0
Large	≥ 500 MWh/yr	7	28%	7	2
Small	< 500 MWh/yr ≥ 25 MWh/yr	105	33%	14	0
Very Small[4]	< 25 MWh/yr	39	1%	0	0
Total		**165**	**100%**	**29**	**4**
Percent of Ex Ante Savings				**68%**	**25%**

[1]Strata weight are rounded, resulting in a sum of rounded numbers that does not equal 100 percent.
[2]Onsite reviews are a subset of desk reviews.
[3] Two Whole Building (WB) Small Projects (NCR-17-00416 and NCR-19-00640) were actually one project split across two meters. For the purposes of evaluation, these two "WB Small" projects were recombined into one "WB Large" project.
[4] The "Very Small" strata includes nine design modeling incentive projects with zero savings and no premise ID. There was also an issue combining projects NCR-19-00812 and NCR-19-00813. These should have been combined into one premise but were not, resulting in one "Small Project" (812) and one "Very Small" project (813).

Sampling as a Percent of Tracked Savings

Source: AEP Ohio tracking data and Guidehouse evaluation analysis



03 Evaluation Findings

Savings Results – Program Level

The 2019 evaluation of AEP Ohio's NRNC program shows the program is operating well with realization rates at 0.95 for energy (kWh) and 0.95 for peak demand (kW). The program exceeded its energy savings goals by 16 percent and missed the peak demand savings goal by 26 percent.

	Program Goals[1] (a)	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings[2] (c)	Realization Rate (c / b)	% to Goal (c / a)	Relative Precision (at 90% Confidence)
Energy Savings (MWh)	28,773	35,292	33, 413	0.95	1.16	3.2%
Demand Savings (kW)	6,314	4,958.2	4,686.3	0.95	0.74	2.2%

[1] AEP Ohio Volume 1: 2017 TO 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016

[2] Evaluation of AEP Ohio tracking data from PY2019

Savings Results – By Path

The 2019 evaluation of AEP Ohio's NRNC program shows the Custom/Prescriptive and Whole Building program tracks are performing similarly, with energy realization rates near one.

Path		Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Custom/ Prescriptive	Energy Savings (MWh)	27,342	25,644	0.94
	Demand Savings (kW)	3,671	3,442	0.94
Whole Building	Energy Savings (MWh)	7,951	7,769	0.98
	Demand Savings (kW)	1,287	1,244	0.97
Totals	**Energy Savings (MWh)**	**35,292**	**33,413**	**0.95**
	Demand Savings (kW)	**4,958**	**4,686**	**0.95**

Rounding is included in these numbers, and explains any discrepancies in addition.

Energy Savings Results – Site Summary

The figure below is a graphical representation of the site level ex ante versus ex post energy savings. The diagonal line represents the goal of a realization rate of one. Points above and to the left of the realization rate = 1 line represent sites with energy realization rates above one, while those points below and to the right are sites with realization rates less than one.

The overall energy realization rate is 0.95. Site specific findings are discussed later in the report and are grouped based on the types of adjustments made. Overall, most adjustments increased ex post savings for some projects while decreasing ex post savings for others.

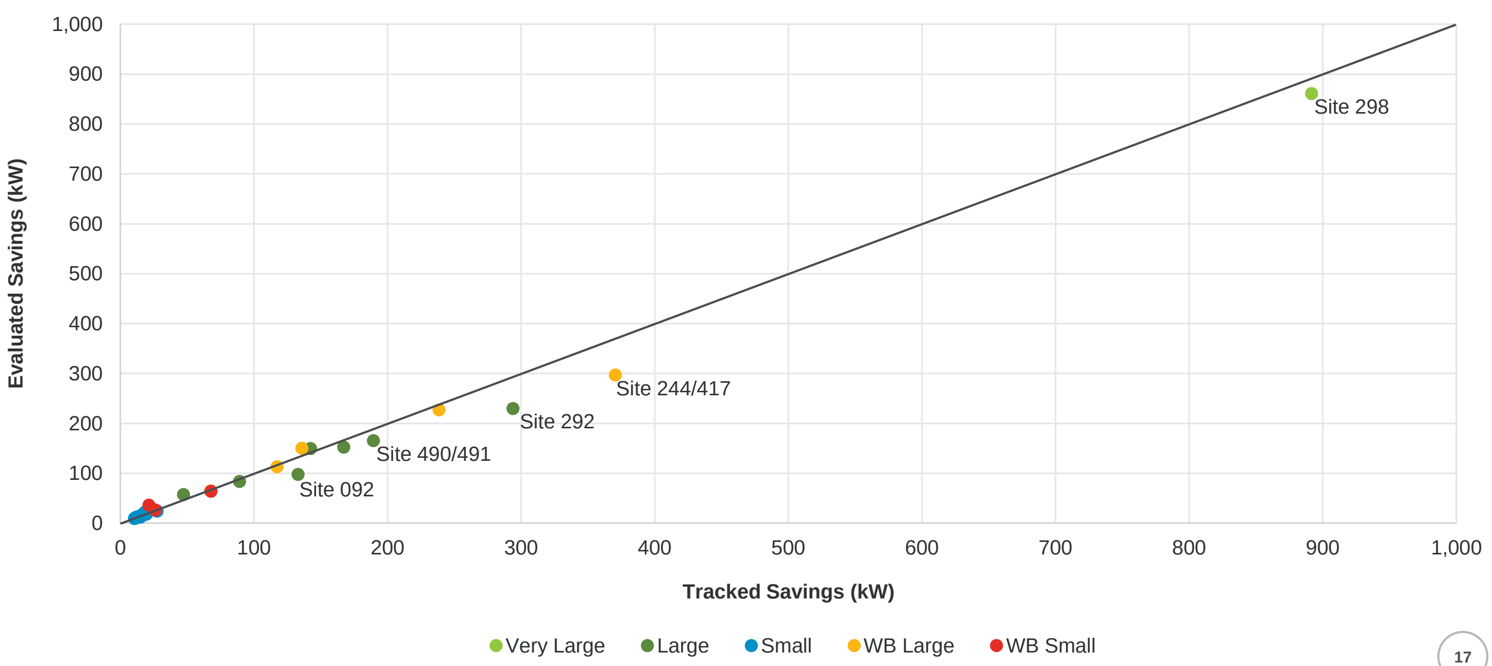
ENERGY SAVINGS RESULTS

Peak Demand Savings Results – Site Summary

This figure represents coincident peak demand savings, where again the diagonal line represents a realization rate of one.

The overall peak demand realization rate is 0.95.

DEMAND SAVINGS RESULTS



Major Realization Rate Drivers – ASHRAE “Zone”

Exterior LPD baseline allowances are defined in ASHRAE 90.1-2007 and ASHRAE 90.1-2010 based on the regional “Zone” of the new construction. Zones 0 and 1 relate to national and state parks. Zone 2 includes predominantly residential areas, neighborhood business districts and strip malls, and light industrial. Zone 4 includes high-activity commercial districts in major metropolitan areas. Zone 3 is a catch all for all other areas. Guidehouse applies Zones to projects individually as appropriate. The ex ante calculations instead average Zones 2 and 4, and applies these averages to all projects, resulting in major discrepancies for projects in all Zones except Zone 3.

Affected Projects:
292, 696, 606, 717, 547, 722, 610, 690, 442, 026

Project	Ex Ante Incremental Savings (kWh) (b)	Ex Post Incremental Savings (kWh) (c)	Realization Rate (kWh) (c / b)	Ex Ante Incremental Savings (kW) (d)	Ex Post Incremental Savings (kW) (e)	Realization Rate (kW) (e / d)
292	3,521,746	2,754,555	0.78	293.9	230.1	0.78
696	114,928	94,339	0.82	14.9	12.2	0.82
606	48,980	41,306	0.84	10.6	9.6	0.91
717	570,341	500,975	0.88	89.2	83.7	0.94
547	140,040	133,928	0.96	18.5	22.3	1.20
722	1,607,744	1,474,933	0.92	167.3	152.4	0.91
610	219,670	238,151	1.08	10.6	9.6	0.90
690	62,001	61,859	1.00	11.7	11.7	1.00
442	95,534	89,673	0.94	12.7	12.7	1.00
026	139,065	146,191	1.05	19.5	18.2	0.93

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Major Realization Rate Drivers – Occupancy Controls Savings

Ex ante calculations often do not account for additional savings resulting from optional occupancy sensors and do not account for the hours of use (HOU) reduction resulting from occupancy sensors required by code. They also do not account for the exterior “base site allowance.” These impacts resulted in increased energy savings realization rates.

Occupancy Sensors Affected Projects:
292, 709, 538/703, 812, 547, 722, 690, 026

Base Site Allowance Affected Projects:
292, 538/703, 696, 442, 026

Project	Ex Ante Incremental Savings (kWh) (b)	Ex Post Incremental Savings (kWh) (c)	Realization Rate (kWh) (c / b)	Ex Ante Incremental Savings (kW) (d)	Ex Post Incremental Savings (kW) (e)	Realization Rate (kW) (e / d)
292	3,521,746	2,754,555	0.78	293.9	230.1	0.78
709	725,406	953,715	1.31	142.4	149.5	1.05
538/703	92,655	130,233	1.41	16.3	16.8	1.03
812	47,870	43,248	0.90	13.9	12.5	0.90
547	140,040	133,928	0.96	18.5	22.3	1.20
722	1,607,744	1,474,933	0.92	167.3	152.4	0.91
690	62,001	61,859	1.00	11.7	11.7	1.00
026	139,065	146,191	1.05	19.5	18.2	0.93

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Major Realization Rate Drivers – Incorrect Baseline Code

Guidehouse found several whole building simulation projects where ex ante calculations used the wrong baseline code. As of January 1, 2017, the baseline code became ASHRAE 90.1-2010. All buildings with permit dates after January 1, 2017 should use 2010 as the baseline, and all permit dates prior to 2017 should use 2007. The most likely explanation is that design began well before the code change-over date, with the intent of permitting before January 1, but delays in the design process pushed the actual permit application date past the January 1 deadline, and the baselines were never updated. At least one project also used ASHRAE 90.1-2010 when ASHRAE 90.1-2007 was the appropriate code, resulting in increased savings.

The code changes most influential on savings are changes in LPD limits and HVAC efficiencies. Though there are a few exceptions, in general ASHRAE 90.1-2010 requires lower lighting power densities than 2007. HVAC efficiencies from ASHRAE 90.1-2010 are always greater than or equal to 2007. If a project claimed 2007 when 2010 was appropriate, evaluated savings would be lower, resulting in a realization rate less than 1. If a project claimed 2010 when 2007 was appropriate, savings and the realization rate would increase.

Affected Projects:
709, 244/417, 127, 472, 045

Project	Ex Ante Incremental Savings (kWh) (b)	Ex Post Incremental Savings (kWh) (c)	Realization Rate (kWh) (c / b)	Ex Ante Incremental Savings (kW) (d)	Ex Post Incremental Savings (kW) (e)	Realization Rate (kW) (e / d)
709	725,406	953,715	1.31	142.4	149.5	1.05
244/417	694,081	489,004	0.70	370.5	296.9	0.80
127	778,741	940,797	1.21	47.2	57.7	1.22
472	142,735	230,841	1.62	21.4	36.3	1.70
045	579,574	481,173	0.83	135.8	150.0	1.10

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Major Realization Rate Drivers – Qualifying for Controls Exemptions

ASHRAE 90.1-2007 and 90.1-2010 require automatic lighting controls in some interior space types. There are also exemptions for spaces intended for 24-hour operation, where patient care is rendered, or where automatic shutoff would endanger occupants. The types of spaces that require automatic controls varies between the 2007 and 2010 codes, but the exemptions do not. Guidehouse found several projects where the ex ante calculations inappropriately assigned exemptions to spaces that did not meet the requirements as defined by ASHRAE.

Affected Projects:
674, 442, 706, 730

Project	Ex Ante Incremental Savings (kWh) (b)	Ex Post Incremental Savings (kWh) (c)	Realization Rate (kWh) (c / b)	Ex Ante Incremental Savings (kW) (d)	Ex Post Incremental Savings (kW) (e)	Realization Rate (kW) (e / d)
674	174,524	106,029	0.61	27.5	24.1	0.88
442	95,534	89,673	0.94	12.7	12.7	1.00
706	118,491	111,620	0.94	16.6	15.6	0.94
730	57,182	53,553	0.94	11.3	10.6	0.94

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Major Realization Rate Drivers – Small Changes or Corrections to Parameters

Guidehouse noted and adjusted small errors or corrections to calculation parameters in several projects. Changes included the following items.

- Guidehouse updated the fixture quantities and/or fixture wattages for several projects (Sites 292, 092, 527, 722, 717, 696, 690, 026, 454).
- The workpapers and calculation tools allot different hours for CFLs and non-CFL lamps. Multiple projects applied CFL-specific HOU to LED lamps and fixtures (Site 674).

Project	Ex Ante Incremental Savings (kWh) (b)	Ex Post Incremental Savings (kWh) (c)	Realization Rate (kWh) (c / b)	Ex Ante Incremental Savings (kW) (d)	Ex Post Incremental Savings (kW) (e)	Realization Rate (kW) (e / d)
292	3,521,746	2,754,555	0.78	293.9	230.1	0.78
092	808,626	773,777	0.96	132.9	97.9	0.74
527	47,706	43,188	0.91	11.0	10.0	0.91
722	1,607,744	1,474,933	0.92	167.3	152.4	0.91
717	570,341	500,975	0.88	89.2	83.7	0.94
696	114,928	94,339	0.82	14.9	12.2	0.82
690	62,001	61,859	1.00	11.7	11.7	1.00
026	139,065	146,191	1.05	19.5	18.2	0.93
454	37,112	37,967	1.02	12.2	12.2	1.00
674	174,524	106,029	0.61	27.5	24.1	0.88

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Major Realization Rate Drivers – Small Changes or Corrections to Parameters

Guidehouse noted and adjusted small errors or corrections to calculation parameters in several projects. Changes included the following items.

- Some projects used incorrect parameters from the workpapers, including baseline EER or SEER values, EFLH, CF, or HOU (Sites 292, 538/703, 092, 547, 026).
- One modeling project did not update model characteristics to the most up-to-date as-built building characteristics. Guidehouse updated HVAC capacities and efficiencies to match those of installed equipment. (Site 292).
- One custom evaluation project used trend data for custom calculations. Guidehouse's evaluation took place several months after the ex ante calculations, allowing more complete updated trend data and deeper and/or better insight. (Site 298).

Project	Ex Ante Incremental Savings (kWh) (b)	Ex Post Incremental Savings (kWh) (c)	Realization Rate (kWh) (c / b)	Ex Ante Incremental Savings (kW) (d)	Ex Post Incremental Savings (kW) (e)	Realization Rate (kW) (e / d)
292	3,521,746	2,754,555	0.78	293.9	230.1	0.78
538/703	92,655	130,233	1.41	16.3	16.8	1.03
092	808,626	773,777	0.96	132.9	97.9	0.74
547	140,040	133,928	0.96	18.5	22.3	1.20
026	139,065	146,191	1.05	19.5	18.2	0.93
298	5,601,231	5,360,825	0.96	891.6	860.9	0.97

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Major Realization Rate Drivers – Manual Evaluation of Exterior LPD

Several projects used simulation software to calculate savings resulting from exterior LPD reductions. Modeling software does a notoriously poor job of estimating savings for exterior lighting. It also assigns peak demand savings to lights that are never on during summer peak periods. Guidehouse conducted manual LPD savings evaluations for all projects with exterior lighting, often resulting in significant changes to savings from exterior lighting projects, including changes to peak demand savings.

Affected Projects Include:
001, 244/417, 045, 523, 640/416

Project	Ex Ante Incremental Savings (kWh) (b)	Ex Post Incremental Savings (kWh) (c)	Realization Rate (kWh) (c / b)	Ex Ante Incremental Savings (kW) (d)	Ex Post Incremental Savings (kW) (e)	Realization Rate (kW) (e / d)
001	3,485,808	3,508,055	1.01	238.5	227.2	0.95
244/417	694,081	489,004	0.70	370.5	296.9	0.80
045	579,574	481,173	0.83	135.8	150.0	1.10
523	229,894	231,993	1.01	67.7	64.1	0.95
640/416	665,440	606,942	0.91	117.3	113.0	0.96

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Common Themes

Guidehouse found a number of discrepancies or realization rate drivers repeated across a number of different projects.

1. Exterior LPD baseline allowances are defined in ASHRAE 90.1-2007 and ASHRAE 90.1-2010 based on the regional “Zone” of the new construction. Zones 0 and 1 relate to national and state parks. Zone 2 includes predominantly residential areas, neighborhood business districts and strip malls, and light industrial. Zone 4 includes high-activity commercial districts in major metropolitan areas. Zone 3 is a catch all for all other areas. Guidehouse applies Zones to projects individually as appropriate. The ex ante calculations instead average Zones 2 and 4, and applies these averages to all projects, resulting in major discrepancies for projects in all Zones except Zone 3.
2. Ex ante calculations often do not account for additional savings resulting from occupancy sensors and never account for the exterior “base site allowance”. They also never account for the hours of use (HOU) reduction resulting from required occupancy sensors.
3. Guidehouse found several whole building simulation projects where ex ante calculations used the wrong baseline code. As of January 1, 2017, the baseline code became ASHRAE 90.1-2010. All buildings with permit dates after January 1, 2017 should use the 2010 code as the baseline, and all permit dates prior to 2017 should use the 2007 code. The most likely explanation is that design began well before the code change-over date, with the intent of permitting before January 1, 2017, but delays in the design process pushed the actual permit application date past the January 1 deadline, and the baselines were never updated.
4. ASHRAE 90.1-2007 and ASHRAE 90.1-2010 require automatic lighting controls in some interior space types. There are also exemptions for spaces intended for 24-hour operation, where patient care is rendered, or where automatic shutoff would endanger occupants. The types of spaces that require automatic controls varies between the 2007 and 2010 codes, but the exemptions do not. Guidehouse found several projects where the ex ante calculations inappropriately assigned exemptions to spaces that did not meet the requirements as defined by ASHRAE.

Expected Useful Life Review

Overall, the EULs for most measures were found to align well between ex ante and ex post, with an EUL realization rate of 0.97. Guidehouse used the implementer’s 2019 Workpapers for verification purposes, resulting in a slight adjustment from the ex ante kWh-weighted EUL of 15.1 to the ex post kWh-weighted EUL of 14.7.

The outstanding exception was the EUL for LPD as modeled using building simulation software (Whole Building projects). These projects calculated a weighted average EUL based on energy end use and the EULs of those measures. The worksheet uses EULs for each measure that often do not align with the workpapers, such as an EUL of 11 years for lighting while the workpapers prescribe an EUL of 15 years for lighting.

EUL REVIEW

Path	Ex Ante EUL (b)	Ex Post EUL (c)
Custom/ Prescriptive	15.7	14.7
Whole Building	13.2	14.8
Overall	15.1	14.7

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Incremental Measure Cost Review

Guidehouse used the incremental measure costs of measures provided by the implementer's 2019 workpapers whenever possible. When individual measures or their costs were not documented in the implementer's 2019 workpapers, such as LPD improvements, Guidehouse used the implementer's 2017 Workpapers, 2010 Ohio TRM, or other TRM documents.

The most common factor driving the ex post IMC down was lower energy realization rates on modeling projects where the IMC is directly related to the energy savings at $0.22 per kWh saved.

Other individual project drivers included:

1. Ex ante IMCs for the lighting controls in project 292 were nearly five times ex post evaluated IMCs. Ex ante calcs may have claimed IMCs for occupancy sensors required by code.
2. HVAC IMCs are typically $100 per ton per the workpapers. Ex ante IMCs for project 538/703 were over $800 per ton.

IMC REVIEW		
Path	**Ex Ante IMC (b)**	**Ex Post IMC (c)**
Custom/ Prescriptive	$6,430,130	$5,763,031
Whole Building	$1,749,350	$1,669,252
Overall	$8,179,480	$7,432,283

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Cost-Effectiveness Review

This section addresses the cost-effectiveness of the 2019 NRNC Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Average Measure Life	15
Premises	165
Unique Projects	173
Ex Post Annual Energy Savings (kWh)	33,413,160
Ex Post Coincident Peak Savings (kW)	4,686
Third Party Implementation Costs	$991,117
Utility Administration Costs	$713,495
Utility Incremental Incentive Costs	$2,122,998
Incremental Measure Costs	$7,432,283

Based on these inputs, the TRC ratio is 1.4 and the program passes the TRC test for the program in its entirety.

COST-EFFECTIVENESS RESULTS	
Benefit-Cost Ratio–Test Results	**Ratio**
Total Resource Cost	1.3
Participant Cost Test	3.7
Ratepayer Impact Measure	0.5
Utility Cost Test	4.0

Additional benefits related to the reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

04

Recommendations

Recommendations

Overall, Guidehouse found AEP Ohio's NRNC program to be accurately characterizing energy and demand impacts in aggregate. Guidehouse was pleased to see that the program had implemented previous recommendations, including:

- Project files delivered to Guidehouse were generally complete, and usually included the most up to date calculators and models.
- Exterior spaces were identified as "Exterior" instead of receiving the same building type as the site.

FINDING #1

Ex ante calculations average the baseline wattage allowances from ASHRAE Zones 2 and 4, and use these averages for all projects. This results in exterior realization rates around 0.75 for projects in Zone 2 and around 1.5 for projects in Zone 4.

RECOMMENDATION #1

Identify the appropriate Zone based on the project site's actual location, and use the wattage allowances for that specific zone.

FINDING #2

Ex ante calculations often do not account for additional savings resulting from occupancy sensors and never account for additional savings from the exterior "base site allowance". The calculations also never account for the hours of use (HOU) reduction resulting from required occupancy sensors.

RECOMMENDATION #2

Include separate columns to identify whether occupancy sensors are required for a space, whether they are installed, and use these columns to modify the hours of use for those spaces in baseline and efficient cases. This approach will correctly account for installed and required occupancy sensors and their effects on consumption.

FINDING #3

Guidehouse found several whole building simulation projects where ex ante calculations used the wrong baseline code. As of January 1, 2017, the baseline code became ASHRAE 90.1-2010. All buildings with permit dates after January 1, 2017 should use ASHRAE 90.1-2010 as the baseline, and all permit dates prior to 2017 should use the 2007 code.

RECOMMENDATION #3

Review permit application dates to identify the appropriate code-minimum for each building.

Recommendations (continued)

FINDING #4

Guidehouse found several projects where the ex ante calculations inappropriately assigned exemptions to spaces that did not meet the requirements as defined by ASHRAE.

RECOMMENDATION #4

Mandatory controls exemptions exist only for spaces intended for 24-hour operation, where patient care is rendered, or where automatic shutoff would endanger occupants. The types of spaces that require automatic controls varies between the 2007 and 2010 codes, but the exemptions do not. Only apply the automatic controls exemptions to spaces which meet at least one of the required criteria.

FINDING #5

Small errors were noted in at least ten of the sampled projects.

- Guidehouse updated the fixture quantities and/or fixture wattages for several projects.
- The workpapers and calculation tools allot different hours for CFLs and non-CFL lamps. Multiple projects applied CFL-specific HOU to LED lamps and fixtures.
- One modeling project did not update model characteristics to the most up-to-date operating parameters and as-built building characteristics.

RECOMMENDATION #5

Perform additional quality assurance or quality control on project details, including model operating parameters, as-built characteristics, equipment type, building type, space type, and hours of use. If DLC test data is available for a specific lamp or fixture, use those wattages instead of manufacturers' specifications.

FINDING #6

Several projects used simulation software to calculate savings resulting from exterior LPD reductions.

RECOMMENDATION #6

Modeling software does a notoriously poor job with exterior lighting savings. Exterior LPD Savings should be evaluated outside the model.

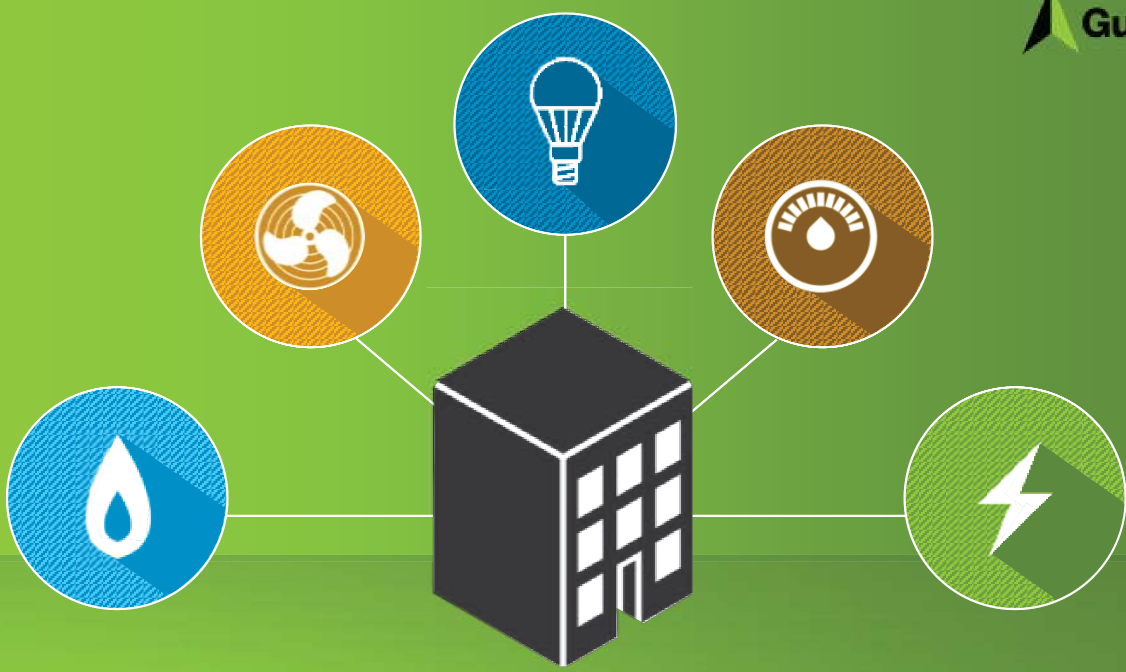
FINDING #7

The expected useful lives used in the ex ante analysis of Whole Building projects are outdated. For example, LPD resulting from a Whole Building simulation receives an EUL of 11 years, while LPD performed separately as its own measure receives an EUL of 15 years as documented in the workpapers.

RECOMMENDATION #7

Update the EULs in the Whole Building analysis worksheets to match those documented in the workpapers.

APPENDIX N



Express

2019 Impact Evaluation Report

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Content of Report

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January, 24 2020

Table of Contents

01 Introduction

Program Summary

The Express Program provides turnkey energy audits at no-cost with direct installation of energy efficiency measures at low cost for small and medium businesses excluding corporate owned national accounts.

Specifically, the Express Program includes:

- Lighting retrofit measures, including linear and other types of LED lamps and fixtures, occupancy sensors and lighting control measures, and refrigeration measures such as ECM motors, anti-sweat heater controls, and LED case lighting.
- A focus on small business customers that typically do not participate in other business program offerings due to various market barriers, including lack of capital, inadequate energy expertise, or insufficient personnel to explore energy efficiency options.
- Free audit by an Energy Service Representative (ESR), higher equipment incentives than other AEP Ohio business offerings, and a suite of services to streamline the customer experience.
- Integrated delivery of audit services, measure installation, and application handling. The program is managed by the implementation contractor in coordination with AEP Ohio.
- A maximum of 400,000 kWh annual usage, which was increased in 2019 from 200,000 kWh, to increase program savings by including larger businesses.

https://www.aepohio.com/save/business/programs/ExpressProgram.aspx

Evaluation Objectives

The 2019 impact evaluation objectives include:

01 Quantify energy and summer coincident peak demand savings impacts at the meter from the program during 2019.

02 Conduct billing analysis to identify problematic sites and understand reasons for discrepancy on these sites.

03 Determine program cost-effectiveness.

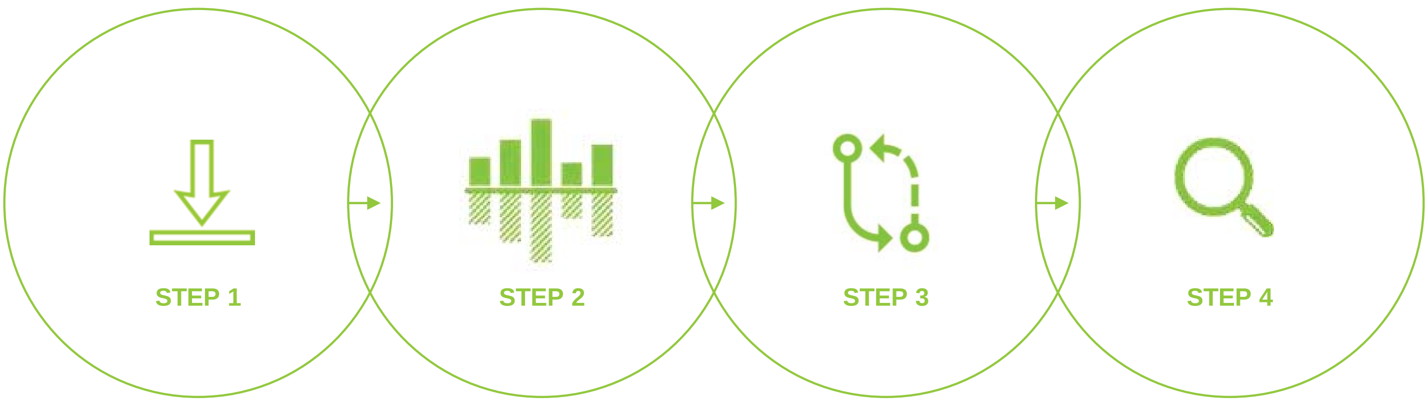
04 Determine key strengths and weaknesses in how the program calculates impacts and identify ways in which the program can be improved.

02

Methodology

Evaluation Methodology

AEP Ohio provided Guidehouse with the tracking and billing data for all participating Express customers. Guidehouse analyzed the various datasets using different methodologies. The evaluation process followed these steps.



STEP 1: Conduct preliminary billing analysis on Wave 1 and Wave 3 data and identify problematic sites with a very low or high Realization Rate (RR), increase in usage or minimal change in usage in the post period. Select a sample from these problematic sites for further onsite review.

STEP 2: Conduct onsite review of sample problematic sites identified in billing analysis and identify causes for unexpected usage patterns and unexpected realization rates (RR).

STEP 3: Conduct regression analysis with Wave 3 billing data of Express participants. Use a weather adjusted pre/post model to quantify actual savings accrued during the program year. Conduct desk reviews for demand savings calculation, and use verified wattage and quantities from onsite reviews to substitute values in desk reviews.

STEP 4: Use findings from onsite reviews to identify drivers of billing analysis RR. Use billing analysis results for energy savings RR, and desk review to determine demand savings RR.

Billing Analysis Methodology

Guidehouse conducted a billing analysis of all Express participants using a weather adjusted pre/post model. Weather data at the zip code level was used to conduct the analysis. The billing analysis results were used to calculate the program ex post energy savings.

The complete billing data for the Express program included 734 accounts covering 593 projects. After cleaning the data, Guidehouse ran the model on a total of 346 accounts.

BILLING ANALYSIS DISTRIBUTION		
Project data	**Population Acounts**	**Sample Accounts Evaluated**
Projects used in billing data	593	346
Percentage of population	100%	58.3%

The model specification is as follows:

$$ADU_t = \sum_{i=1}^{12} \beta_{1i} Month_{ti} + \beta_2 CDD_t^{55} + \beta_3 Post_t + \varepsilon_t$$

ADU_t- Is the average daily usage in kWh for the participant during bill month *t*

$Month_{ti}$- Equals 1 when *t* falls within month *i* and 0 otherwise (monthly fixed effect)

CDD_t^{55}- Is the number of degree-days above 55°F in bill month *t*

$Post_t$-Equals 1 when bill month *t* has a start date after the latest project completion date for the participant.

ε_t-Is a random disturbance term

β_{1-3}- Are parameters to be estimated

The Model Assumptions are:

- All variables correlated with usage are captured in the model.
- Weather effects corrected by introducing cooling degree day (CDD) term.
- The base temperature for CDD is 55°F.

In addition to the billing analysis (described in the next slide), Guidehouse also conducted a sensitivity analysis, by retaining a larger population of sites. In all variations, the RR varied between 0.71 to 0.73, demonstrating that the final RR is representative of the population.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Billing Analysis Methodology

The following data cleaning steps were followed to arrive at the 346 projects sample (bold highlighted row). Each monthly bill is referred to as an observation in the table below.

Data Filtering Stepo be	Number of Accounts	Number of Observations	Percent Change in Customer Count	Percent Change in Observation Count	Details of Data Cleaning Step
Raw data	734	17,419			Raw data contained data for incomplete projects that were not included in the analysis.
Remove accounts with no corresponding project data	593	15,227	0.00%	0.00%	
Remove exact duplicates	593	15,227	0.00%	0.00%	
Drop Observations with Bad Read Codes	593	14,879	0.00%	2.29%	Excludable read codes taken from previous analyses.
Flatten to one observation per month	593	14,372	0.00%	3.33%	Aggregate bills that end in the same month.
Remove Fewer Than Five Months of Post, Fewer than Eight Months of Pre	346	8,575	41.65%	38.07%	"Post" defined as bill start date after the latest project completion date. “Pre” defined as bill end date before any project initiation date.
Remove measure install window	**346**	**8190**	**0.00%**	**2.53%**	**This step removes the bills during measure installation. Guidehouse completed the billing analysis based on these 346 accounts.**
Remove New Accounts*	319	7,607	4.55%	3.83%	"New" account defined as not having a bill ending in January 2018.
Remove Customers With Unexplained Jumps*	238	5,692	13.6%	12.58%	"Jumps" are defined as 1.85 times or 0.5 times previous bill within the same period (pre/post), or three times difference between min and max bill within period. The list of bills identified with jumps were then manually reviewed by Guidehouse team to ensure they indeed showed jumps and should be flagged.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

*The last two data cleaning steps were only conducted for the exploratory sensitivity analysis and discussed later in this report.

Evaluation Methodology

Through the billing analysis, Guidehouse identified problematic sites with erratic RR values. A sample of these sites was selected for site inspection.

As part of the onsite analysis, Guidehouse reviewed hours of use (HOU), asked customers about overtime hours, increases or decreases in production, burn out quantities, and reviewed efficient wattages. Hours of use and coincidence factors (CF) were logged at thirteen of the sites.

Additionally, Guidehouse conducted a thorough review of the tracking data. This desk review result was used for calculating peak demand savings. The desk review was conducted to verify that:

- Engineering adjusted calculations align with the implementer’s assumptions.
- Inputs in the tracking data align with Guidehouse’ s onsite findings.

Realization rates for the billing analysis (energy) and desk reviews (peak demand) were calculated using the following equation:

$$RR = \frac{\sum_{population} E_{ex-post}}{\sum_{population} E_{ex-ante}}$$

Where *E* = the electric energy savings or peak demand reduction for each project

Data Collection Activities

DATA COLLECTION TYPE

1	2	3	4
Preliminary billing analysis for sample selection	**Site Surveys**	**Billing Analysis**	**Tracking Data Review**
Targeted Population **All program participants**	Targeted Population **Sample of sites with problematic billing analysis results**	Targeted Population **All program participants**	Targeted Population **All program participants**
Sample Frame **Wave 1 and Wave 3 tracking database**	Sample Frame **Billing analysis sample**	Sample Frame **Filtered population**	Sample Frame **Tracking Database**
Sample Size **Filtered population**	Sample Size **20**	Sample Size **346**	Sample Size **655**
Timing **Oct-2019 to March-2020**	Timing **Nov-2019 to Mar-2020**	Timing **Mar-2020**	Timing **Mar-2020**

Site Visits Sample Selection

Sites which yielded unexpected results in the billing analysis were inspected and a sample of 20 sites were selected for further onsite investigation, of which 18 were completed. The evaluation team found several sites showing unexpected trends in their billing data. The onsite sample was selected from sites demonstrating one or more of the following usage patterns:

- Increase in usage after enrolling in program, resulting in a negative RR.
- Minimal change in post period usage leading to a very low RR.
- RR similar to population RR of 0.71.
- Unexpected drop in usage yielding extremely high savings and a very high RR.

The table below shows the percentage of sites demonstrating irregular patterns within the billing analysis sample and the onsite sample selected.

Onsite Sample Selection

	Total in billing analysis	Negative RR	RR between 0 - 0.20	RR between 0.20 – 0.40	RR Between 0.40-0.70	RR Between 0.70-1.25	RR > 1.25	Not in billing Analysis
Billing analysis sample	346	28	31	80	45	90	72	247
	100%	8.09%	8.96%	23.12%	13.01%	26.01%	20.81%	-
Onsite Visit Sample	18	5	5	1	1	1	4	1

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

03 Evaluation Findings

Savings Results – Program Level

The 2019 evaluation of AEP Ohio's Express program shows a difference between the implementer's savings calculations and estimates from the billing analysis and tracking data review. Realization rates were calculated as 0.71 for energy savings (kWh) based on the billing analysis, and 0.93 for peak demand savings (kW) based on the tracking data review.

	Program Goals* (a)	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings** (c)	Realization Rate (c / b)	Percent of Goal (c / a)
Energy Savings (MWh)	14,691	12,262	8,692	0.71	59.2%
Demand Savings (kW)	4,034	2,483	2,309	0.93	57.2%

Additionally, Guidehouse found that 295 of the 346 sites in the billing analysis claimed greater than 30 percent savings compared to energy use. The savings were compared to the Express participants usage in 2018 prior to enrolling in the program. Guidehouse believes this level of savings per site is high for a direct install program which primarily includes LEDs and some refrigeration measures.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Sensitivity Analysis

Guidehouse conducted a sensitivity analysis using more stringent data cleaning steps to calculate impacts with different sets of data. Most customers removed in the sensitivity analysis were customers with sudden jumps or ramp up in their usage. Scenarios two and three show that dropping customers with jumps did not impact the program realization rate significantly.

Since all three scenarios yield similar RR results, Guidehouse decided to report the more inclusive scenario (scenario one).

Sensitivity Analysis					
Scenario	**Strata**	**Projects in analysis**	**Total Ex Ante Savings (kWh)**	**Realization Rate**	**Percent of Population used for Analysis**
1	Baseline billing analysis	346	7,030,857	0.71	58.3%
2	Baseline case + Drop customers with new accounts	319	6,555,857	0.73	53.7%
3	Baseline case + Drop customers with new accounts+ Drop customers flagged for jumps	236	5,267,486	0.71	40.1%

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Program Level

Guidehouse conducted a tracking data review to recalculate demand savings. The ex post demand savings included the following adjustments to tracking database values:

- All measures with no previous controls were assigned 0 savings.
- All exterior lamps were assigned coincident factor (CF) and savings of 0.
- All exit sign CF values were assigned as 1.
- Refrigeration savings were reported as provided in tracking database.
- The coincidence factor and interactive effects were verified with external sources.

Demand savings equation

$$Demand\ savings = [kW.base * (QTY.base - QTY.burnout) - kW.eff * QTY.eff] * CF * HVAC.kW$$

kW.Base- Base measure wattage
QTY.base - Base measure quantity
QTY.burnout - burnout quantity
kW.eff* - efficient measure wattage
QTY.eff* - efficient measure quantity
CF* - coincidence factor
HVAC.kW **- HVAC interactive effects

Additionally, the following verified values were used from site visits to replace ex ante values:

- Efficient wattage
- Efficient quantity
- Coincidence factor

Demand Savings Analysis				
Project Count	**Ex Ante Savings (kW) (a)**	**Ex Post Savings (kW) (b)**	**Realization Rate (b / a)**	**Percent of Population used for Analysis**
655	2,483	2,309	0.93	100%

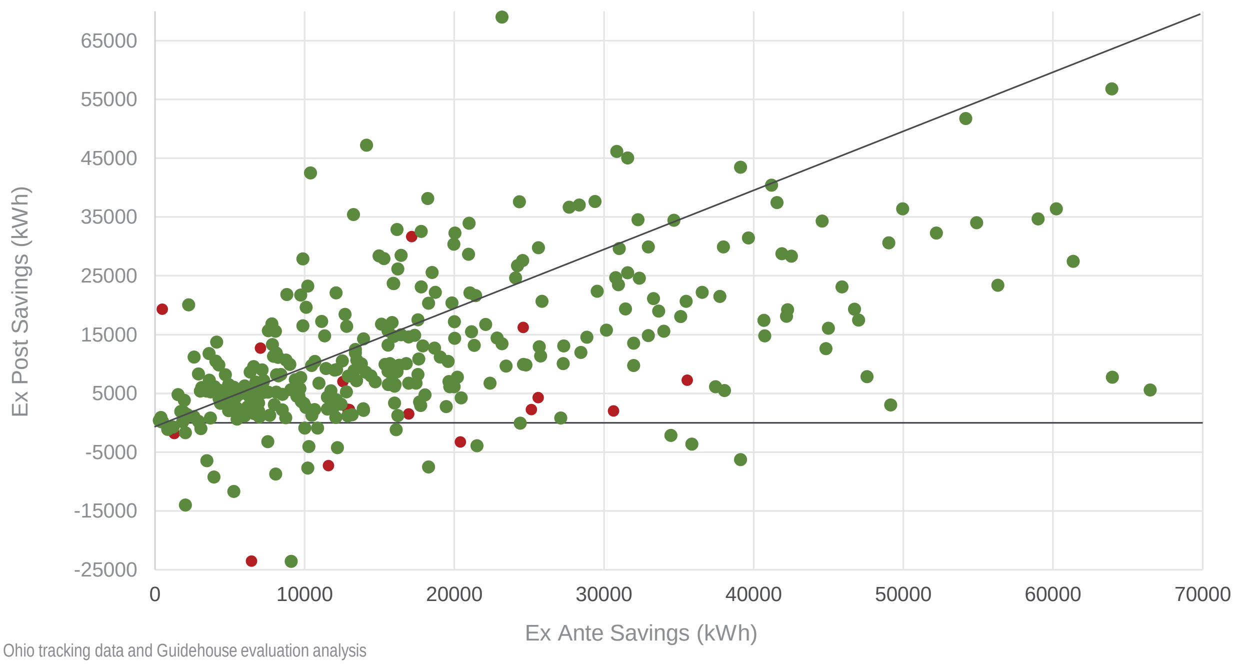
Source: AEP Ohio tracking data and Guidehouse evaluation analysis
*These parameters were replaced with onsite findings wherever available
** From the 2019 Appendix A Workpapers

Energy Savings Results – Billing Analysis

The figure below is a graphical representation of the site level ex ante versus ex post energy savings for the 346 accounts that were analyzed using billing data. The diagonal line represents the goal of a realization rate of one. Points above and to the left of the RR=1 line represent sites with energy realization rates above one, while those points below and to the right are sites with realization rates less than one. Sites below the horizontal line represent sites with negative RR.

The overall energy savings realization rate is 0.71. Sites that also received an onsite visit (colored in red) are discussed in the site-level details later in the report.

ENERGY SAVINGS RESULTS



Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Energy Savings Results – Onsite Analysis

The accounts selected for site visits were not part of a random sample and instead were selected based on billing analysis results to identify a range of sites primarily with unexpected RRs. Due to unexpected usage data, Guidehouse expected to find differential measure and business operational characteristics, many of which were in fact observed during site visits. These differences are in many cases drivers of the billing analysis RRs. However, onsite savings estimates do not necessarily align with billing analysis estimates for a variety of reasons, including:

- Hours of use changes between when the project was complete and the onsite visit took place
- Changes to facility use, including seasonal closures and different or expanded business operations
- Removal or addition of measures
- Excessive burnout lamps and fixtures in old equipment
- Differences in efficient wattage between reported and verified equipment

Because the onsite sample was not a random sample, it is important to note these discrepancies are not representative of the population and should not be used to generalize program performance; findings are presented to help understand the myriad issues common in the small business sector that can contribute to differences between ex ante and ex post savings estimates.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Sites with Negative RR

Sites with negative RR often showed sudden spikes in billing data, even after adjusting for CDD. Factors identified during site visits that contributed to increased usage after the project was completed include:

- More units found onsite than reported.
- Burned out lamps and fixtures replaced with functional measures.
- Increase in production and hours of use.
- Efficient measures not installed despite being provided through the program.

Site with Negative Realization Rates

Project ID	Ex Ante Savings kWh (a)	Ex Post Savings (Billing Analysis) kWh (b)	RR (Billing Analysis) (b / a)	RR (Site Visit)	Onsite Findings
AEP0092709.1	6,448	-23,517	-3.65	0.81	The owner was not aware of reasons for the increase in usage and Guidehouse was not able to verify the drivers for increase in usage onsite. Guidehouse however saw sudden spikes in usage during the cooling season in 2019, however the usage did not spike in 2018 around the same months. Hence the billing analysis picked up these usage jumps to yield a negative RR.
AEP0136614.1	1,291	-1,825	-1.41	0.33	This lighting site had 11 lamps while only four were reported in the tracking database. These lamps were either added after the program or replaced burned out measures which were not captured in the tracking database, driving up usage compared to the pre period. Additionally the verified efficient wattage was slightly higher than database wattage (6.09) vs (5.5), further driving down savings. The onsite HOU were significantly lower than in the database (4036 vs. 6376). The combined effects resulted in negative billing analysis RR, and low onsite RR.
AEP0130878.1	11,592	-7,281	-0.63	0.74	No specific reason found onsite and site manager only mentioned bills increased during as cooling equipment was used extensively during cooling months. Measure quantity, wattage and HOU were all reasonable and aligned with tracking data.
AEP0063561.1	20,404	-3,257	-0.16	0.47	This site had increased production, and therefore increasing electric usage. Despite that, logged HOU recorded in winter months was 70 percent of database HOU. Additionally, 11 out of 30 lights that were provided through the program had not been installed and the facility was functioning with old measures.
AEP0104029.2	2,944	-63	-0.02	1.13	Onsite evaluation found 10 lights replaced instead of seven, leading to higher usage than recorded in tracking data base. Ballasts were not verified since lights were installed in food prep areas and not easily verified.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Sites with RR between 0 – 0.20 RR

Sites with minimal change in usage had similar trends driving down their savings. Reasons for low RR were identified as:

- Low HOU as compared to database.
- Fewer verified measure than reported, in some cases efficient measures were not yet installed.
- Burnt out measures were replaced with efficient measures.

Sites with Minimal Change in Usage					
Project ID	**Ex Ante Savings kWh (a)**	**Ex Post Savings (Billing Analysis) kWh (b)**	**RR (Billing Analysis) (b / a)**	**RR (Site Visit)**	**Onsite Findings**
AEP0124736.1	30,637	2,043	0.07	1.42	Fewer lights found onsite in comparison to database (82 vs. 86) and the efficient lamps onsite had lower wattage than reported. (40.8 vs. 42.0) The HOU was higher than reported (5380 vs. 3413). The higher HOU values led to a high RR in onsite analysis, however the savings in comparison to 2018 usage were minimal.
AEP0005456.1	25,145	2,246	0.09	0.62	The HOU were much lower than ex ante (2039 ex post vs. 2784 ex ante). Additionally, 74 bulbs were verified onsite in comparison to 76 reported. These two factors combined to reduce savings, leading to a low RR.
AEP0044456.1	25,612	4,284	0.17	1.21	This refrigeration site has cooler lights that were always on, driving up usage. More measures were verified onsite, which possibly replaced burnt out measures, hence supressing savings (17 ex post vs. 2 ex ante).
AEP0041941.1	13,000	2,267	0.17	0.86	This site saw 49 baseline fixtures in pre period replaced with 60 efficient fixtures (during site visit), which resulted in more usage and less savings than expected. Logged HOU were varied, but overall lower than ex ante HOU when weighted by connected wattage (2653 vs. 3066), which further reduced savings and RR.
AEP0069581.2	12,879	2,319	0.18	2.49	Site visit found that several exterior burnt out lights were replaced with new LEDs. Additionally there were still CFL lamps onsite which had not been replaced. It was unclear if the CFLs were added after program audit and measure installation. Measure quantity onsite was higher than reported in tracking data (101 vs. 100). These factors led to lower savings than expected and hence low RR in billing analysis. The HOU was higher than reported (6096 vs. 5193). Some measures also had negative savings in the tracking database, the reasons for which are unclear. Onsite RR was very high due to these factors.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Sites with RR between 0.20 – 0.40 RR

One site with a small change in usage was selected for a site visit. Reasons for low RR were identified as:

- More measures added onsite after program installation
- Efficient measures replacing burned out measures.
- Low HOU as compared to database
- Higher efficiency than reported

Sites with RR between 0.20 – 0.40

Project ID	Ex Ante Savings kWh (a)	Ex Post Savings (Billing Analysis) kWh (b)	RR (Billing Analysis) (b / a)	RR (Site Visit)	Onsite Findings
AEP0052125.1	35,569	7,270	0.20	1.40	This site had higher verified quantity than reported (145 ex post vs. 101 ex ante), lower wattage (13.6 ex post vs. 23.3 ex ante) and lower HOU (4,099 ex post vs. 5,163 ex ante). The higher quantity onsite was likely because burned out lamps were replaced with efficient measures. Alternately, new lamps could have been added onsite after program audit. Either way, this would reduce savings in billing analysis. The lower efficient lamp wattage resulted in high onsite RR.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Sites with RR between 0.40 – 0.70 RR

One site (consisting of two projects) with slightly below average RR was selected for a site visit. The range 0.40 – 0.70 is representative of the population RR in 2018 and 2019 billing analysis. Reasons for low RR for these were identified as:

- Low HOU
- Higher verified quantity onsite

Sites with RR between 0.40 – 0.70

Project ID	Ex Ante Savings kWh (a)	Ex Post Savings (Billing Analysis) kWh (b)	RR (Billing Analysis) (b / a)	RR (Site Visit)	Onsite Findings
AEP0055671.2; AEP0055671.3	24,614	16,213	0.66	1.02	This was a refrigeration site with one anti-sweat heater control and one LED refrigerated case lighting measure. Five LED case light measures were found onsite, however. Additionally, HOU for this project was 76 percent of reported, driving down savings. Quantity and efficient wattage for this project were verified to match tracking database. The logged HOU for lighting measures were lower than the ex ante HOU (4,900 ex post vs. 6,376 ex ante) with an RR of 77 percent, impacting the energy savings RR.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Sites with RR between 0.70 – 1.25 RR

Sites with RR in the range 0.70 -1.25 were selected for onsite. Reasons for the RR for these were identified as:

- High HOU
- Verified measures had lower wattage than reported
- More measures were found onsite

Sites with RR between 0.70 -1.25

Project ID	Ex Ante Savings kWh (a)	Ex Post Savings (Billing Analysis) kWh (b)	RR (Billing Analysis) (b / a)	RR (Site Visit)	Onsite Findings
AEP0067936.1; AEP0067936.2; AEP0067936.3	5,054	5,281	1.05	1.26	This particular site had three associated projects. The verified quantities for the three projects combined were higher than reported. Logged HOU for the three projects combined were greater than reported HOU and the efficient wattages were lower than reported. All three factors combined led to a RR greater than one. The third project saw all three findings; verified measures were (75 ex post vs. 55 ex ante), lower efficient wattage (47 ex post vs. 48 ex ante) and higher verified HOU (4,342 ex post vs. 3,406 ex ante).

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Sites with RR > 1.25

Sites with high savings and RR showed similar trends in billing data. Drivers for high realization rates were:

- Businesses closed seasonally or permanently, driving a sudden decrease in usage and increase in savings in billing analysis
- More retrofitted measures (not replacing burnt out measures) onsite compared to reported measures.
- In some cases, the business changed, and it was not possible to verify the cause for high savings
- High HOU

Sites with High RR

Project ID	Ex Ante Savings kWh (a)	Ex Post Savings (Billing Analysis) kWh (b)	RR (Billing Analysis) (b / a)	RR (Site Visit)	Onsite Findings
AEP0049188.1	7,050	12, 717	1.80	0	This site was shut for the season, leading to a sudden drop in usage in the billing analysis and high RR. The measures could not be verified onsite due to closure.
AEP0076869.1	17,163	31,679	1.85	0.93	Found more fixtures replaced than reported in tracking data (47 ex post vs. 45 ex ante) and the site also had higher HOU than database value (3,806 vs. 3,463). 33 fixtures listed as 4-lamp fixtures were found to be 3-lamp fixtures on site, reducing usage and driving up savings.
AEP0064588.2	15,289	137,010	8.96	0	Site has permanently shut down, but billing data was provided through the end of the year. Billing data shows sudden drop in usage which incorrectly shows up as very high savings.
AEP0020224.3	486	19,345	39.8	0	Site visit found different measures installed than expected. The project listed one six-lamp T5 fixture replaced by a 178W LED fixture. However, on site, the engineer found 48 4-Lamp fixtures had been replaced with LED fixtures. On further inspection, it was found that the business had changed.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Common Themes

Guidehouse found a number of discrepancies or realization rate drivers across a number of different projects. The site visits helped identify these realization rate drivers to help explain the results of the billing analysis and provide more actionable recommendations for program improvement.

1. Ex ante calculations often overestimate HOU based on lighting logger data and interviews from site visits. The hours of use RR for all lighting measures reviewed during onsite visits was found to be 0.71 (Guidehouse notes that the onsite sample results are not statistically representative of the population, however).
2. Ex ante calculations account for some burnouts (1.46 percent of the total reported base quantities), but Guidehouse found additional non-functional baseline lamps that were replaced with efficient lamps driving an increase in usage and lower savings in the billing analysis.
3. Some measure quantities may have been incorrectly noted; in most cases more measures were found onsite than reported, but it was unclear whether additional measures were installed after project completion or if there was a discrepancy in the tracking data. In one case, efficient measures provided through the program had not been installed at the time of site visits.
4. Verified onsite savings calculations do not allocate savings to additional measures (greater verified quantities than reported) found onsite. Such measures are picked up in the billing analysis leading to an increase in usage and potentially lower RR, however. Similarly, operational changes such as increases in production, overtime hours, or additional electric load lead to increased usage and lower RR. Conversely, the onsite analysis yields greater savings for such sites due to increased HOU.
5. Guidehouse found the reported EULs were reasonable in most cases. The ex ante EULs were reported between 8.5 – 20; ex post EUL for LEDs was calculated using a value of 13 years.

EUL and IMC Results

This section addresses verification of the effective useful life (EUL) and incremental measure cost (IMC) for the 2019 Express Program. When individual costs or lifetimes were not documented in the tracking data or documents sent over by AEP Ohio, Guidehouse applied AEP Ohio values or other TRM documents values as appropriate.

Guidehouse found the ex ante EULs to be reasonable in most cases. The ex post EUL for LEDs was calculated using a value of 13 years.

EUL REVIEW

	Ex Ante EUL	Ex Post EUL
Effective Useful Life	13.6	12.9

The IMC is reported as the total project cost reported in the tracking database for projects that were completed in 2019.

IMC REVIEW

Item	Ex Ante IMC	Ex Post IMC
Incremental Measure Cost	$2,055,693	$2,055,693

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Cost-Effectiveness Review

This section addresses the cost-effectiveness of the 2019 Express Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Average Measure Life	12.9
Projects	655
Ex Post Annual Energy Savings (kWh)	8,692,345
Ex Post Coincident Peak Savings (kW)	2,309
Utility Incentive Costs	$3,002,840
Utility Administration Costs	$699,407
Total incremental Project Cost	$2,055,693

Based on these inputs, the TRC ratio is 0.7 and the program fails the TRC test for the program in its entirety.

COST-EFFECTIVENESS RESULTS	
Benefit-Cost Ratio–Test Results	**Ratio**
Total Resource Cost	0.7
Participant Cost Test	4.9
Ratepayer Impact Measure	0.4
Utility Cost Test	1.0

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

04

Recommendations

Recommendations

Overall, Guidehouse found AEP Ohio's Express program successfully included larger businesses in 2019, and the program energy savings RR was 0.71.

FINDING #1

Guidehouse estimated an energy RR of 0.71 based on a billing analysis of 346 sites. 127 accounts from the final billing analysis sample (36.7%) claimed greater than 30 percent savings in 2019; this savings rate is high for a direct install program which primarily includes LEDs and some refrigeration measures.

RECOMMENDATION #1

Review and update assumptions for ex ante savings calculations, including base wattage, efficient wattage, fixture type, burnout rate and hours of use. Document all changes in assumptions in project and tracking data to Guidehouse for review.

FINDING #2

Guidehouse found several instances of post-project business changes and shut downs which impacted ex-post savings results from the billing analysis. These changes included:

- 29 sites from billing analysis sample where businesses changed partway through the year (based on analysis of billing data); one site visit found a new business that had removed all of the project measures.
- Two sites where businesses were either shut down or closed seasonally (based on onsite visits).

RECOMMENDATION #2

Guidehouse acknowledges that post-project business changes and shut downs are somewhat out of the direct control of the implementation team. They nonetheless can affect ex post savings. Consider adjusting ex ante savings based on post-installation audits findings or a review of business status after project completion.

Recommendations

FINDING #3

Hours of use were found to be overstated. Based on site visits, Guidehouse found the weighted hours of use RR (through logging and interviews) to be 0.71, which directly impacts ex post savings and energy savings RR.

The coincidence factor (CF) is slightly overstated in the tracking database. Site visit verifications yielded a CF RR value of 0.98 which impacts the demand savings RR.

RECOMMENDATION #3

Continue to refine auditors' HOU estimates for specific hours of use for various areas where fixtures are installed (for example, different hours of use for office vs. kitchen vs. restroom). Guidehouse recommends the implementer use lighting loggers to measure HOU for a subset of projects.

FINDING #4

Guidehouse believes the implementer is not capturing the complete burnout rates. While the tracking data records a 1.46 percent burnout rate, Guidehouse believes this number is much higher. During site visits, it was found that several burnt out lamps were replaced, however this was not recorded or accounted for in the tracking database or ex ante calculations.

RECOMMENDATION #4

Implement additional quality assurance during the initial audit to track burnouts. The program should maintain a complete count of the number of efficient measures that are used to replace non-functional measures, removed measures, and new measures that are added.

FINDING #5

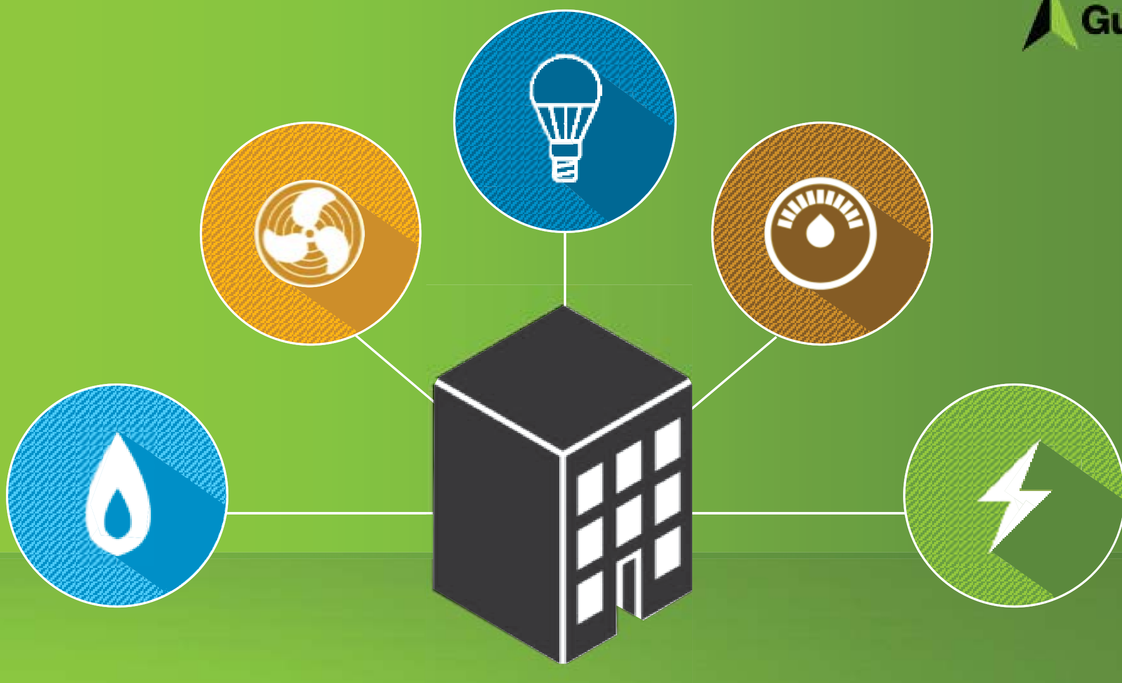
The onsite verification found that overall some of the savings parameters were different than the tracking data indicated:

- Efficient wattage RR of 0.97, indicating the implementer may be reporting higher efficient wattages than found onsite.
- The efficient quantity RR of 1.03, indicating site visits recorded more measures than what was reported in the tracking database.

RECOMMENDATION #5

Ensure that quality controls measures after the initial installation are in place to ensure all measures in the project scope are installed. Interview site managers as needed and document post installation audit information in the project and tracking data.

APPENDIX O



Data Center

2019 Impact Evaluation Report

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April 10, 2020

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Content of Report

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April 10, 2020

Table of Contents

01

Introduction

Program Summary

AEP Ohio’s Data Center Program supports customer efforts to achieve higher levels of energy efficiency in facilities with data centers. The program is designed to overcome customer barriers to implementing energy efficiency improvements through technical assistance and incentives based on a project’s annual energy savings.

Any AEP Ohio business customer operating a data center is eligible to apply for technical assistance and incentives through the program. Program incentive applications must be submitted within six months of project completion. The program is delivered by an implementation contractor on behalf of AEP Ohio. The 2019 program year represents the seventh year of operation for the Data Center Program.

Source: https://www.aepohio.com/save/business/programs/DataCenterProgram.aspx

Evaluation Objectives

The 2019 impact evaluation objectives include:

01 Quantify energy and peak demand savings impacts at the meter from the program during 2019.

02 Sample enough projects to achieve a 90% evaluation confidence and a +/-10% precision for both the program energy and demand savings.

03 Determine program cost-effectiveness.

04 Determine key program strengths and weaknesses and identify ways in which the program can be improved.

02

Methodology

Evaluation Methodology

Program impacts for the 2019 Data Center Program were evaluated in terms of electric energy and peak demand savings. Through a review of the tracking data, the evaluation team divided the completed projects into strata based on ex ante energy savings. A random sample was selected from each stratum to be reviewed by the evaluation team, with the intention of achieving 90 percent confidence and a +/-10 percent relative precision for both the program energy and peak demand savings.

The ex post energy and peak demand savings of the sampled projects were determined by engineering review of the project files, engineering review of the ex ante savings analysis, in-depth review of the building energy models and/or site verification of the installed components of the energy efficiency measures designed for the subject buildings. Peak demand savings are determined by engineering analysis of the savings potential during the peak period.

Desk reviews were conducted on all sampled projects using industry-standard engineering approaches. If uncertainties in the savings calculation existed, a site visit was conducted. Site visits inspected equipment specifications and quantities, collected energy management system data and/or metered systems where required, and answered any outstanding questions. The results of the verification of the sampled projects were statistically applied to the entire population of projects to determine ex post savings.

Evaluation Methodology

(continued)

Realization rates for each stratum are calculated using the following equation:

$$RR_i = \frac{\sum_{sampled} E_{ex\ post}}{\sum_{sampled} E_{ex\ ante}}$$

Where *E* = the electric energy savings or summer peak demand reduction for each project in the stratum and i refers to the stratum.

The stratum realization rate is then applied back to the project population of that stratum with the following equation:

$$E_{i,ex\ post} = RR_i * E_{i,ex\ ante}$$

Finally the program population savings are the sum of all stratum savings:

$$E_{population,\ ex\ post} = \sum_i E_{i,\ ex\ post}$$

Data Collection Activities

DATA COLLECTION TYPE

Project File Review	Onsite Verification
Targeted Population	Targeted Population
Random sample of completed projects within each stratum	**Projects with uncertainties or inconsistencies in ex ante savings calculations, ambiguities or conflicts in energy efficiency measure details or existing systems, and a sample of projects with exceptionally high impacts on savings**
1	2

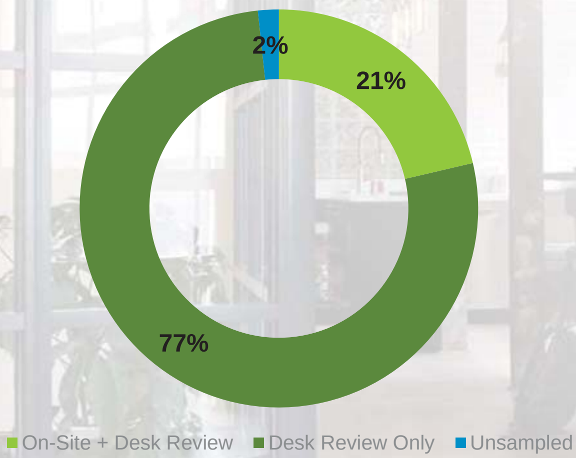
Sample Design

Guidehouse stratified the program population at the project level and designed the sample to target 90% confidence and 10% relative precision for both energy and peak demand savings, resulting in the following sample.

For some customers, the program implemented multiple phases of new construction projects, each of which could contain two or three identical projects. Guidehouse randomly sampled one project of each phase for further verification and applied the realization rate of that project to other identical projects in the same phase.

Guidehouse completed an engineering desk review for projects accounting for 98 percent of the claimed energy savings. Projects accounting for 21 percent of the claimed energy savings also had an onsite review.

Sampling as a Percent of Tracked Energy Savings



Strata	Criteria	Population	Strata Weight by Energy	Number of Desk Reviews	Number of Onsite Reviews[1]
New Construction Large	≥ 3,000 MWh/yr	4	54%	4	1
New Construction Small	< 3,000 MWh/yr	7	37%	7	1
Large	≥ 500 MWh/yr	1	5%	1	0
Small	< 500 MWh/yr	6	3%	2	1
Total		**18**	**100%**	**14**	**3**
Percent of Ex Ante Savings				**98%**	**21%**

[1]Onsite reviews are a subset of desk reviews.
Source: AEP Ohio tracking data and Guidehouse evaluation analysis

03

Evaluation Findings

Savings Results – Program Level

In 2019 the verified energy and peak demand savings are 26.6 GWh and 3.45 MW, respectively. The realization rate for energy savings is 1.01 and 1.10 for peak demand savings. The verified program savings significantly exceeded the 2019 targets of 14.3 GWh energy savings and 1.27 MW peak demand savings.

	Program Goals[1] (a)	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings[2] (c)	Realization Rate (c / b)	% to Goal (c / a)	Relative Precision (at 90% Confidence)
Energy Savings (MWh)	14,252	26,426	26,612	1.01	1.87	2.00%
Peak Demand Savings (kW)	1,272	3,142	3,447	1.10	2.71	3.46%

The primary driver of the energy realization rate are the phase 4-1 and 4-2 projects in the New Construction strata, with realization rates higher than unity due to Guidehouse including more data than was available when the project closed and subtracting ex post savings from previous phases as opposed to the implementer subtracting ex ante savings from previous phases. The phase 4-1 and 4-2 projects here, refer to the projects implemented in 2019 for three identical new data centers that are being built and loaded in phases, with phase one completed in 2016.

Regarding peak demand savings, the primary factor driving the program level realization rate was the same New Construction strata projects. The implementer incorrectly subtracted higher claimed peak demand savings for one of the phase three projects in the New Construction Large strata. Guidehouse subtracted the actual claimed peak demand savings resulting in higher verified peak demand savings for this project.

[1] AEP Ohio Volume 1: 2017 TO 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016

[2] AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – By Strata

The realization rates for all four strata are close to one for energy savings. The New Construction Large strata has a realization rate greater than one due to higher savings verified for the two phase 4-1 projects. The New Construction Small strata has a realization rate slightly lower than one due to lower savings verified for the one phase 4-2 project in this strata.

Path		Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
New Construction Large	Energy Savings (MWh)	14,370	14,676	1.02
	Demand Savings (kW)	1,563	1,887	1.21
New Construction Small	Energy Savings (MWh)	9,891	9,785	0.99
	Demand Savings (kW)	1,299	1,283	0.99
Large	Energy Savings (MWh)	1,431	1,453	1.02
	Demand Savings (kW)	162	164	1.02
Small	Energy Savings (MWh)	734	699	0.95
	Demand Savings (kW)	118	113	0.96
Totals	**Energy Savings (MWh)**	**26,426**	**26,612**	**1.01**
	Demand Savings (kW)	**3,142**	**3,447**	**1.10**

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Energy Savings Results – Project Summary

The figure below is a graphical representation of the project level ex ante versus ex post energy savings for all sampled projects. The diagonal line represents a realization rate of one. Points above and to the left of the line represent projects with energy realization rates above one, while those points below and to the right are projects with realization rates less than one. The further a point is away from the diagonal line, the greater the difference between verified savings and tracked savings.

The overall program energy realization rate is 1.01. Projects with relatively higher or lower realization rates are discussed in the project-level details later in the report.

ENERGY SAVINGS RESULTS

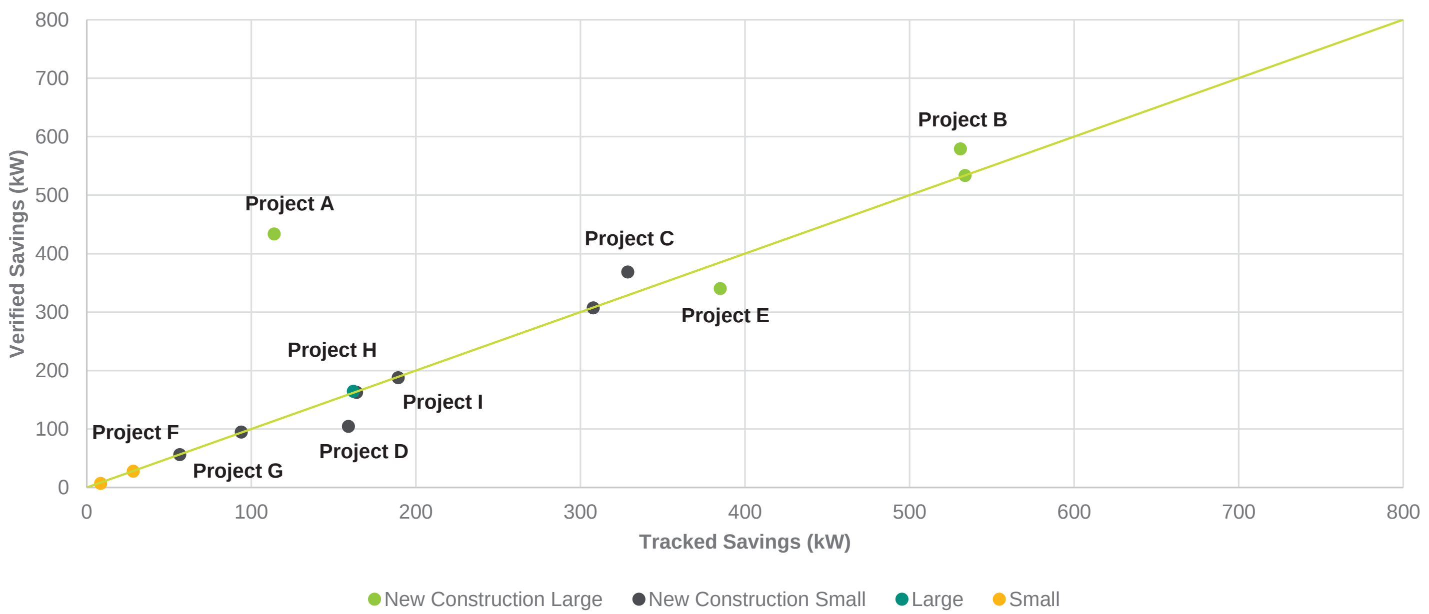
Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Peak Demand Savings Results – Project Summary

This figure represents peak demand savings, where again the diagonal line represents a realization rate of one.

The overall program peak demand realization rate is 1.10. Projects with relatively higher or lower realization rates are discussed in the project-level details later in the report.

DEMAND SAVINGS RESULTS



Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Project Level

Projects A, B, and C

Project and Measure Description

The Projects A, B, and C represent the phase 4-1 of the three new data center projects for the same customer implemented at different facilities and are being built and loaded in phases, with phase 1 of these projects completed in 2016. The savings from phase 4-1 of these projects were evaluated in 2019.

These new construction data center projects incorporate several advanced energy efficiency measures to lower the Power Usage Effectiveness (PUE) and cooling energy required. The same system is used to support the Uninterruptible Power Supply (UPS) electrical rooms. Savings are also claimed for the new UPS units. Ex ante calculations compare measured actual performance to the baseline given by the 2013 California (CA) Baseline[1] document for new data centers. The implementation contractor provided a detailed analysis model to calculate savings.

Comments on Ex Ante Calculations

Overall, the implementation contractor's analysis of the three phase 4-1 projects was accurate with respect to the data available at the time the project was completed. Guidehouse made several adjustments in the ex post calculations, summarized below.

Guidehouse Adjustments

Guidehouse collected more operational data and verified slightly higher IT load, which affected both the baseline and actual energy profiles.

[1] Even though the new construction baseline has been updated, it was decided to "grandfather" the baseline in 2018 since equipment has been purchased before the baseline shift. This will be the last year of grandfathering the old baseline.

Savings Results – Project Level

Projects A, B, and C

(continued)

The 2019 ex ante phase 4-1 energy and demand savings subtracted the 2018 phase three, 2017 phase two and 2016 phase one ex ante savings. The 2019 ex post phase 4-1 energy and demand savings subtracted the 2018 phase three, 2017 phase two and 2016 phase one ex post savings. This led to slightly higher ex post savings as compared to the ex ante savings. Overall, the slightly higher IT load had a much larger effect resulting in increased project-level savings for both energy and demand.

The three phase 4-1 projects in 2019 have higher realization rates than one, which are 1.10, 1.07, and 1.10 for energy. The realization rates for peak demand are 3.81, 1.09, and 1.12, for the three projects respectively. The reason why one project has a realization rate of 3.81 for peak demand is that the ex ante calculation mistakenly entered higher 2018 phase three peak demand savings. This error resulted in lower claimed demand savings for phase 4-1. Guidehouse subtracted the actual verified phase three peak demand savings resulting in more savings being verified in the ex post as compared to the ex ante for this phase.

Realization Rates for Project A:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	3,079,375	3,373,859	1.10
Demand Savings (kW)	113.90	433.91	3.81

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Project Level

Projects A, B, and C

(continued)

Realization Rates for Project B:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	4,374,898	4,674,279	1.07
Demand Savings (kW)	530.80	579.32	1.09

Realization Rates for Project C:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	2,551,874	2,796,023	1.10
Demand Savings (kW)	328.80	368.64	1.12

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Project Level

Projects D, E

Project and Measure Description

The Projects D and E represent the phase 4-2 of the two data center projects implemented at different facilities that are being built and loaded in phases.

These new construction data center projects incorporate several advanced energy efficiency measures. Ex ante calculations compare measured actual performance to the baseline given by the 2013 California (CA) Baseline* document for new data centers. The implementation contractor provided a detailed analysis model to calculate savings.

Comments on Ex Ante Calculations

Overall, the implementation contractor's analysis of the two phase 4-2 projects was accurate with respect to the data available at the time the project was completed. Guidehouse made the following adjustment in the ex post calculations, summarized below.

Guidehouse Adjustments

- The 2019 ex ante phase 4-2 energy savings subtracted the 2019 phase 4-1, 2018 phase three, 2017 phase two and 2016 phase one ex ante savings. The 2019 ex post phase 4-2 energy savings subtracted the 2019 phase 4-1, 2018 phase three, 2017 phase two and 2016 phase one ex post savings. Due to higher savings verified for the phase 4-1 of the projects, lower savings were verified for the phase 4-2 of the projects.

[1] Even though the new construction baseline has been updated, it was decided to "grandfather" the baseline in 2018 since equipment has been purchased before the baseline shift. This will be the last year of grandfathering the old baseline.

Savings Results – Project Level

Projects D and E

(continued)

The two phase 4-2 projects in 2019 have realization rates lower than one, which are 0.66 and 0.91 for energy savings. The realization rates for peak demand savings are 0.66 and 0.88 for the two projects respectively. The low realization rates for these projects are due to higher savings verified for the previously evaluated phase 4-1 of these projects.

Realization Rates for Project D:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	1,018,432	670,624	0.66
Demand Savings (kW)	159.00	104.89	0.66

Realization Rates for Project E:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	3,019,307	2,733,205	0.91
Demand Savings (kW)	385.00	340.33	0.88

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Project Level

Project F – Replaced Three Old CRAC Units with New CRAC Units

Project and Measure Description

The customer replaced three of their twenty, 30-ton CRAC units with new 30-ton Liebert DX CRAC units. The old units are estimated to be around 18-20 years old and the implementation contractor assumed them to be at the end of their useful service life.

Comments on Ex Ante Calculations

The implementation contractor established the baseline for this project based on the 2019 AEP Ohio program manual to be three 25-ton DX CRAC units. The actual consumption of the installed units was calculated using logger data collected for the current draw of the units and assumptions made for the voltage and power factor parameters. Guidehouse made the following adjustments to the ex ante calculations.

Guidehouse Adjustments

- Guidehouse conducted a site visit for this project and collected spot readings for the voltage, current and power factor of the three units that were part of the project. Guidehouse updated the voltage and power factor assumptions made in the ex ante estimates with the on-site readings which resulted in higher actual consumption for the installed units and consequently lower savings.

Realization Rate for Project F:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	73,413	62,623	0.85
Demand Savings (kW)	8.40	7.15	0.85

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Savings Results – Project Level

Projects G, H and I

Project and Measure Description

The Projects G, H and I represent the phase 1 of three new data center projects implemented at different facilities and are being built and loaded in phases.

These new construction data center projects incorporate several advanced energy efficiency measures to lower the Power Usage Effectiveness (PUE) and cooling energy required. The same system is used to support the Uninterruptible Power Supply (UPS) electrical rooms. Savings are also claimed for the new UPS units. Ex ante calculations compare measured actual performance to the baseline given by the 2019 AEP Ohio Data Center Energy Efficiency Program guidelines for new data centers. The implementation contractor provided a detailed analysis model to calculate savings.

Comments on Ex Ante Calculations

Overall, the implementation contractor’s analysis of the three phase 1 projects was accurate with respect to the data available at the time the project was completed. Guidehouse made the following adjustment in the ex post calculations, summarized below.

Guidehouse Adjustments

- Guidehouse updated the part load ratio (PLR) coefficient C from 0.4104 to 0.4101 used to calculate the chilled water pump power to be consistent with the 2019 AEP Ohio program manual.
- Guidehouse updated the savings algorithm used to calculate the cooling tower flow rate to be consistent with the 2019 AEP Ohio program manual.

Savings Results – Project Level

Projects G, H, and I

(continued)

The three phase 1 projects in 2019 have a realization rate of 1.00 for energy and a realization rate of 0.99 for peak demand. The reason for the 0.99 realization rate for the three projects is that slightly higher ex ante demand savings were claimed for the project H in the tracking data as compared to the project files.

Realization Rates for Project G:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	442,968	442.714	1.00
Demand Savings (kW)	56.60	56.21	0.99

Realization Rates for Project H:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	1,191,725	1,191,042	1.00
Demand Savings (kW)	163.90	162.76	0.99

Realization Rates for Project I:

	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings (c)	Realization Rate (c / b)
Energy Savings (kWh)	1,429,393	1,428,574	1.00
Demand Savings (kW)	189.20	187.88	0.99

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Effective Useful Life

The Effective Useful Life (EUL) was verified on a complete census of the implemented measures. Guidehouse noted discrepancies between the Data Center tracking data and the project files for the phase four sampled projects. Guidehouse found this has been a recurring discrepancy in multiple-year evaluations. The ex ante values are from the tracking data. Guidehouse verified that the ex ante EULs are accurate.

Project Description	Project File EUL[1]	Ex Ante EUL	Ex Post EUL
New Construction – Phase 1	20	20	20
New Construction – Phase 2	19	19	19
New Construction – Phase 4 – 1	12	17	17
New Construction – Phase 4 – 2	12	17	17
CRAC Unit Replacement	15	15	15
Colocation Relocation	15	15	15
Cooling Upgrade	N/A	15	15
IT Exp Direct to Chip Cooling	15	15	15

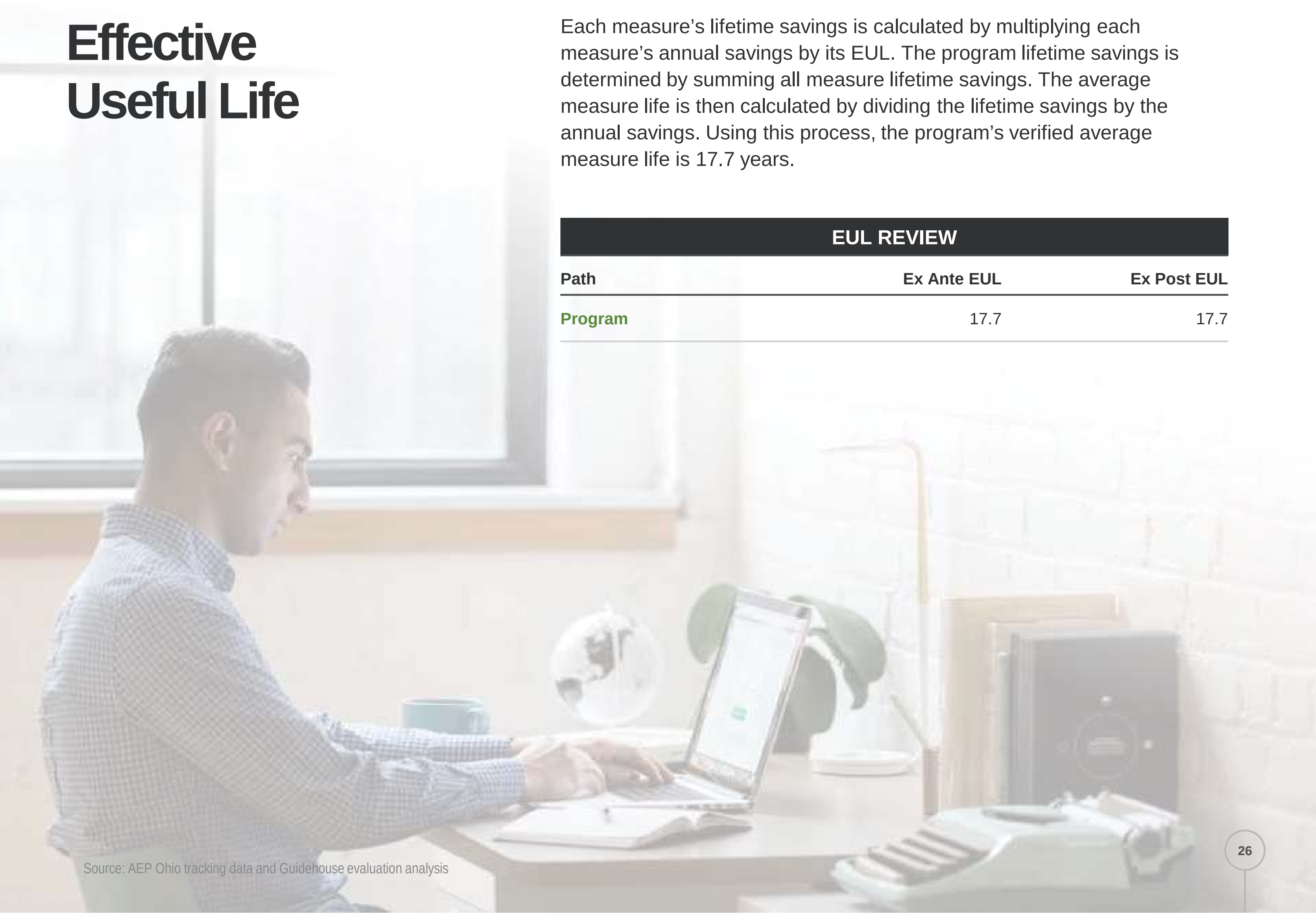
[1] N/A is input in projects that were not sampled as part of the impact study. They are not applicable because Guidehouse did not receive the project files

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Effective Useful Life

Each measure's lifetime savings is calculated by multiplying each measure's annual savings by its EUL. The program lifetime savings is determined by summing all measure lifetime savings. The average measure life is then calculated by dividing the lifetime savings by the annual savings. Using this process, the program's verified average measure life is 17.7 years.

EUL REVIEW		
Path	Ex Ante EUL	Ex Post EUL
Program	17.7	17.7



Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Incremental Cost

The project incremental cost is an important parameter in the benefit/cost analysis. The incremental cost is defined as the difference between the cost of the proposed energy efficient equipment and the cost of baseline efficient equipment in lieu of the energy efficient option. In cases where the existing equipment has significant remaining useful life, the baseline cost is zero; in the case where the affected equipment is near the end of life, the baseline cost is the least expensive equipment that meets the commercial energy code, is commercially available, and will meet performance requirements. Incremental cost is recorded in the measures tracking data.

Guidehouse verified lower incremental cost than reported incremental cost for the phase 4 -1 new construction projects. Guidehouse conducted the on-site verification at a later time after the implementation contractor performed the ex ante calculations and was able to collect additional operational data. Guidehouse verified slightly higher IT load based on the additional data and in order to serve this higher load an additional chiller along with other chilled water components were added to the baseline. This increased the total baseline cost resulting in a lower incremental cost.

IMC REVIEW		
Path	**Ex Ante IMC (b)**	**Ex Post IMC (c)**
Program	$7,755,688	$5,825,529

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

Cost-Effectiveness Review

This section addresses the cost-effectiveness of the 2019 Data Center Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS

Item	Value
Average Measure Life	18
Projects	18
Ex Post Annual Energy Savings (kWh)	26,612,463
Ex Post Coincident Peak Savings (kW)	3,447
Third Party Implementation Costs	$659,255
Utility Administration Costs	$359,942
Utility Incremental Incentive Costs	$1,249,913
Incremental Measure Costs	$5,825,529

Based on these inputs, the TRC ratio is 1.7 and the program passes the TRC test for the program in its entirety.

COST-EFFECTIVENESS RESULTS

Benefit-Cost Ratio–Test Results	Ratio
Total Resource Cost	1.7
Participant Cost Test	4.5
Ratepayer Impact Measure	0.5
Utility Cost Test	6.1

Additional benefits related to the reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC.

Source: AEP Ohio tracking data and Guidehouse evaluation analysis

04

Recommendations

Recommendations

Overall, Guidehouse found AEP Ohio's Data Center Program to be operating well in 2019. The following slides summarize Guidehouse's findings and recommendations from the 2019 Data Center Program impact evaluation.

FINDING #1

Guidehouse found that incorrect phase 3 peak demand savings were subtracted for one phase 4-1 project resulting in lower demand savings being claimed in this phase.

RECOMMENDATION #1

Conduct extra quality control efforts to make sure correct savings are subtracted from previous phases of the projects.

FINDING #2

For the new construction phase 1 and phase 2 projects, an incorrect Part Load Ratio (PLR) coefficient was used when calculating the chilled water pump power.

RECOMMENDATION #2

Update the PLR coefficient for chilled water pump to be consistent with the 2019 AEP Ohio manual.

FINDING #3

For the new construction phase 1 and phase 2 projects, the cooling tower flow rate was incorrectly calculated. Guidehouse updated the cooling tower flow rate algorithm as per the 2019 AEP Ohio program manual in the verified calculations.

RECOMMENDATION #3

Update the algorithm used to calculate the cooling tower flow rate to be consistent with the 2019 AEP Ohio manual.

FINDING #4

For one new construction phase 1 project, slightly higher ex ante peak demand savings were claimed in the tracking data as compared to the peak demand savings in the project files.

RECOMMENDATION #4

Conduct extra quality control efforts to make sure savings claimed in the tracking data match the savings calculated in the project files.

Recommendations (continued)

FINDING #5

Guidehouse found that the implementation contractor used default voltage and power factor values that differed from the actual values for the installed equipment. These differences in the default and the actual values had an effect on the estimated energy use.

RECOMMENDATION #5

Ensure that operational data or spot readings are collected for voltage, amperage, power factor, and/or Root Mean Square (RMS) power to understand better the actual performance of the installed equipment.

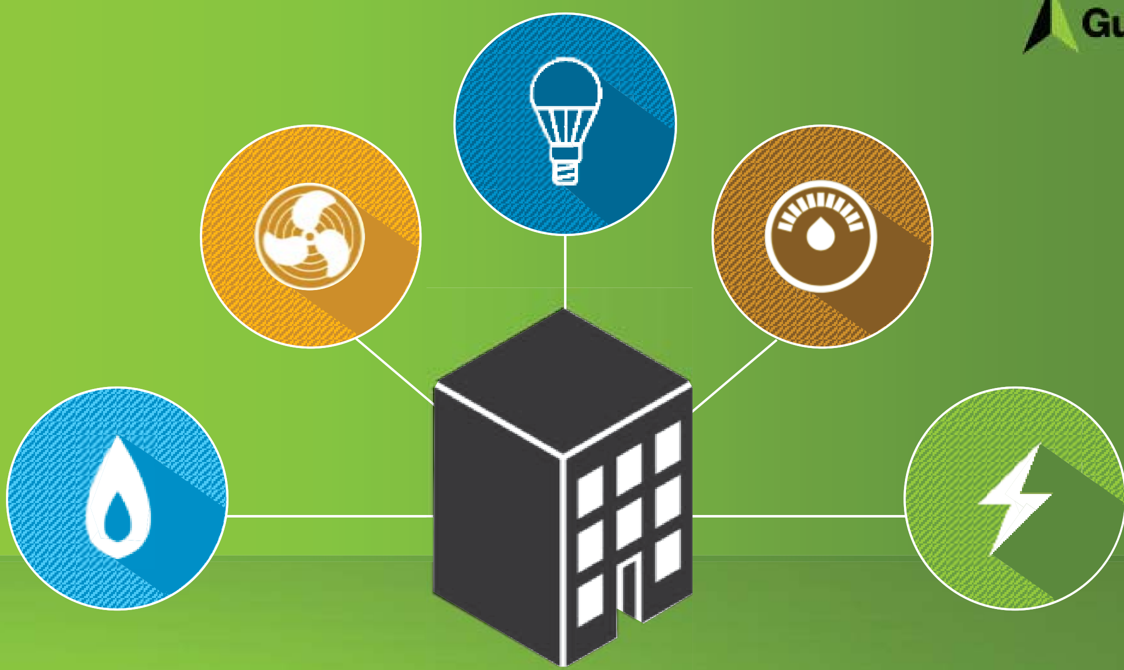
FINDING #6

The measure life for four projects in the tracking database did not align with the measure life in the project files. The verified measure life used by Guidehouse is consistent with the tracking data measure life for these four projects.

RECOMMENDATION #6

Conduct a comprehensive quality control of the tracking data and ensure that all important data is consistent across the project files and the tracking database.

APPENDIX P



Continuous Energy Improvement Program

2019 Impact Evaluation Report

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Content of Report

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January, 24 2020

Table of Contents

01 Introduction

Program Summary

What is the Continuous Energy Improvement (CEI) Program?

The CEI Program provides training for commercial and industrial customers on how to view energy consumption at their facilities in a holistic manner and identify no cost/low cost opportunities to reduce energy use.

Specifically, the CEI program includes:

- Coaching assistance, tools, and templates to support participants in their efforts to meet facility and corporate cost savings targets
- Custom statistical models for each customer to measure and manage energy intensity
- An Energy Coach and technical resources to help customers identify and implement energy saving opportunities
- A structured support group of local companies that share best practices and provide team support, encouragement, and accountability

These practices can reduce energy use at an individual site from three to five percent with little or no financial investment from the customer.

AEP Ohio CEI website

https://www.aepohio.com/save/business/programs/continuousenergyimprovement.aspx

Adjustments to the Program

Facility size adjustments.

- AEP Ohio originally designed the CEI program in January of 2013 to target AEP Ohio's largest industrial customers (>10 GWh annually)
- AEP Ohio expanded the program in May of 2013 to support customers using more than three GWh annually which is the threshold for 2019

Facility type adjustments.

- In 2015 AEP Ohio expanded the CEI program to large commercial customers beyond the industrial sector
- The 2019 participants include offices, schools, and other large commercial businesses as well as industrial facilities

Program structure adjustments.

- The 2019 evaluation includes "alumni" customers who participated in past years of the CEI program
- In total, the 2019 program included 115 projects as compared to the 57 projects in 2018. As the program has increased in size, Guidehouse has used sampling in order to estimate savings for this program
- Guidehouse treated all savings claimed from the alumni group as incremental savings to avoid double counting with prior years

Cohort Description

The CEI program consists of “cohorts” or groups of program participants who began the program in roughly the same calendar year. These customers often attend group training sessions together and form a peer group for discussing CEI related savings activities.

The 2019 evaluation consisted of cohorts 9 through 16, which were split into two major groups:

1. Customers in their first year of participation in the CEI Program (cohorts 13 through 16)
2. Alumni customers who participated in prior program years, but continued to receive training and other program support in 2019 (cohorts 9 through 12)[1]

Footnote 1: Alumni customers could include any facilities who were a part of cohorts 1 through 8 in past program years. Savings claimed by the program for cohorts 9 through 12 in 2019 are incremental changes to 2018 claimed savings to avoid double counting.

Evaluation Objectives

The 2019 evaluation objectives include:

01 Quantify energy and summer coincident peak demand savings impacts at the meter from the program during 2019.

02 Design sample to achieve a 90% evaluation confidence and +/-10% precision for both the program energy and demand savings.

03 Determine program cost-effectiveness.

04 Determine key strengths and weaknesses in how the program calculates impacts and identify ways in which the program can be improved.

02
Methodology

Sample Design

Guidehouse began the impact evaluation process by designing a sample of the cohort 9 through 16 participants. Sites were categorized by annual energy savings strata defined as follows.

- **Small – Less than 125,000 kWh**
- **Mid – 125,000 to 500,000 kWh**
- **Large – Greater than 500,000 kWh**
- **Zero/Negative – 0 or negative kWh**

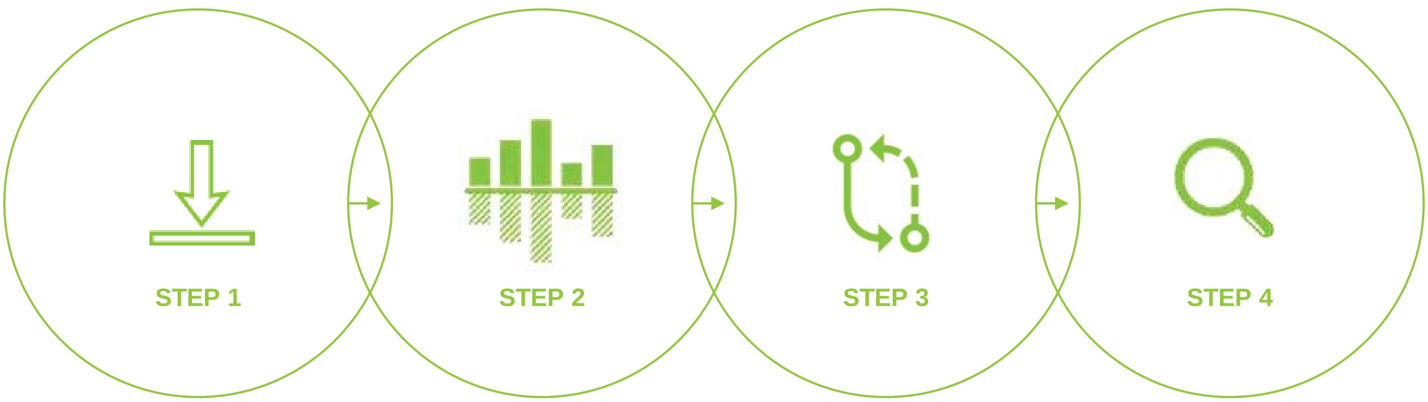
To achieve the 90 percent confidence interval and 10 percent maximum relative precision, Guidehouse selected 27 participants with 39 facility site models according to the following distribution numbers. Although Zero/Negative sites do not impact the relative precision of the model, a small number of these sites were included for due diligence, as negative savings are often a result of non-CEI activities:

- **Small – 11**
- **Mid – 12**
- **Large – 12**
- **Zero/Negative – 4**

These 39 sites were then evaluated according to the process outlined in this section.

Evaluation Methodology

AEP Ohio provided Guidehouse with the energy and demand models as well as the CEI reports for all sites participating in cohorts 9 through 16 of the CEI Program. Guidehouse reviewed the models and used the data to recreate the pre- (baseline) and post-program implementation savings estimates. Evaluation staff generally followed these steps below:



Step 1: Guidehouse staff reviewed all facility-level program documentation to identify potential issues impacting CEI savings

Step 2: The evaluation team confirmed the baseline model by running a regression analysis on the baseline data provided by the CEI participant

Step 3: The evaluation team used the new baseline model to estimate the preliminary post-program savings, ensuring that all capital projects were accounted for in the results

Step 4: In order to estimate the final post-program (ex post) savings, Guidehouse staff Identified and adjusted for:

1. Outliers found in the data
2. Any other factors impacting site-level energy use, such as new equipment or non-CEI activities

Evaluation Methodology

(continued)

During the first step of the impact evaluation. Guidehouse identified any impacts from non-CEI activities that may have impacted energy consumption, and reflected the impacts in the ex post models. These impacts could include:

- Changes in hours of operation
- Changes in number of employees
- Changes in production
- Capital measures installed at the site through other AEP Ohio energy efficiency programs
- Newly-installed equipment or site expansion

When such activities were identified, evaluation staff estimated the impact of these activities and included it in the final ex post savings

In addition, Guidehouse identified outliers in model variables. For each variable, evaluation staff identified data points in the post period that were either greater than 110 percent of the baseline maximum or below 90 percent of the baseline minimum. The team then reviewed the energy savings during these outlier events to understand their impact on the energy savings. If the outlier resulted in energy savings that appeared inconsistent with normal operation, these data points were addressed by the evaluation staff. The CEI analysis tool provides detailed descriptions for each outlier found and how the team adjusted savings.

Data Collection Activities

DATA COLLECTION TYPE

1

Review Provided Site Models

Targeted Population
Sample of sites in cohorts 9 through 16

Sample Frame
Tracking Database

Sample Size
27
(39 energy models)

Timing
Feb-20

2

In-Depth Telephone Interview

Targeted Population
Implementation Contractor and Program Manager

Sample Frame
Contact from Implementation Contractor

Sample Size
2

Timing
Feb-20

3

Site Telephone Surveys

Targeted Populations
Sample of sites with problematic energy models

Sample Frame
Contact from Site

Sample Size
10

Timing
March-20

03
Evaluation Findings

Savings Results – Sample Level

For cohorts 9 through 16, Guidehouse evaluated a sample of facility energy models (39 sites) to calculate the sampled energy (kWh) and demand (kW) realization rates as shown in the table.

Strata	Number of Sample Sites	Ex Ante Incremental Savings (kWh)* (a)	Ex Post Incremental Savings (kWh) (b)	Sample Realization Rate (b/a)	Ex Ante Demand Savings (kW)* (c)	Ex Post Demand Savings (kW) (d)	Sample Realization Rate (d/c)	Overall Relative Precision of Program @ 90% Confidence
Small	11	831,033	845,558	1.02	-111	-111	1.00	27.6%
Mid	12	2,884,018	3,444,013	1.19	-146	-125	0.86	3.8%
Large	12	11,049,017	11,136,704	1.01	1,720	1,720	1.00	0.4%
Zero/Negative	4	-	-	NA	-157	-157	1.00	NA
Sample Totals	39	14,764,068	15,426,276	1.04**	1,306	1,327	NA	2.8%

* Values from AEP Ohio's claimed savings tracking data file AEPCEI_YE2019
**Value represents weighted average
Note: totals may not sum due to rounding

Source: Guidehouse 2019 evaluation

Savings Results – Program Level

The 2019 evaluation of AEP Ohio's CEI program shows the program is operating with realization rates at 1.04 for energy savings. The program's ex post energy savings achieved 92 percent of the energy goal set forth in the 2017-2020 Action Plan. The program did not show significant demand saving in 2019 as shown in the table. Overall the total program demand savings was negative and so Guidehouse did not apply the sampled realization rate to the demand savings.

	Program Goals* (a)	Ex Ante Incremental Savings (b)	Ex Post Incremental Savings** (c)	Realization Rate (c/b)	Percent to Goal (c/a)
Energy Savings (kWh)	23,052	20,451	21,353	1.04	92%
Demand Savings (kW)	484	-838	-817	NA	NA

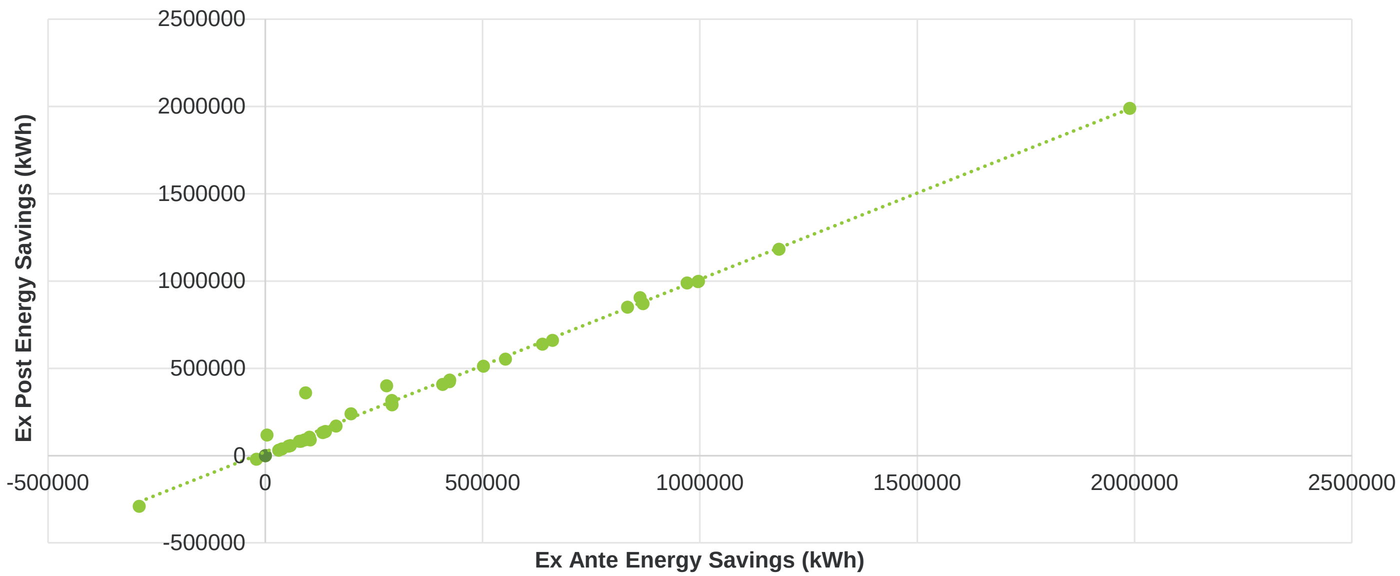
* AEP Ohio Volume 1: 2017 TO 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016
** Evaluation analysis of AEP Ohio tracking data from 2019

Savings Results – Site Summary

The figure below is a graphical representation of the site level ex ante versus ex post energy savings. The diagonal line represents the goal of a realization rate of 1.00. Points above and to the left of the RR=1.00 line represent sites with energy realization rates above 1.00, while those points below and to the right are sites with realization rates less than 1.00.

The majority of the sites reviewed in the 2019 evaluation have a realization rate at or near 1.00. Sites with higher or lower realization rates are discussed in the site-level details later in the report.

ENERGY (kWh) RESULTS



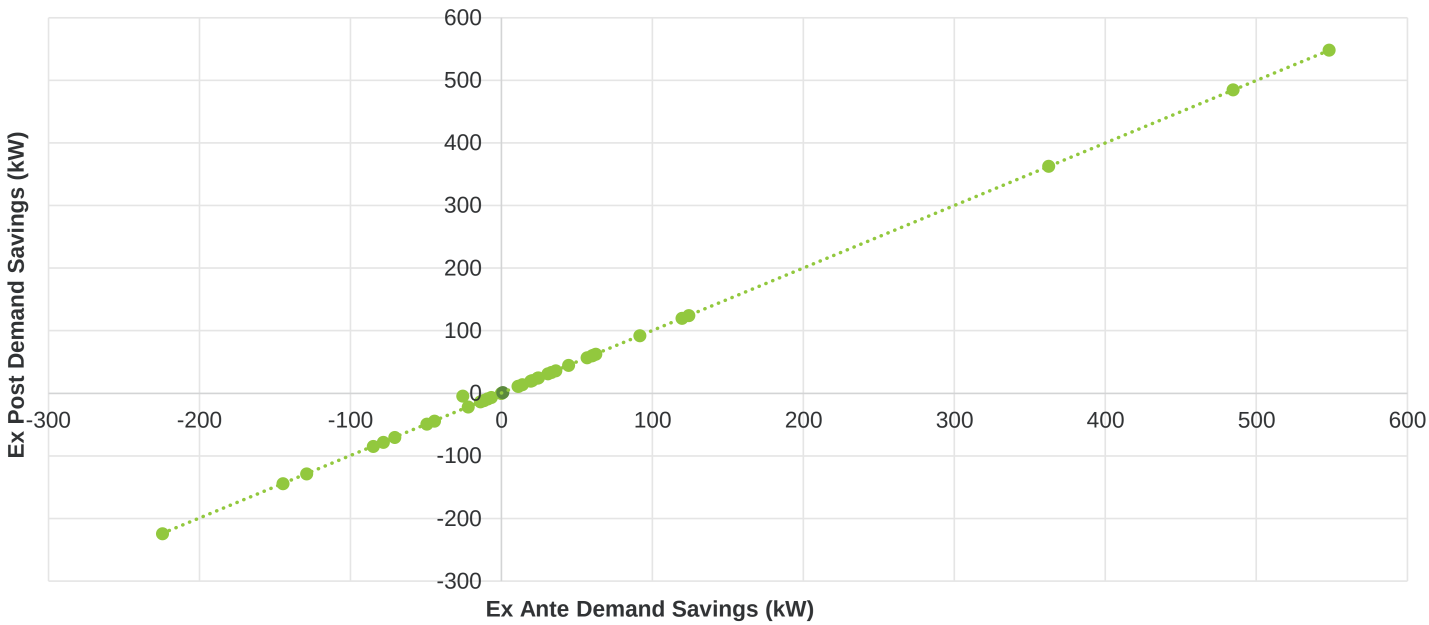
Source: Guidehouse 2019 evaluation

Savings Results – Site Summary

This figure represents coincident peak demand savings for the sample projects. The diagonal line represents the goal of a realization rate of 1.00. Points above and to the left of the RR=1.00 line represent sites with energy realization rates above 1.00, while those points below and to the right are sites with realization rates less than 1.00.

Nearly all of the sample projects reviewed in the 2019 evaluation have a demand realization rate of 1.00. See the site-level detail slides later in the report for information on sites with higher or lower demand realization rates.

DEMAND (kW) RESULTS



Source: Guidehouse 2019 evaluation

Savings Results – Site Level

The following report section summarizes the site-level results for each participant site demonstrating an ex post realization rate above or below 1.00. Guidehouse identified thirteen sites achieving realization rates above 1.00; and one site below 1.00, These sites are summarized in the table below. The reason for realization rate discrepancy categories (annualization, data exclusion, and/or non-CEI activities) are detailed in following slides.

Sample Site	Sample Site Realization Rate	Ex Ante Incremental Savings (kWh)	Ex Post Incremental Savings (kWh)	Reason for Realization Rate Discrepancy
1	1.43	278,964	400,210	Annualization: short-term construction activity
2	1.05	862,166	903,863	Annualization: meter issues in post period
3	1.02	833,175	849,512	Annualization: plant shutdown
6	1.02	970,149	989,171	Annualization: plant shutdown
8	1.04	162,865	169,379	Annualization: abnormal production
10	1.02	53,354	54,400	Annualization: plant shutdown
13	1.02	501,708	511,546	Annualization: abnormal chiller operation
15	1.21	197,185	238,457	Annualization: abnormal chiller operation
19a	29.56	3,958	117,002	Data exclusion: excessive cooling
19b	1.08	290,864	315,102	Annualization: construction due to remodeling
23b	1.04	101,064	105,107	Annualization: building automation issues
23c	0.86	103,282	88,935	Non-CEI activities: building operation disruption Data exclusion: building automation system issues
23e	1.00	38,328	38,328	Annualization: HVAC operational issues
24c	3.88	92,391	358,414	Data exclusion: expanded production
25	1.02	423,920	432,232	Annualization: holiday not reflected in baseline

Savings Results – Annualization

A number of sample sites (sites 1, 2, 3, 6, 8, 10, 13, 15, 19b, 23b, 23e, and 25) reported non-CEI operation activities and removed the associated data points from their savings model. The site models explained the removal of these points adequately, but did not re-annualize savings to a full 52 weeks. Guidehouse annualized savings to represent the 52 week measurement period.

Additionally, the evaluation team reviewed these models to determine if outliers had an atypical impact on savings. Data points were removed when atypical behavior was observed. Since these savings were removed, Guidehouse annualized savings to represent a 12-month period. If appropriate, Guidehouse adjusted the demand model to reflect the removal of the same data points. These changes resulted in additional energy savings for these sites.

Common issues reported by sample sites and/or confirmed during site interviews included:

- Unexpected shutdowns
- Construction
- Unusually high or low production
- Extreme weather
- Short-term equipment malfunction
- Energy meter issues

Source: Guidehouse 2019 evaluation project workbooks

Savings Results – Data Exclusion

Guidehouse observed that three of the sample sites (sites 19a, 23c, and 24c) identified and adequately detailed site activities that were not commensurate with the baseline, but did not exclude the associated data points from the energy model.

Guidehouse describes excludable data points as building issues, such as equipment malfunctions, that are unrelated to CEI activity but impact the CEI model. Examples of excludable data points are bulleted on the preceding slide and below. It is the goal of the CEI model to calculate the savings for the program independent of other activities occurring at the site. For this reason, all issues that are unrelated to CEI activities need to be considered and accounted for appropriately. For the three sample sites listed herein, the IC identified data points that were causing issues in the energy model but did not account for the impacts.

During evaluation, if Guidehouse removed data points from savings calculations savings were annualized to represent a 52-week period.

If appropriate, Guidehouse also adjusted the demand model to reflect the removal of the same data points. These changes resulted in additional energy savings for these sites.

Specific issues reported by sample sites included:

- Building automation system malfunction
- HVAC control issues

Savings Results – Non-CEI Activities

Guidehouse identified one site (site 23c) demonstrating an increase in energy savings not resulting from CEI activities. These activities were instead related to short-term equipment issues.

When reviewing provided energy models, evaluation staff observed a sudden change in energy savings. Upon further investigation, Guidehouse determined that this activity was related to non-CEI activities and the impact of these activities was removed from the energy model.

For site 23c, unusual operation resulted in increased energy usage for a short period of time. Guidehouse confirmed that this was not a CEI-related activity and removed the impact associated with these activities.

Effective Useful Lifetime (EUL) & Incremental Cost

Effective Useful Lifetime (EUL)

Guidehouse complete primary research for AEP as a part of the 2016 evaluation in order to estimate the EUL of the CEI program. Guidehouse was unable to determine the measure life of each individual activity that was a part of the CEI program and instead estimated measure life based on total program savings. Guidehouse estimated the program had a measure life of approximately 4.3 years, but noted many of the sites reporting negative savings mentioned this situation was due to issues with model accuracy, not lack of motivation. For this reason a EUL of 5 years has been used for this program since this evaluation.

Incremental Measure Cost (IMC)

Since this was a behavior based program, no incremental measure costs were claimed for this program.

- Ex Ante Total IMC: $ 0
- Ex Post Total IMC: $ 0

Cost-Effectiveness Review

This section addresses the cost-effectiveness of the 2019 CEI Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Average Measure Life	5
Projects	115
Ex Post Annual Energy Savings (kWh)	21,353,485
Ex Post Coincident Peak Savings (kW)	-817
Third Party Implementation Costs	$1,342,464
Utility Administration Costs	$419,030
Utility Incremental Incentive Costs	$415,467
Incremental Measure Costs	$0

Based on these inputs, the TRC ratio is 1.5 and the program passes the TRC test for the program in its entirety.

COST-EFFECTIVENESS RESULTS	
Benefit-Cost Ratio–Test Results	**Ratio**
Total Resource Cost	1.5
Participant Cost Test	N/A
Ratepayer Impact Measure	0.4
Utility Cost Test	1.5

Participant Cost Test is not analyzed as the implementation contractor did not supply data for the participant contribution to the incremental measure costs

Additional benefits related to the reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC.

04

Recommendations

Recommendations

FINDING #1

Guidehouse observed that eleven of the sample sites (sites 2, 3, 6, 8, 10, 13, 15, 19b, 23b, 23e, and 25) removed one or more data points from the post-condition model due to conditions that were not commensurate the baseline. The site models explained the removal of these points adequately, but did not re-annualize savings to a full 52 weeks.

RECOMMENDATION #1

Guidehouse recommends that sites annualize their models when removing data points not reflected in the baseline to report an accurate summary of savings.

FINDING #2

Guidehouse observed that three of the sample sites (sites 19a, 23c, and 24c) identified and adequately detailed site activities that were not commensurate with the baseline, but did not exclude the associated data points from the energy model. All issues that are unrelated to CEI activities need to be considered and accounted for appropriately.

RECOMMENDATION #2

Guidehouse recommends that sites identify, detail, and remove data points that result in non-typical energy operation not reflected in the baseline to report an accurate summary of savings.

FINDING #3

Guidehouse identified one site (site 23c) demonstrating an increase in energy savings not resulting from CEI activities. These activities were instead related to short-term equipment issues.

RECOMMENDATION #3

Guidehouse recommends the implementer review the model to verify that sudden changes in energy consumption, relative to total claimed savings, can be linked to CEI activities. If the sudden changes cannot be explained by CEI activities, the implementer should remove the data points from the model.

FINDING #4

Guidehouse identified one site (site 7) that implemented control activities recommended by the CEI program that resulted in a short-term increase in energy usage. This activity was reversed later, but the site received zero savings as a result of this issue.

RECOMMENDATION #4

Guidehouse recommends the implementer carefully monitor the impact of control changes to site energy usage. This control change was in place for several months, and if its impact could have been identified more quickly, the site may have received savings overall.

APPENDIX Q

Transmission and Distribution and Internal System Efficiency Improvements Program

2019 Evaluation Report

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April 24, 2019

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1. PROGRAM DESCRIPTION

AEP Ohio's Transmission and Distribution and Internal System Efficiency Improvements Program (load loss reduction program) is targeted to transmission and distribution (T&D) facilities that are candidates for efficiency improvements, typically in concert with other benefits, such as increased capacity or reliability performance. For most of these projects, T&D savings are achieved when lines and equipment are replaced with similar facilities producing lower line and equipment losses. For example, replacing smaller, high resistance wire with larger wire with lower resistance is commonly referred to as reconductoring. Physical losses accrue in the form of heat losses. When heating losses are high due to loading equipment above normal ratings for extended periods of time, equipment can be damaged or experience premature loss of life.

Loss reduction also is achieved when new lines are added and existing lines reconfigured, lines are converted to operate at a higher voltage (resulting in lower current needed to supply the same amount of load); feeder power factor is improved, and low loss devices are installed, such as highly-efficient transformers. T&D efficiency benefits accrue via lower peak demand and reduced energy losses. Because losses are proportional to the square of the load served, the percent reduction in peak demand losses are higher than the percent reduction in energy losses.

AEP Ohio's T&D loss reduction program for projects placed in service during 2019 focuses on several of the following measures listed (not all are necessarily implemented in any given year). The methodology AEP Ohio employed to derive demand and energy loss savings is presented in the following sections. **Error! Reference source not found.** lists the Ohio TRM evaluation protocols[1] AEP Ohio applies to each of the categories.

- Line reconductoring (distribution, subtransmission and transmission)
- New substations and circuits (distribution, subtransmission and transmission)
- Voltage conversion
- Power factor improvement (via capacitor banks, regulators and load-tap changers)
- Feeder reconfiguration
- Load transfers and phase balancing

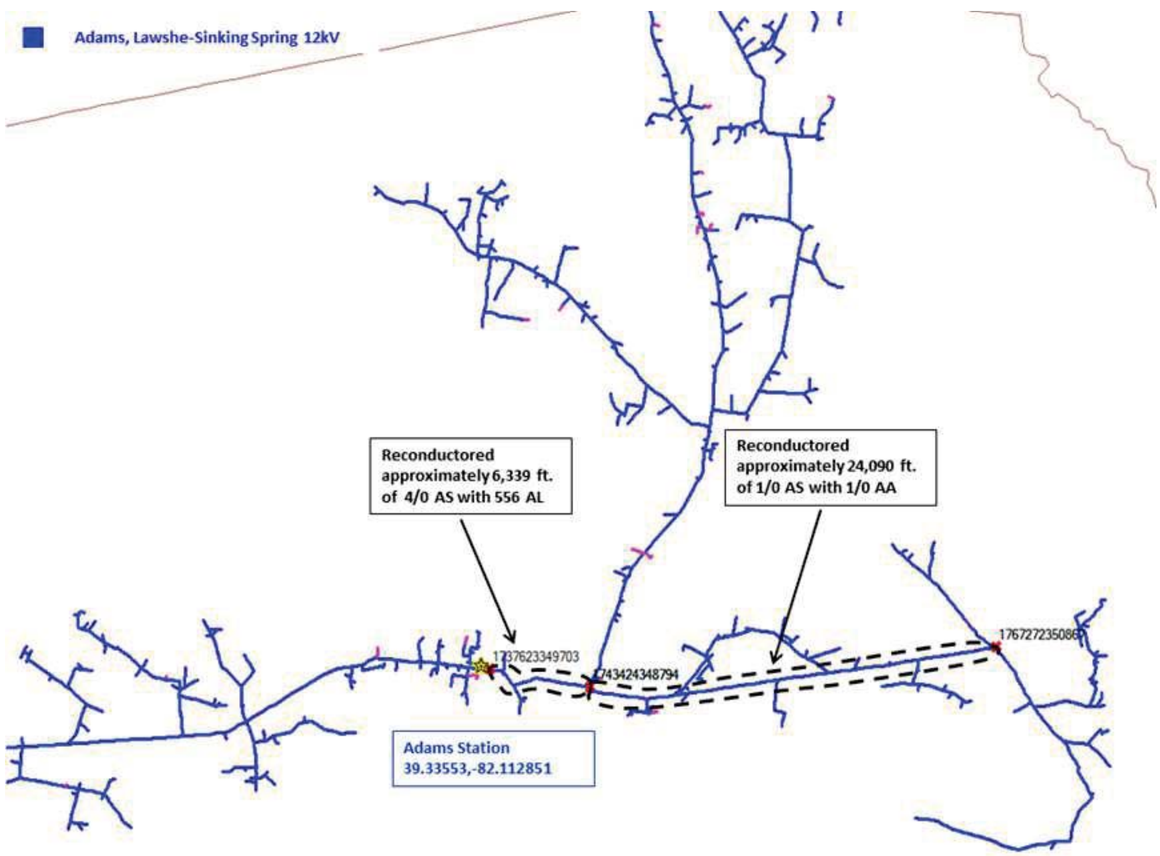
The items previously listed commonly are referred to as loss reduction programs, and include both load and no-load losses. Some electrical equipment, such as transformers, produce load and no-load losses. Load losses vary as the amount of current increases or decreases. No-load losses are independent of load, and occur during all hours the device is in service. No-load losses typically occur only on equipment requiring inductive current (magnetizing current) to operate, such as transformers and motors. Loss reduction programs sometimes may include the replacement of equipment with high no-load losses with devices with lower no-load losses. The load reduction savings AEP Ohio estimated for the aforementioned programs do not appear to include any projects focusing mostly on reduction of no-load losses, which is common among utilities.

[1] *State of Ohio Energy Efficiency Draft Technical Reference Manual.* Prepared for the Public Utilities Commission of Ohio by Vermont Energy Investment Corporation, August 6, 2010.

2. METHODOLOGY

AEP Ohio estimated load loss reduction amounts using tools and methods commonly employed to accurately predict peak demand and energy savings. These efforts include use of a comprehensive and detailed distribution feeder load flow simulation model (CYMDist) and network transmission load flow models (PSS/E) to estimate loss savings at the time of the feeder peak. The CYMDist and PSS/E models are commonly used by power industry professionals and each applies a level of rigor sufficient to accurately predict losses for transmission and distribution facilities.[2] The accuracy of the model results is highly dependent on model inputs and assumptions. AEP Ohio provided Guidehouse with distribution model loss output tables and electrical diagrams illustrating the upgrades and changes made for each feeder, with before and after loss summaries, thereby ensuring loss estimates are based on net loss savings. Typical line segments of a representative feeder targeted for loss savings is illustrated in Figure 2-1.

Figure 2-1. Example Project Diagram: Reconductor - Adams Station, Lawshe-Sinking Spring Circuit



In this example, about 6 miles of a continuous section of the Adams Station Southeast circuit was reconductored from 4/O AS to 556 AL or from 1/O AS to 1/O AA conductor. The reconductoring reduced

[2] The loss reduction projects cited by AEP Ohio include distribution lines, typically 15 kV class and below. Projects also include higher rated distribution and transmission lines rated 23 kV, 34.5 kV, 69 kV, 138 kV and 345 kV. Lines rated 34.5 kV, 69 kV and 138 kV often operate radially, but may be configured in a network arrangement, particularly 138 kV. Lines rated 345 kV are almost always operated in a network configuration.

net peak loss savings from 344 kW to 303 kW, a 12 percent reduction (several other distribution projects achieved a comparable reduction in line losses).

Peak demand losses are derived by conducting load flow studies with and without the upgrade, with the difference in losses between the two cases equal to the net loss savings. AEP Ohio provided copies of model results and feeder maps confirming AEP Ohio's distribution planning personnel included a high level of detail in the CYMDist feeder model for each of the loss reduction programs previously listed. The peak load loss savings AEP Ohio derived for each of the projects listed are consistent with the percent savings Guidehouse has determined in its own studies of similar upgrades for utility distribution systems, as well as results we have reviewed from projects developed by other utilities.

To derive energy loss savings, AEP Ohio employs the following formula, which Guidehouse supports as a reasonable and accurate approach (the resulting value of the calculation within the bracket is defined as the Loss Factor). This equation has been vetted and accepted within the utility industry for decades.

$$\text{Energy Loss Savings} = \text{Peak Loss Savings} * (C_1 * LF + C_2 * LF^2) * 8760$$

Where LF is the feeder load factor, and C1 and C2 are coefficients derived using methods outlined in published industry literature. C_1 and C_2 for AEP Ohio are 0.1 and 0.9, respectively.[3]

The loss factor for the preceding formula typically is between 0.30 and 0.50. The loss factor AEP Ohio used to derive 2019 energy loss savings is 42.02 percent. The results of AEP Ohio's loss reduction program are presented in subsequent sections of this report.

[3] The Energy Loss Savings formula and values used by AEP Ohio were obtained from an internal report titled "AEP Ohio Power Company 2015 Analysis of System Losses", revised 10/2016. This report compiled the results of system loss investigations conducted during 2015 by Management Applications Consulting, Inc. for CSPCO and OPCO. This study also included derivation of the C1 and C2 coefficients. The load factor for AEP Ohio Power Company is 63% obtained from the 2015 Analysis of System Losses and subsequently updated in October 2016.

3. DETAILED FINDINGS

Table 3-1 summarizes the peak demand and energy reductions for AEP Ohio in 2019. Results are presented separately for distribution and transmission assets. Similar to prior years, 2019 reported loss savings are higher for transmission facilities. Total T&D peak demand and energy loss savings also increased from 2018 to 2019. Total peak demand losses increased by approximately 1,450 kW and total energy loss savings increased by 5,364,035 kWh, an average increase of 83 percent for each loss component compared to 2018. The total number of T&D loss reduction projects increased from 25 to 35 between 2018 and 2019. Table A-2 (Appendix) presents reported demand and energy loss savings for specific T&D projects AEP Ohio placed in service during 2019. AEP Ohio reports that the outlook for 2020 is uncertain due to possible delays associated with Covid-19.

Table 3-1. Peak Demand and Energy Reductions

	Number of Projects	Peak (kW)	Energy (kWh)
Distribution	12	416	1,532,330
Transmission	23	2,800	10,306,666
TOTAL	**35**	**3,216**	**11,838,996**

3.1 Distribution Loss Savings

Guidehouse's review confirmed AEP Ohio's composite peak demand savings of approximately 416 kW for distribution is reasonable and consistent with the level of savings associated with the 12 projects summarized above and listed individually in Table A-2 (Appendix). This conclusion is supported by the type of projects included in the AEP Ohio loss reduction program and the methods AEP Ohio employed to derive these savings. Guidehouse notes that although the number of projects increased from 8 in 2018 to 12 in 2019, the amount of peak demand savings decreased by about 69 kW from those reported in 2018 (a 14% decrease). A similar decrease occurred for energy savings, with 255,330 kWh lower savings than 2018. Further, the average demand and energy savings per distribution project in 2019 decreased by about 44 percent compared to projects completed in 2018. AEP Ohio reports the decrease in 2019 was due to the larger percentage of loss reduction for reconductoring projects completed in 2018.

Guidehouse's review confirms the peak demand and energy reductions are reasonable given the scope of each upgrade. Further, similar to most electric utilities, most distribution projects are implemented to address capacity shortages or improve reliability or operating flexibility, with loss reduction as an ancillary benefit - major upgrades typically are not justified on loss reduction benefits alone. For example, most projects are line reconductoring; that is, replacing smaller wire with larger wire. However, the amount of wire replaced typically is a relatively small percent of the total miles of conductor on the feeder, which accounts for the relatively small amount of loss savings as a function of total feeder load. However, because distribution feeder losses typically are less than five percent of total feeder demand, the reduction that AEP Ohio cites for each project represents significant savings.

3.2 Transmission Loss Savings

The magnitude of total loss savings (2,800 kW at peak) associated with transmission level is based on the combined savings associated with 23 projects or line segments resulting in loss savings. The 2019 transmission peak loss savings is approximately 1,526 kW higher than 2018, a 120 percent increase. **Error! Reference source not found.** (Appendix) lists specific transmission projects and upgrades placed into service in 2019. Notably, the number of transmission projects increased modestly compared to 2018 (23 versus 17). Also, the average demand reduction per project increased significantly, from 75 kW to 122 kW of savings per project. The average energy savings per project also increased, from approximately 275,000 kWh in 2018 to about 448,000 kWh in 2019, an increase of 62 percent. AEP Ohio reports the increase in transmission loss savings was due to larger projects going into service in 2019, such as the new Flushing to Smyrna 69kV line, the replacement of high voltage transformers at Hyatt, Sterling and Bixby and system reconfiguration on Jug to Corridor 345kV and 138kV lines.

Similar to prior years, the magnitude of transmission demand and energy loss savings is greater than distribution. This finding is not unusual, as major transmission upgrades often result in substantial line loss savings, as the amount of power delivered per line mile is much higher than distribution lines. Guidehouse views AEP Ohio's transmission peak loss savings as consistent with the level of loss reduction achieved by other utilities implementing upgrades comparable with those listed in **Error! Reference source not found.**. Similar to distribution, transmission upgrades usually are implemented to improve performance and increase capacity transfer capability, with loss reduction as an added benefit.

Guidehouse's conclusions are supported by the review of AEP Ohio's project details and the analysis AEP Ohio prepared for each project, each of which confirms the level of rigor applied to transmission level projects also is consistent with methods employed by electric utilities and transmission system operators. Further, the analysis AEP Ohio used to derive transmission energy savings is consistent with methods used by many electric utilities. Most importantly, AEP Ohio Transmission Planning reports it performed detailed network load flow studies to estimate transmission loss savings.[4] Based on the amount of transmission network load and types of upgrades outlined in **Error! Reference source not found.**, Guidehouse concludes AEP Ohio's reported peak and energy loss savings are reasonable and accurate.

[4] The loss savings for transmission projects were derived on a composite basis for AEP Ohio, as it was necessary to conduct network load flow studies with all upgrades and modifications in service. Thus, the transmission projects are not mutually exclusive in terms of their combined impact on the transmission network, as the resultant line loadings will vary as the network is changed. Thus, the loss savings associated with each project, if modeled individually, are not additive.

Appendix A. T&D PROJECT TYPES

Table A-1 lists the T&D project types from the Draft Ohio TRM. Most 2019 T&D projects were for System Reconfiguration or Conductor (reconductoring) protocols. Note that some project categories used in prior years did not apply in 2019 as no projects were undertaken. For example, no mass plant retrofit or large customer connection projects were completed in 2019.

Table A-1. T&D Project Types

Ohio TRM T&D Project Types
1. Mass Plant Replacement and Expansion Analysis Protocol
2. Conductor Analysis Protocol
3. Large Customer Connection Analysis Protocol
4. Mass Plant Retrofit Analysis Protocol
5. Substation Transformer Analysis Protocol
6. System Reconfiguration Analysis Protocol
7. Voltage Conversion Analysis Protocol

Table A-2 lists the project name, scope, whether the project was either Transmission (T) or Distribution (D), the type of project in terms of the Ohio TRM designations, the peak demand reduction (kW) and the annualized loss reduction (kWh).

Table A-2. AEP Ohio T&D Projects

	Project	Description	Scope	TRM Project Type	Peak Reduction (kW)	Annualized Loss Reduction (kWh)	Transmission or Distribution (T or D)
1.	Racine Station, Racine Circuit	Reconductored approximately 12,042 feet of 4/0 AS with 556 AL conductor. This improved the conductor ampacity to 730 amps per phase.	Reconductoring	2	87.2	321,050	D
2.	Clark Street Station SR 56 Circuit	Reconductored approximately 3,456 feet of 4/0 AA with 556 AL conductor. This improved the conductor ampacity to 730 amps per phase.	Reconductoring	2	32.5	119,590	D
3.	Clark Street Station Vore Ridge Circuit	Reconductored approximately 2,187 feet of 4/0 AS with 556 AL and approximately 1,104 feet of 4/0 AS with 750 MCM AL underground. This resulted in an annualized loss reduction of 132.81 MWhs.	Reconductoring	2	36.1	132,810	D
4.	Adams Station, Lawshe-Sinking Spring Circuit	Reconductored approximately 6,339 feet of three phase primary consisting of 4/0 AS with 556 Al and approximately 24,090 feet of 1/0 AS with 1/0 AA. This resulted in an annualized loss reduction of 149.23 MWhs.	Reconductoring	2	40.5	149,230	D
5.	Bentonville Station, River South Circuit	"Reconductored approximately 1,454 feet of three phase primary consisting of 1/0 AS with 4/0 AA conductor. This improved the conductor ampacity to 410 amps per phase.	Reconductoring	2	6.1	22,600	D

	Project	Description	Scope	TRM Project Type	Peak Reduction (kW)	Annualized Loss Reduction (kWh)	Transmission or Distribution (T or D)
6.	Raven Station, Manchester Circuit	Reconductored approximately 7,600 feet of 4/0 AS with 556 AL and approximately 2,552feet of 1/0 with 4/0 AA. This resulted in an annualized loss reduction of 71.48 MWhs.	Reconductoring	2	19.4	71,480	D
7.	Slate Mills Station, 50 West Circuit	Changed taps at four locations to balance load. This resulted in an annualized loss reduction of 168.62 MWhs.	System Reconfiguration	6	45.8	168,620	D
8.	Waverly Station, Zahn's Corner – Given Circuit	Reconductored approximately 10,891 feet of 4/0 AS with 556 AL conductor. This improved the conductor ampacity to 730 amps per phase.	Reconductoring	2	60.8	223,880	D
9.	Macksburg Station, Dexter City Circuit	Reconductored approximately 6,280 feet of #2 AA with 4/0 AA and approximately 4,824 feet of #4CU with 1/0 AA. This resulted in an annualized loss reduction of 42.88 MWhs.	Reconductoring	2	11.7	42,880	D
10.	East Haverhill Station, Haverhill Circuit	Reconductored approximately 17,500 feet of #4 CU with 556 AL. This improved the conductor ampacity to 730 amps per phase.	Reconductoring	2	8.3	30,630	D
11.	Friendship Station, South Circuit	Tap changed on one location. Installed three voltage regulators. This resulted in an annualized loss reduction of 158.46 MWhs.	System Reconfiguration	6	43.1	158,460	D

	Project	Description	Scope	TRM Project Type	Peak Reduction (kW)	Annualized Loss Reduction (kWh)	Transmission or Distribution (T or D)
12.	Newark Station Seroco Circuit 4 kV to South Newark Station East Circuit 12 kV	Segment of Newark Station Seroco circuit 4 KV was converted to South Newark Station East Circuit 12kV. Transferred one MVA of load from Newark station Seroco circuit 4 kV to South Newark station East Circuit 12 kV. This resulted in an annualized loss reduction of 91.10 MWhs.	System Reconfiguration	6	24.8	91,100	D
13.	TA2011012	Rebuild the Haviland - East Lima 138 kV and Logtown - North Delphos 138 kV double circuits on the Lima - Fort Wayne 138 kV line (section Haviland to structure 78 A) with the conductor size 1033 ACSR 54/7 Curlew.	Reconductoring	2	inc	inc	T
14.	TA2011012	Rebuild the Hedding Road Switch to North Waldo section of the West Mount Vernon-South Kenton 138kV circuit (24.41 miles) with the conductor size 1033 KCM ACSR 54/7 Curlew.	Reconductoring	2	inc	inc	T
15.	TA2011012	Rebuild the Good Hope - Harrison section (30 miles) of the Lemaster - Harrison 138 kV circuit with the conductor size 1033 ACSR 54/7 Curlew.	Reconductoring	2	inc	inc	T
16.	TA2011012, TA2016801	Rebuild the Uncapher Switch to Waldo section (12.5 miles) of the North Waldo - Harpster 69 kV circuit with the conductor size 795 ACSR 26/7 Drake.	Reconductoring	2	inc	inc	T

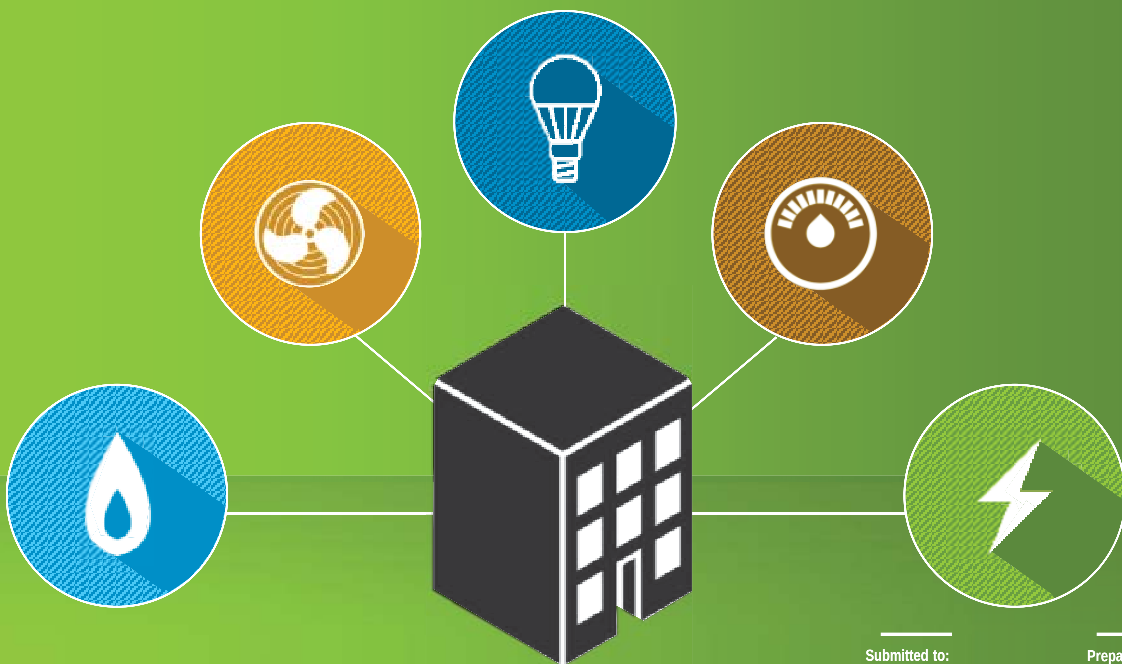
	Project	Description	Scope	TRM Project Type	Peak Reduction (kW)	Annualized Loss Reduction (kWh)	Transmission or Distribution (T or D)
17.	TA2011012, TA2016801	Rebuild the East Delphos - North Spencerville section (9.8 miles) of the North Delphos - North Spencerville 69 kV circuit and the Delphos - North Middlepoint section (5.9 miles) of the North Delphos - Van Wert 69 kV circuit with the conductor size 795 ACSR 26/7 Drake.	Reconductoring	2	inc	inc	T
18.	TA2015043	At Hyatt station transformers 1A and 1B were each replaced with 345/138 kV 450 MVA Transformers #7 and #1, respectively.	Substation Transformer Analysis	5	inc	inc	T
19.	TA2015043	At Sterling station two new 138/34.5 kV 75 MVA transformers were installed.	Substation Transformer Analysis	5	inc	inc	T
20.	TA2015703	Rebuild the Adams-Rarden 69kV circuit (8.15 miles) with the conductor size 795 ACSR 26/7 Drake.	Reconductoring	2	inc	inc	T
21.	TA2018111	At Bixby station, replace the failed transformer No.1 with a 675 MVA, 345/138 kV transformer.	Substation Transformer Analysis	5	inc	inc	T
22.	TP2007102	Rebuild the Torrey - Gambrinus Road 69kV circuit (1.05 miles) and the Gambrinus Road Sw to Bliss Park section (1.4 miles) of the Gambrinus Road Sw - Reedurban 69 kV circuit line section (1.4 miles) with the conductor size 1033 ACSR 54/7 Curlew.	Reconductoring	2	inc	inc	T

	Project	Description	Scope	TRM Project Type	Peak Reduction (kW)	Annualized Loss Reduction (kWh)	Transmission or Distribution (T or D)
23.	TP2007102	Rebuild the Gambrinus Road - Bliss Park 69kV line section (1.4 miles) with the conductor size 1033 ACSR Curlew conductor and steel poles.	Reconductoring	2	inc	inc	T
24.	TP2014159	Convert from 23 kV to 69 kV 14.7 miles for the Summitville to Hammondsville section of the Bane - Hammondsville 69 kV circuit.	Voltage Conversion	7	inc	inc	T
25.	TP2014183	Construct new 138 kV line from Herlan station to Blue Racer station (3.2 miles) with thr conductor size 1234 ACSS/TW Yukon and OPGW.	System Reconfiguration	6	inc	inc	T
26.	TP2014183	Rebuild Summerfield-Berne 138kV line with 3.47 miles of 1234 ACSS/TW Yukon and OPGW.	Reconductoring	2	inc	inc	T
27.	TP2015008	Build a new 69 kV circuit, Flushing - Smyrna (12.5 mile) with the conductor size 795 ACSR 26/7 Drake. Convert from 34.5 kV to 69 kV Smyrna to Vail (3.5 miles) with the conductor size 795 ACSR 26/7 Drake.	System Reconfiguration and Voltage Conversion	6, 7	inc	inc	T
28.	TP2015203	Rebuild/upgrade 2.3 miles of line between Glencoe and Willow Grove Switch 69 kV with the conductor size 795 ACSR 26/7 Drake.	Reconductoring	2	inc	inc	T
29.	TP2016063	Rebuild the June Rd to Oneida section of the June Road - Pekin 69 kV circuit with the conductor size 795 ACSR 26/7 Drake.	Reconductoring	2	inc	inc	T

Project		Description	Scope	TRM Project Type	Peak Reduction (kW)	Annualized Loss Reduction (kWh)	Transmission or Distribution (T or D)
30.	TP2016065	Rebuild the Ohio Central-Dresden section of the Ohio Central - Cyclops 69 kV circuit (2.33 miles) with the conductor size 795 ACSR 26/7 Drake conductor. Replace the 50 MVA Ohio Central 138/69 kV transformer with a 90 MVA unit.	Reconductoring and Substation Transformer Analysis	2, 5	inc	inc	T
31.	TP2016065	Rebuild the Conesville to Cyclos section of the Cyclops - Ohio Central 69kV circuit (1.8 miles) with the conductor size 795 ACSR 26/7 Drake.	Reconductoring	2	inc	inc	T
32.	TP2017079	Install a new 138 kV double circuit line extension (approximately 0.75 mile) from the East Leipsic - Yellow Creek 138 kV circuit to the Newbery station double-circuit with the conductor size 1033 ACSR 54/7 Curlew.	System Reconfiguration	6	inc	inc	T
33.	TA2016801	Rebuild and convert Smryna-Vail SS 69 kV 3.5 miles with the conductor size 795 ACSR 26/7 Drake.	Reconductoring	2	inc	inc	T
34.	TP2016051	Gavin 69 kV reconfiguration to a ring bus configuration which enabled parallel operation of the two exisitng Gavin 138/69 kV 130 MVA transformers. This parallel operation effectively splits the flow across the two Gavin 138/69 kV 130 MVA transformers lowering the losses on them.	System Reconfiguration	6	inc	inc	T

Project	Description	Scope	TRM Project Type	Peak Reduction (kW)	Annualized Loss Reduction (kWh)	Transmission or Distribution (T or D)
35. TP2016095	Rebuild the Jug - Corridor 345 kV circuit (6.43 miles) in a double circuit configuration with the new Jug - Corridor 138 kV circuit (6.43 miles).The Jug - Corridor 345 kV circuit and the Jug - Corridor 138 kV circuit both have the conductor size of two bundled 1590 ACSR (54/19) Falcon.	Reconductoring and System Reconfiguration	2, 6	inc	inc	T

APPENDIX R



Business Sector

2019 Comprehensive Process Evaluation Report

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January, 24 2020

Table of Contents

01

Introduction

Business Sector Services

The Business sector's portfolio of programs offer a range of technical services, incentives, and financing to nonresidential customers installing high-efficiency electricity-consuming equipment. The Business portfolio is marketed, administered, and delivered as seven unique programs by AEP Ohio. 2019 represents the eleventh year of operation for the Business portfolio.

Program	Implementation Contractor	Services
Efficient Products for Business (EP4B)	DNV GL	Prescriptive incentives (including rebate, midstream, and Bid4Efficiency tracks) for standard energy efficiency measures[1]
Process Efficiency (PE)	DNV GL	Custom incentives for non-standard energy efficiency measures[2]
Self Direct (SD)	DNV GL	Provides incentives to large Business customers that have installed measures over the past three years[3]
Continuous Energy Improvement (CEI)	CLEAResult	Large Business ongoing strategic energy management[4]
Non-Residential New Construction (NRNC)	CLEAResult	Incentivizes design, construction and installation of energy-efficient equipment within new building/major renovation projects
Express (EXP)	Lime Energy	Direct installation and incentives for small businesses[5]
Data Center (DC)	Willdan	Technical assistance and incentives specific to data center measures

[1] Measures: lighting, HVAC, motors, drives, refrigeration, etc.
[2] Measures: any cost-effective measure or condition not served through Efficient Products
[3] Measures: consistent with Process Efficiency or Efficient Products for Business programs
[4] Customer types: industrial, hospitals, universities, distribution centers, mining operations, municipal water and waste water facilities, etc.
[5] Measures: lighting, refrigeration

Business Sector Services

Business programs are tailored to meet the needs of specific customer segments:

- **Express** overcomes small business barriers by providing direct installation services for a consistent set of lighting and refrigeration measures.
- **Continuous Energy Improvement** is designed for the largest business customers, provides training, and empowers customer staff to analyze and advance efficient measures and management practices.
- **Process Efficiency, Efficient Products for Business,** and **New Construction** provide predictable services and incentives that encourage energy efficiency actions across the range of customer segments. In response to large business opt-outs, smaller business customers, including institutional, have been included in these programs.

AEP Ohio's **Energy Advisors** play a key role in assisting customers to identify opportunities within their businesses and aligning with the best program services.

Comparison of Business Programs and Customer Segments

Program	Large Business[1]	Medium Business	Small Business[2]
Continuous Energy Improvement	✓	-	-
Data Center	✓	✓	✓
Efficient Products	✓	✓	✓
Express	-	-	✓
Non-Residential New Construction	✓	✓	✓
Process Efficiency	✓	✓	✓
Self Direct	✓	-	-

Source: Guidehouse analysis
✓ Principle segment service
✓ Available segment service

[1] Large business customer definition (for Self Direct): annual energy usage greater than 700,000 kWh or national or regional account with multiple facilities in one or more states.
[2] Small business customer definition (Express): annual energy consumption of less than 100 KW or 400,000 kWh, based on the last 12 months of billing history.

Evaluation Objectives

Process evaluation activities focus on determining key process-related program strengths and weaknesses, and identifying ways to improve the comprehensive portfolio and each program individually. The Process Evaluation team researched the questions impacting participation, program effectiveness and satisfaction, and administration and delivery.

Participation

- What are the key interests and motivations for potential and actual participants beyond the financial incentive offered?
- What are the key barriers to participation in the program?

Program Effectiveness and Satisfaction

- What improvements could be made to create a more effective program and to help increase energy and demand impacts?
- What is the status of implementing recommendations/issues identified in previous evaluations?
- How do the findings in the current year's evaluation compare to previous evaluations?
- Are participants and providers satisfied with the programs?
- Have implementation changes effectively increased satisfaction and/or participation?

Administration and Delivery

- Is program administration functioning effectively?
- Are there any problems with program delivery?
- Are program tracking systems adequate? Are program tracking systems consistently maintained? Do program tracking systems contain all data required to support AEP Ohio supervision, program tracking, and evaluation?
- Are program procedures documented and followed?
- Are verification procedures implemented in a manner consistent with program design?
- Are the implementation contractors meeting key performance indicators?

Process Evaluation Activities

Guidehouse conducted a number of Process Evaluation activities. Tasks included program manager and implementation contractor interviews, participant online and telephone surveys, and the comparative analysis across all Business sector programs.

PY2019 PROCESS EVALUATION TASKS							
Process Evaluation Activity	**CEI**	**DC**	**EP4B**	**EXP**	**NRNC**	**PE**	**SD**
Program Manager Interviews	✓	✓	✓	✓	✓	✓	✓
Implementation Contractor Interviews	✓	✓	✓	✓	✓	✓	✓
Participant Telephone Surveys	✓	-	✓	✓	-	-	-
Tracking Database Review	✓	✓	✓	✓	✓	✓	✓

Evaluation Reporting

Guidehouse developed a single comprehensive stand-alone 2019 Business Process Evaluation report compiling, comparing, and contrasting activities across the portfolio of Business programs. This method provides the most complete picture of how customers perceive the overall Business sector programs, and their motivations and barriers to program participation. This presentation of results aligns with the cross-cutting nature of business program marketing, satisfaction, cross-program referral opportunities, and customer experiences.

Results of each Process Evaluation activity are summarized across all programs. Findings and recommendations are presented as either cross-cutting (affecting multiple or all programs) or program specific (affecting one program).

Data Collection Details

Program Manager and Implementation Contractor Interviews

Guidehouse interviewed AEP Ohio Business Program Managers and Implementation Contractors two times for the 2019 program year. The interviews were conducted in November 2019 and March 2020, and were structured to coincide with and support other Process Evaluation activities. Each interview investigated specific program activities:

1. Current program activities and implementation challenges.
2. Follow-up questions, investigate status of 2018 evaluation recommendations, and provide feedback to AEP Ohio staff on preliminary evaluation activity findings.

This interview methodology is designed to support final evaluation findings and recommendations that are relevant and actionable by the AEP Ohio team.

1

Participant Telephone Surveys

Telephone surveys assessed customer experiences with AEP Ohio's business programs with the largest number of participants. Survey questions were consistent across programs (when relevant program activities permit) to allow comparative analysis of different programs. While consistent across broad topic areas for cross-program comparison, surveys were customized for each program to align with a participant's relevant program experiences. Surveys investigated participant barriers, program satisfaction, engagement with AEP Ohio staff and contractors, and key participant interests and motivations beyond the financial incentive offered. Telephone surveys were conducted in January 2020.

2

Tracking Database Review

Tracking databases for all programs were analyzed consistently across all programs. The review included checking for:

- Completeness
- Accuracy
- Elapsed time between key project milestones
- Distribution of savings across measures and program activities

3

02

Cross-Cutting Findings & Recommendations

Cross-Cutting Findings and Recommendations

Cross-cutting findings and recommendations have been developed based on the compilation of Process Evaluation activities across all programs, including Tracking Database Review, Customer Feedback, Program Manager and Implementation Contractor Interviews.

Details of cross-cutting activities are presented following the findings and recommendations.

Cross-cutting findings and recommendations are applicable to either a group or all of the Business sector programs.

Business Sector Successes

2019 Business programs performed well due to:

- **Bringing outreach in-house:** which synchronized the customer engagement approach across the portfolio and resulted in more projects according to AEP Ohio staff.
  - Was instrumental in getting participation in new CEI cohorts
  - Provided more time to work on NRNC early design meetings
  - Led to more EP4B and PE projects
- **Introducing a new midstream offering (Incentive NOW):** AEP Ohio efficiently introduced a midstream offering within the EP4B program. INCENTIVE NOW was rolled out systematically and helped EP4B and the Business portfolio achieve 2019 goals.
- **Positive customer feedback:** customer feedback from Express, EP4B, and CEI indicates participants were satisfied with the programs and the energy-efficient equipment installed[1].
- **Programs efforts to reach new customer types:**
  - NRNC reached more diverse customers with the Multifamily My Solutions application and a bonus incentive for Ohio Hospital Association members.
  - CEI is focusing on measures tailored to hospital and schools cohorts.
- **Increased channeling:** one fifth of 2019 program participants completed more than one project, seven percent more than 2018, suggesting the Business programs are well designed to meet the varied needs of customers.

[1] Customer feedback was not researched from DC, NRNC, PE, or SD

Cross-Cutting Recommendations

FINDING #1

CC-1. AEP Ohio's portfolio delivers unique service offerings to different customer segments. Customer feedback from Express, EP4B, and CEI indicates customer motivations to participate in energy efficiency programs differs across small, medium, and large businesses.

- Small businesses (Express) participate to save money. Medium-sized businesses (EP4B) want to save both money and energy, but participate for the incentive. Together Express and EP4B comprise 90% of Business projects but 51% of savings, with lower per-project savings compared to the rest of the programs.
- Larger businesses (CEI) want to save energy, yet also have more nuanced motivations (such as protecting the environment and networking opportunities with other participants). Where large businesses can have resources and dedicated engineers to manage projects, DC, PE, NRNC, and CEI deliver higher savings per-project and typically entail more complicated measures.

RECOMMENDATION #1

CC-1. Continue to tailor program services and messaging to reflect the needs of AEP Ohio's customer segments.

- Continue providing individual support to small business to help them find low and no cost ways to save energy and money.
- Cater messaging to large business with specific non-energy benefits that appeal to them. Continue providing networking opportunities for large business customers.

FINDING #2

CC-2. AEP Ohio's internal business sector customer satisfaction survey has a low response rate. Customer feedback requiring follow-up is communicated to program staff. Positive, average, and cross-cutting survey results are not consistently shared with program staff.

RECOMMENDATION #2

CC-2a.Consider revamping AEP Ohio's customer survey design and implementation tactics to increase response rates and open-ended feedback.

CC-2b. Prioritize data review and collaboration between program managers to provide up-to-date customer perspective and ensure future customers are engaged and satisfied.

Cross-Cutting Recommendations

FINDING #3

CC-3. Miscellaneous end uses account for 19% of all Business portfolio savings.

- Of those miscellaneous end uses, 81% were from PE “custom” projects. Guidehouse reclassified some miscellaneous end uses, bringing the portfolio miscellaneous category down to 16%.
- Reporting end uses with increased specificity would allow AEP Ohio to tailor program messaging and incentives to specific suppliers, contractors, and customers to achieve overall program goals.

RECOMMENDATION #3

CC-3. Classify measures into end-use categories with as much specificity as possible, particularly for PE projects. Collaborate with the PE IC to determine whether more specific end-use categories are appropriate to use for “custom” PE projects, and when to apply them.

FINDING #4

CC-4. Customer feedback indicates Express and EP4B customers are least satisfied with their ability to easily find program information.

RECOMMENDATION #4

CC-4. Review program materials for completeness and simplicity. Consider how customers can obtain program information and streamline if possible.

Cross-Cutting Recommendations

FINDING #5

CC-5. 2019 tracking data does not show project overlap between the DC and NRNC programs.

- New construction DC participants should also benefit from NRNC incentives, in addition to DC incentives.
- The DC program manager (PM) sends new construction participant leads to the NRNC PM or an Energy Advisor.

RECOMMENDATION #5

CC-5. Ensure the DC and NRNC teams are collaborating to serve customers. Consider delivering DC and NRNC program services as a bundle to new construction customers with data centers. Encourage collaboration early in the design phases to allow the NRNC program to influence energy-efficient building design.

FINDING #6

CC-6. Customer outreach was brought in-house to AEP Ohio in 2019. Outreach staff are more well-versed in program details and are better able to help customers navigate AEP Ohio's portfolio of energy efficiency programs. Program staff report the process is streamlined; outreach staff can more easily convey program information to bring in more projects as a result. This cross-cutting improvement gave PMs more control over outreach team goals, and they report it has resulted in more projects.

RECOMMENDATION #6

CC-6. Continue collaboration between the outreach team and PMs to develop and manage outreach goals. Continue training Energy Advisors on program details to address customer needs.

Cross-Cutting Recommendations

FINDING #7

CC-7. Guidehouse mapped program staff terminology by task and found differences across programs. Program outreach was aligned and streamlined when it was brought in-house in 2019.

RECOMMENDATION #7

CC-7. Review program terminology and continue simplifying it to allow AEP Ohio outreach staff and program staff to easily communicate to customers and make it easy for customers to navigate the AEP Ohio energy efficiency programs.

AEP Ohio

IC

Third Party

	Express	CEI	DC	NRNC	EP4B | PE | SD
Outreach	Energy Service Representatives	AEP Ohio Account Manager	Energy Advisors		
Help customer with application	-	-	Energy Engineers	Project Manager/ Coordinator	Energy Advisors
One-on-one customer support	Energy Service Representatives	Energy Coaches	Program Manager	Technical Account Manager with Project Coordinator	Customer Services Group (Customer Service Engineers, Account Managers, Customer Service Representatives)
Additional technical support	-	Modelers/ Engineers	Energy Engineers	Analysts/ Engineers	Review Team/Review Engineer
Equipment installation	Solution Providers (contractors)			Solution Providers (architect/engineer)	Solution Providers (contractors)
Contractor management	Operations Team	-			AEP Ohio Contractor Manager and Outreach Team

Business Portfolio Results

Program Activities

Program tracking databases were reviewed to:

- Compare program performance across the Business portfolio
- Determine whether data is accurately and consistently tracked for each program and across the portfolio
  - Is data entry within reasonable bounds? (minimums, maximums, averages)
  - Are critical data fields complete?
- Identify elapsed times for critical project tasks, such as:
  - Total project time
  - Time from project completion to incentive payment

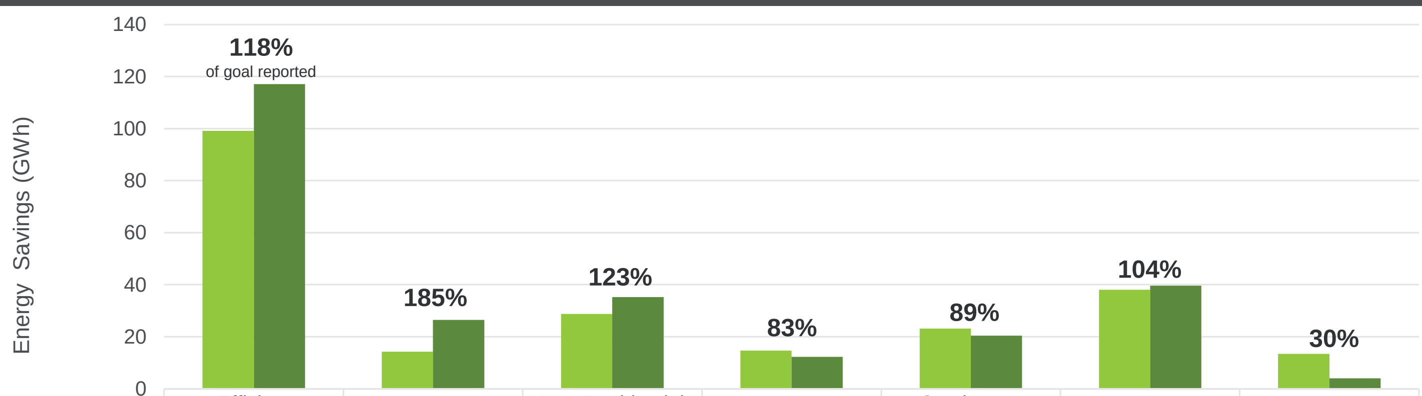
The portfolio is managed through individual program databases; all data is sourced from final 2019 program tracking databases.

Business Sector Results: Energy Savings Goals vs. Reported (Ex Ante) Savings

Finding: While the Business Sector ex ante savings exceeded the portfolio goal[1] by ten percent, individual program results varied. 2019 energy performance mirrored that of 2018, where the portfolio energy goal was exceeded by twelve percent.

- Direct comparison of goals vs. reported (ex ante) savings reveals that EP4B, DC, NRNC, and PE exceeded 2019 goals.
  - DC and NRNC led in exceeding goals, DC reported 185 percent of initial goals and NRNC 123 percent.
- Express, CEI, and SD did not achieve program year goals.
  - While CEI and Express achieved 89 percent and 83 percent, respectively, SD achieved 30 percent of target. (Self Direct has a stated goal in the plan, but the program's primary goal is customer satisfaction.)

2019 PROGRAM GOALS VS EX ANTE ENERGY SAVINGS (GWh)



	Efficient Products for Business	Data Center	Non Residential New Consttruction	Express	Continuous Energy Improvement	Process Efficiency	Self Direct
2019 Goal	99.1	14.3	28.8	14.7	23.1	38.1	13.4
2019 Savings	117.1	26.4	35.3	12.3	20.5	39.6	4.0

[1] Goals reflect the filed plan.

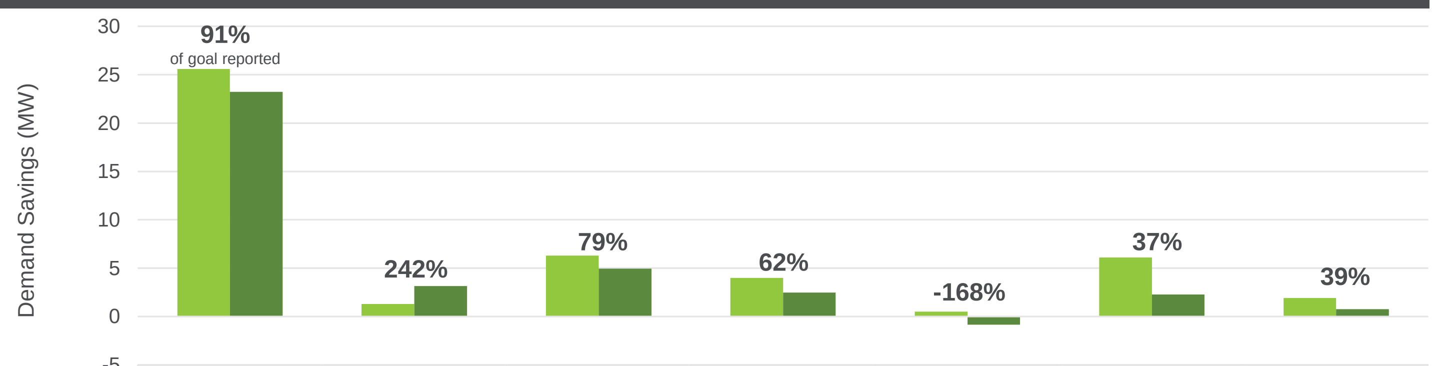
Figure Data Source: Guidehouse analysis of 2019 program tracking databases.

Business Sector Results: Peak Demand Reduction Goals vs. Reported (Ex Ante) Savings

Finding: Overall Business programs achieved 79 percent of the 2019 Peak Demand Reduction goal[1]; this is less than 2018 where 83 percent of the goal was achieved (ex-post results). Performance varied across programs and did not always coincide with the associated energy savings trends.

- Direct comparison of goals vs. reported (ex ante) savings reveals that DC was the only program to meet – and exceed - its demand savings targets.
- Contrary to their energy savings performance (as depicted on the previous slide) EP4B, NRNC, and PE programs did not achieve demand savings goals, highlighting that energy savings and demand savings performance varies across programs.
- Express and SD reported 62 and 39 percent, respectively, of their goals.
- CEI delivered negative demand savings, discussed further in the CEI section.

2019 PROGRAM GOALS VS. EX ANTE DEMAND SAVINGS (MW)



	Efficient Products for Business	Data Center	Non Residential New Consttruction	Express	Continuous Energy Improvement	Process Efficiency	Self Direct
2019 Goal	25.6	1.3	6.3	4.0	0.5	6.1	1.9
2019 Savings	23.2	3.1	5.0	2.5	-0.8	2.3	0.7

[1] Goals reflect the filed plan.

Figure Data Source: Guidehouse analysis of 2019 program tracking databases.

Business Sector Results: Program Comparison

Finding: AEP Ohio achieves its overall portfolio goal by delivering a variety of programs to meet the needs of small and large projects, through many smaller projects or a few very large projects.

- EP4B is the largest program in terms of both savings and projects.
- EP4B and Express are the only programs to have savings-to-project ratios less than one, indicating that these have lower *per-project* savings compared to the rest of the programs.
  - Together EP4B and Express make up 90 percent of projects, but 51 percent of savings
- DC, PE, NRNC, and CEI deliver high savings to project ratios, indicating relatively high *per-project* savings.
  - DC in particular accounts for 10 percent of total portfolio savings (driven by 11 large new construction projects), but less than one percent of projects.

PERCENT OF 2019 Business PORTFOLIO PROJECTS VS. PERCENT OF SAVINGS PER PROGRAM

	Efficient Products for Business	Data Center	Non Residential New Construction	Express	Continuous Energy Improvement	Process Efficiency	Self Direct
%savings	45.9%	10.4%	13.8%	4.8%	8.0%	15.5%	1.6%
%projects	74.5%	0.4%	4.2%	15.8%	2.8%	1.3%	1.0%
Ratio	0.62	23.87	3.32	0.31	2.89	11.51	1.56

Figure Data Source: Guidehouse analysis of 2019 program tracking databases.

Business Sector Results: Project Average Data Table

Finding: The portfolio obtained total ex ante savings of 255,230 MWh at an average (AVG) incentive cost of $0.066/kWh.

EP4B generates the most savings and projects for the portfolio, through relatively low savings and incentive cost per project. Additionally, Express projects had the lowest per project savings and the highest average incentive per kWh. Comparatively, DC serves the smallest number of projects, with a relatively high average savings, participant cost, and incentive.

Program	AVG 2019 Energy Savings per Project (MWh)	AVG 2019 Demand Savings per Project (KW)
EP4B	38	8
DC	1,468	174
NRNC	204	29
Express	19	4
CEI	178	-7
PE	708	41
SD	96	18
SECTOR AVG	**62**	**9**

Figure Data Source: Guidehouse analysis of 2019 program tracking databases

Business Sector Results: Historical Program Energy Savings

Finding: **Portfolio energy savings decreased by seven percent from 2018 to 2019. Programs serving smaller and mid-sized businesses have seen increased savings, while programs serving larger businesses and projects have seen reduced savings**.

- DC performance has increased over time, with a slight 2019 decrease.
- Since 2017, EP4B has trended down. CEI is also trending downwards.
- Conversely, PE performance has decreased over time, with a 2019 increase.
- Express, SD, and NRNC have remained relatively constant over time, with only slight performance variation.

PROGRAM ENERGY SAVINGS (MWh) 2014 to 2019

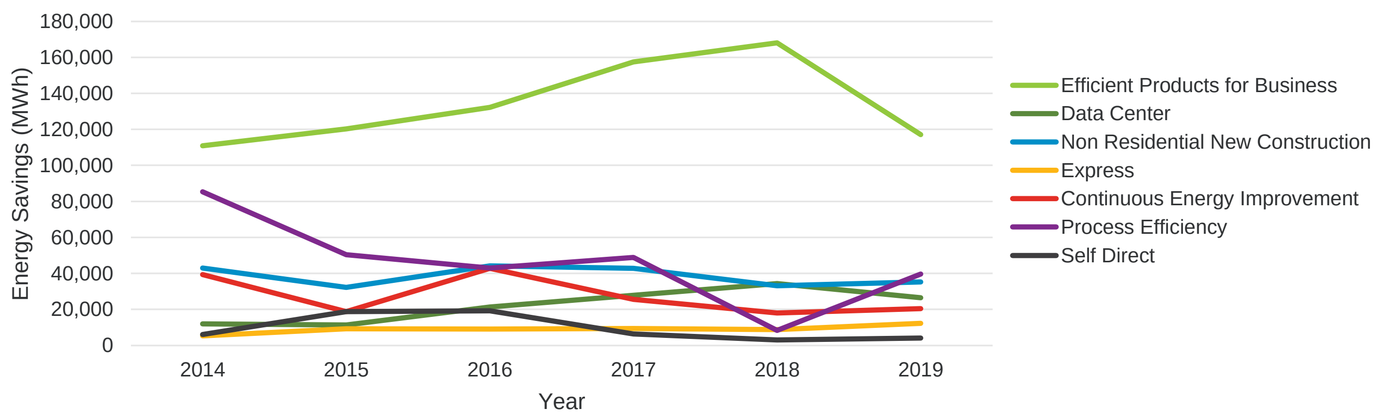


Figure Data Source: Appendix A - Historical MWh Comparison Data-Table 1.

[1] 2014 – 2018 savings are ex post. 2019 savings are ex ante.

[2] 2014 – 2016, Efficient Products for Business was called the Prescriptive Program and Process Efficiency was called the Custom Program.

Business Sector Results: Historical Program Demand Savings

Findings:

- DC and EP4B demand savings performance has increased over time, with a decrease in 2019.
- PE demand savings performance has decreased over time, with an increase in 2019.
- CEI demand performance has varied over time, with a downward trend over the last two years.
- Express, SD, and NRNC have remained relatively constant over time, with some performance variation.

PROGRAM DEMAND SAVINGS (MW) 2014 to 2019

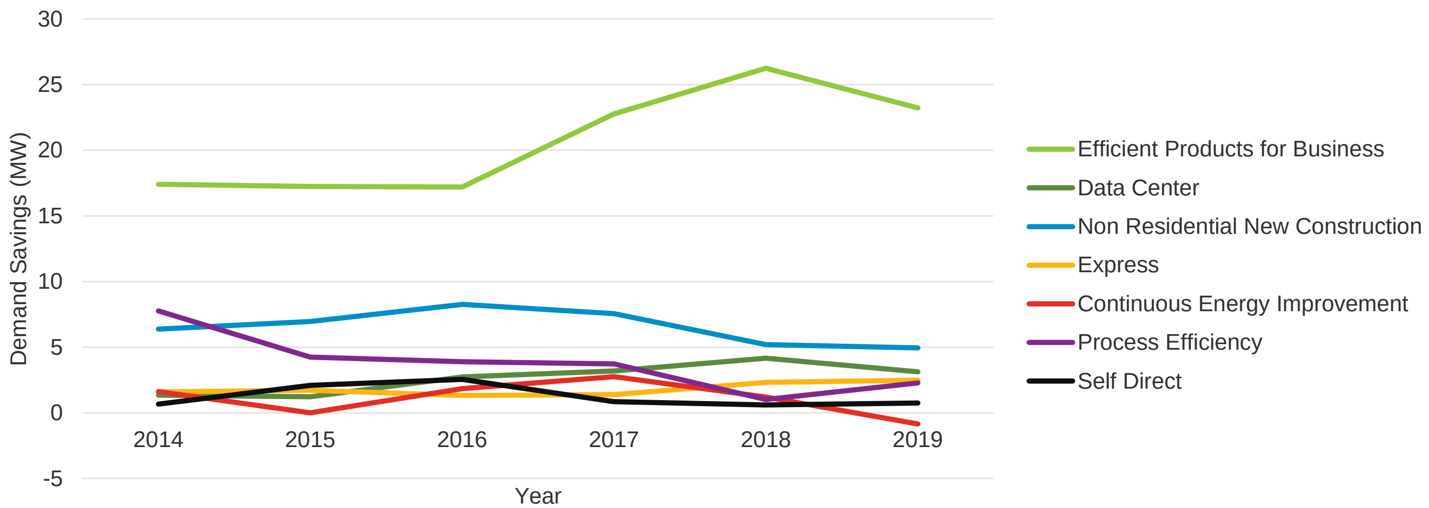


Figure Data Source: Appendix A - Historical MW Comparison Data-Table 2

[1] 2014 – 2018 savings are ex post. 2019 savings are ex ante.

[2] 2014 – 2016, Efficient Products for Business was called the Prescriptive Program and Process Efficiency was called the Custom Program.

[3] In historical reports, Demand Savings is oftentimes referred to as the Coincident Peak Reduction.

Business Sector Results: Economic Segments

Savings to project ratio's compare savings benefits with the number of projects delivered for each economic sector. Often this is related to the deliver mechanism (program type).

Business sector savings and project results vary widely by economic segment. This is illustrated by the economic segments with the most savings (Industrial / Manufacturing and Retail / Service) delivered with different relative percentage of overall projects, resulting in a savings-to-project ratio of 3.1 and 0.7 respectively.

Finding: The savings to project ratio for Data Center (32.4) and Industrial / Manufacturing (3.14) identify these as the leading economic segments for per project savings.

- Industrial/Manufacturing ratio almost doubled from 2018 to 2019, primarily due to increased economic segment participation in PE.
- Data Centers provides 10 percent of the portfolio energy savings with 18 projects.

Segments delivering a higher percentage of the portfolio's projects are more likely to be served through EP4B and Express. Retail / service and office economic segments have lower savings-to-project ratios of 0.7 and 0.3 respectively.

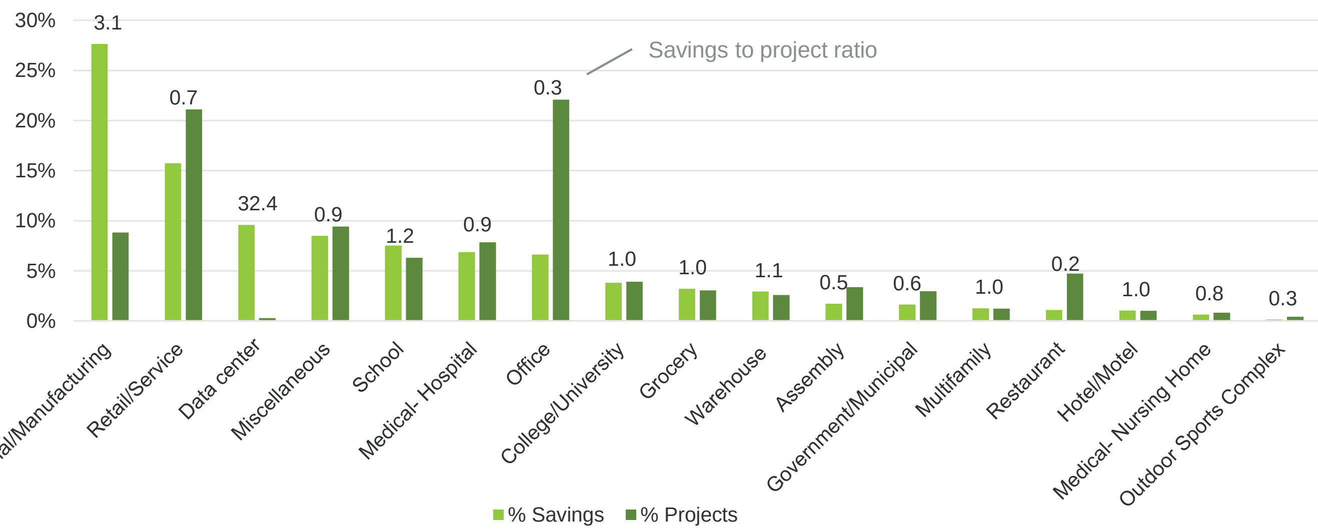


Figure Data Source: Guidehouse analysis of 2019 program tracking databases; Combined Heat and Power (CHP) not included.

Business Sector Results: Economic Segments Data Table

EP4B served all segments, except Data Centers. The leading economic segment for savings, Industrial/Manufacturing, is served by all programs, except DC (majority from PE, followed by EP4B).

Nine percent of the portfolio is allocated to the miscellaneous economic sector, making it difficult to analyze the portfolio's impact on customers; main contributors include EP4B, NRNC, and Express.

Economic Segment	EP4B	DC	NRNC	Express (MWh)	CEI	PE	SD
Assembly	3,172	-	430	757	-	-	1
College/University	7,326	-	531	-	1,511	-	351
Data Center	-	24,475	-	-	-	-	-
Government/Municipal	4,158	-	-	-	-	-	4
Grocery	3,823	-	1,884	583	1,390	-	495
Hotel/Motel	1,283	-	1,383	14	-	-	-
Industrial/Manufacturing	20,947	-	6,442	1,461	4,583	34,918	2,233
Medical- Hospital	5,636	-	6,217	-	5,311	350	10
Medical- Nursing Home	1,623	-	-	-	-	-	-
Multifamily	2,725	-	391	69	-	-	42
Office	10,310	1,431	1,801	1,289	-	1,973	141
Outdoor Sports Complex	326	-	-	-	-	21	-
Restaurant	1,376	-	92	1,354	-	11	-
Retail/Service	28,232	158	4,401	3,170	3,413	116	683
School	13,158	248	2,626	78	897	2,208	-
Warehouse	6,205	-	206	690	279	41	58
Miscellaneous/Unassigned[1]	6,845	114	6,157	2,795	-	-	-
Other Unlisted Segment[2]	-	-	2,732	-	3,068	-	-
TOTAL	**117,144**	**26,426**	**35,292**	**12,262**	**20,452**	**39,637**	**4,017**

Figure data source: Guidehouse analysis 2019 of ex ante program tracking databases. ; Combined Heat and Power (CHP) not included.

[1] Includes projects listed as miscellaneous and/or were not assigned any segment.

[2] Segments less than two percent of portfolio savings and outside of the portfolio-wide segment list.

Note: Different programs use slightly different and sometimes more granular terms to describe economic segments. The evaluation team rolled up sub-segments for portfolio comparison, see Appendix A, Slide 91.

Business Sector Results: End Use

Findings: Lighting and Miscellaneous end uses account for 72 percent of all Business portfolio savings.

- Lighting accounts for over half of portfolio savings; all programs except CEI and DC contain lighting savings.
- Miscellaneous accounts for the second largest end use savings at 19 percent, due to the PE “custom” designation.
- Five of fourteen end uses have relative savings one percent or less, indicating the majority of end uses are contributing small savings to the overall portfolio.

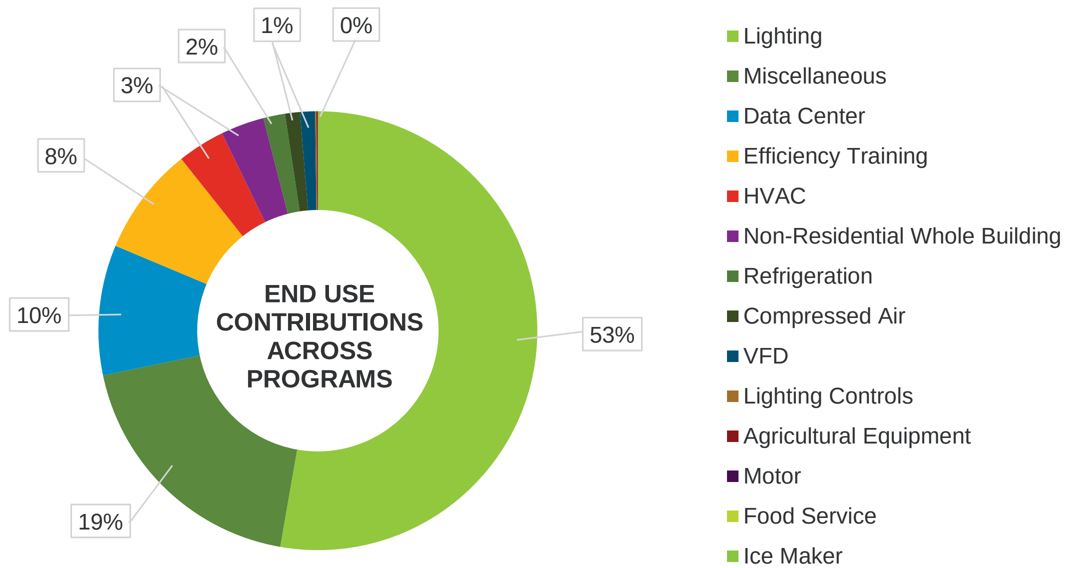


Figure Data Source: Guidehouse analysis of 2019 program tracking databases; Combined Heat and Power (CHP) not included.

Business Sector Results: End Use Data Table

Lighting achieved the most end use savings in EP4B, NRNC, and Express. Not surprisingly, Data Centers and Efficiency Training contributed the most savings to the DC and CEI programs, respectively. The leading end uses by program directly align with 2018 observed trends.

Miscellaneous achieves the most savings in PE due to the “custom” designation, accounting for 98 percent of program savings. Guidehouse proposes a disaggregation of PE end uses in the PE section, slide 60.

End Use	EP4B Total Savings (MWh)	DC Total Savings (MWh)	NRNC Total Savings (MWh)	Express Total Savings (MWh)	CEI Total Savings (MWh)	PE Total Savings (MWh)	SD Total Savings (MWh)
Lighting	104,684	-	16,887	11,640	-	396	1,117
Miscellaneous	2	1,431	6,549	-	-	39,195	1,257
Data Center	-	24,475	-	-	-	-	-
Efficiency Training	-	-	-	-	20,452	-	-
HVAC	5,314	520	2,985	-	-	-	36
Non-Residential Whole Building	-	-	8,074	-	-	-	-
Refrigeration	1,992	-	453	590	-	13	936
Compressed Air	2,805	-	-	-	-	32	52
VFD	2,036	-	73	-	-	0	619
Lighting Controls	-	-	256	32	-	-	-
Agricultural Equipment	176	-	-	-	-	-	-
Motor	96	-	3	-	-	-	-
Food Service	37	-	-	-	-	-	-
Ice Maker	3	-	12	-	-	1	-
Total	**117,144**	**26,426**	**35,292**	**12,262**	**20,452**	**39,637**	**4,017**

Figure Data Source: Guidehouse analysis of 2019 program tracking databases; Combined Heat and Power (CHP) not included.

Business Sector Results: Participation Analysis Data Table

In every program, there are customers that complete more than one project per year. Customers are defined based on the customer name field. In the case of similar, but slightly different customer designations (for example 'Retailer XYZ' versus 'Retailer XYZ Stores'), Guidehouse counted these as a single customer.[1]

Finding: In 2019, 22 percent of Business customers completed more than one project per year. This reflects an increase in unique customer participation compared to 2018, when less than 13 percent of customers completed multiple projects.

Finding: Overall number of participating customers decreased from 1,968 in 2018 to 1,901 in 2019.

Program Name	Total Number of Projects	Total Number of Customers	Number of Customers Completing…					
			1 Project	2-5 Projects	6-10 Projects	11-20 Projects	21-50 Projects	>51 Projects
EP4B	3,091	1,114	930	145	20	7	6	6
DC	18	6	3	2	-	1	-	-
NRNC	173	119	25	67	19	6	1	1
Express	655	542	443	98	1	-	-	-
CEI	115	56	33	21	1	1	-	-
PE	56	38	32	5	1	-	-	-
SD	42	26	24	1	-	1	-	-
TOTAL	**4,150**	**1,901**	**1,490**	**339**	**42**	**16**	**7**	**7**

[1]Counts of customers will not align to AEP filing due to Guidehouse analysis adjustments.
Figure Data Source: Guidehouse analysis of 2019 program tracking databases ; Combined Heat and Power (CHP) not included.

Business Cross-Cutting Customer Feedback

Cross-Cutting Customer Feedback

Cross-Cutting Customer Feedback is informed by telephone surveys with 2019 Express, CEI, and EP4B program participants. The surveys were conducted in January 2020.

The surveys explored:

- Respondent Firmographics
- Program Awareness and Motivation
- Program Experience and Satisfaction
- Benefits and Barriers to Participation

Cross-Cutting Customer Feedback

Respondent Firmographics

Q: How would you categorize the business conducted at this site?

[This should be the main business activity that occurs at this location. For example, is it an office, a warehouse?]

Finding: Survey respondents represented a diverse audience of business types, consistent with economic segment participation analysis.

	Express	EP4B	CEI
Assembly	3%	13%	-
Government/Municipal	1%	8%	-
Grocery	6%	-	-
Industrial/Manufacturing	8%	**19%**	**80%**
Multifamily	1%	-	-
Hotel/Motel	-	2%	-
Office	-	4%	-
Restaurant	13%	5%	-
Retail/Service	**49%**	16%	-
Education/ College/School	-	10%	10%
Warehouse	-	3%	
Hospital/Medical	-	3%	10%
Other[2]	13%	16%	-
Don't Know	-	1%	-
TOTAL PERCENTAGE[1]	**100%**	**100%**	**100%**
TOTAL RESPONSES	**N = 76**	**N = 100**	**N = 10**

[1] Some percentages were rounded, but overall all entries sum to 100%.

[2] Other responses for Express included: childcare center, greenhouse, charitable facility, delivery truck, bowling center, church, meat processing plant, nonprofit food pantry. The other responses for EP4B included: postal service, social service agency, fairgrounds, farming, call center, large office and a gym, church/nonprofit, farm, parking lot or outside area.

Cross-Cutting Customer Feedback

Program Awareness

Q: Now, we'd like to ask a few questions about your participation in the program, and how you learned about it. How did you first learn of the AEP Ohio program?

Finding: Customers learn about the program through various means.

The most common mediums customers hear about the program are an AEP Ohio representative, installation contractors, and their participation in another AEP Ohio EE program.

	Express	EP4B	CEI
AEP Ohio Staff Representative	**38%**	13%	**67%**
AEP Ohio Website	1%	6%	-
Participation with another AEP Ohio EE Program	5%	**22%**	-
Friend/ Colleague/ Word of Mouth	13%	16%	-
Installation Contractor	**25%**	**21%**	-
Retailer/Supplier/Wholesaler	-	20%	-
E-mail	1%	3%	-
Bill Insert	5%	1%	11%
Mail/Letter	17%	-	-
Other[2]	7%	9%	44%
Don't Know	1%	7%	11%
TOTAL PERCENTAGES[1]	**115%**	**118%**	**133%**
TOTAL RESPONDENTS	**N = 87**	**N = 118**	**N = 12**

[1] This was a multiple response question, meaning customers could select multiple options. Because of that, percentages sum to over 100%. Some responses were rounded to display whole numbers.

[2] Other responses for Express included: company trustee, previous company owner, Lime Energy. Other responses for EF4B included: commercial, flyers, telephone call, conferences, mail, energy advisor. Other results for CEI included: AEP Ohio meeting, previous experience.

Cross-Cutting Customer Feedback

Program Experience and Satisfaction

Q: On a scale from 0 to 10, with 0 being very dissatisfied and 10 being very satisfied, how would you rate your level of satisfaction with the following program aspects?

Finding: Overall, all Business customers were satisfied with AEP Ohio EE programs.

The Express and EP4B programs received the highest satisfaction ratings, while the CEI program received a slightly lower overall satisfaction rating. Express and EP4B respondents were very pleased with the products rebated through the program.

CEI program respondents gave lower satisfaction ratings to implementing improvements to their facilities; while not a direct satisfaction indicator for AEP Ohio, it does provide context for their overall project experience.

Satisfaction with final application submission indicates Energy Advisors are well informed to help customers complete EP4B applications and answer questions.

Program Aspect (Mean Satisfaction)	Express	EP4B	CEI
Finding Information about the program	8.3	8.1	
The free energy assessment	9.1		
Preparing and submitting the pre-approval application form		8.6	
The amount of time to indicate funds were reserved		8.6	
The time it took to receive the incentive		8.7	
The final application submission		8.9	
The energy efficiency measures offered through the program	9.2	9.0	
Communication with program staff	9.1	8.9	9.5
Program training			8.3
Implementing improvements to their facility			7.2
PROGRAM OVERALL	**9.1**	**9.1**	**8.9**
TOTAL RESPONDENTS	**N = 76**	**N = 100**	**N = 10**

Question was not asked for these program respondents

[1] "Don't Know" responses were removed from this analysis. As a result, the 'N' may vary slightly by program aspect.

[2] Red text identifies aspects with lower satisfaction while **Blue** text identifies aspects with higher satisfaction.

[3] A follow up question was asked to all respondents to explain the reason for their satisfaction rating.

Cross-Cutting Customer Feedback

Program Motivation

Q: What were the main reasons your company decided to participate in the program?

Finding: Customers participate in the program to save money and energy.

	Express	EP4B	CEI
AEP Ohio/energy efficiency program incentive	12%	39%	30%
Save energy	**32%**	**51%**	**50%**
Save money	**76%**	**50%**	30%
Technical Assistance	6%	-	-
Protect the environment	1%	2%	20%
Recommended by contractor	1%	-	-
Old equipment was no longer functioning, replacement was necessary	13%	14%	-
To demonstrate our company's belief in energy efficiency	5%	7%	20%
Improved Lighting	17%	18%	
Other[2]	8%	9%	70%
TOTAL PERCENTAGE[1]	**172%**	**190%**	**220%**
TOTAL RESPONDENTS	**N = 131**	**N = 190**	**N = 22**

Question was not asked for these program respondents

[1] This was a multiple response question, meaning customers could select multiple options. Because of that percentages sum to over 100%. Some responses were rounded to display whole numbers.

[1] Other responses for Express included: short payback period, better products, replacing old equipment that was still working, newer equipment. The other responses for EP4B included: competitive advantage, ease of applying the rebate, return on investment, financial feasibility, to be a solution provider for AEP Ohio, the energy documentation, rebuilding old motors. The other responses for CEI included: learning about new technologies, progression modeling, networking, free to participate, hearing ideas from other participants.

Cross-Cutting Customer Feedback

Benefits to Participation

Q: What do you see as the main benefit(s) to participating in the AEP Ohio Program?

Findings:

- **Benefits to participation varied by program. Common themes include energy savings, the incentive, and improved lighting.**
- **CEI participants stressed that networking is one of the main benefits of the program. Participants enjoy learning about energy efficiency from others in their cohort.**
- **Notably, technical assistance was not identified as a main benefit for any program.**

	Express	EP4B	CEI
The incentive	21%	44%	20%
Energy savings	**72%**	**72%**	20%
Design/technical assistance	13%	1%	10%
Environmental and sustainability benefits	13%	14%	0%
Improved lighting	28%	28%	
Networking			**40%**
Other[2]	24%	29%	30%
Don't know	1%	1%	10%
TOTAL PERCENTAGE[1]	**172%**	**189%**	**130%**
TOTAL RESPONDENTS	**N = 131**	**N =189**	**N =13**

Question was not asked for these program respondents

[1] This was a multiple response question, meaning customers could select multiple options. Because of that percentages sum to over 100%. Some responses were rounded to display whole numbers.

[2].Other responses for Express included: easy process, and quality of the equipment. The other responses for EP4B included: partnerships, productivity gains, the learning opportunity, seeing a lot better, a good business sales point, networking, helps fund other marginal projects, ease of participation. Other responses in the CEI section included: Receiving the Energy Champion Award, the low cost/no cost aspect of it, ability to identify energy waste was helpful, learning a wealth of information.

Cross-Cutting Customer Feedback

Barriers to Participation

Q: What do you see as the drawback(s) to participating in the program?

Finding: Most Express, EP4B, and CEI participants did not report any barriers to participation. Respondents had positive remarks about their experience in the programs.

	Express	EP4B	CEI
Completing the application	-	10%	-
The time it takes to plan and complete the project	3%	3%	10%
The time it takes to receive the incentive	-	2%	-
Upfront costs	-	10%	-
There are no drawbacks	**72%**	**61%**	**70%**
Other[2]	25%	15%	20%
Don't Know	-	3%	-
TOTAL PERCENTAGE[1]	**100%**	**104%**	**100%**
TOTAL RESPONSES	**N = 76**	**N = 104**	**N = 10**

[1] This was a multiple response question, meaning customers could select multiple options. Because of that, percentages sum to over 100%. Some responses were rounded to display whole numbers.

[2] Other responses for Express included: No energy savings, the interruption of the contractor, lack of program information, the upfront cost. Other responses for EP4B include: only certain things are covered, follow-up questions to validate energy savings, "have to lay a little money out at the start", "just that I didn't know about it earlier". Other responses from the CEI section include: "Reporting. It is difficult to record everything the facility is doing to be more efficient, no program incentive.

03

Program Specific Findings & Recommendations

Continuous Energy Improvement Program

Findings & Recommendations: Continuous Energy Improvement

The Continuous Energy Improvement (CEI) program provides tools within a structured training program to help large-scale businesses implement strategic energy management with little or no capital investment.

While the program is expanding into other segments such as universities, schools and hospitals, manufacturing continues to represent the largest group of participants. Eligible customers also include distribution centers, mining operations, municipal waste and clean water processing facilities, schools, offices, restaurants, and others.

PROCESS EVALUATION ACTIVITIES	
Program Manager Interviews	✓
Implementation Contractor Interviews	✓
Participant Telephone Surveys[1]	✓
Tracking Database Analysis	✓

[1] One combined set of telephone surveys was conducted for both the Process Evaluation and Impact Evaluation project verification.

CEI Program Demand Savings

In 2019, the Continuous Energy Improvement (CEI) program had an overall negative ex ante demand savings value.

Since CEI participants are involved with the program over multiple program years, negative demand savings in the tracking data tend to be a result of adjustments between expected and reported savings across years of repeat participation.

Negative kW does not mean that the CEI site did not conduct activities or that those activities are not saving energy. Rather, the model, as built, cannot detect the impact of those activities. This could be due to a change in facility operation, natural site noise, building expansion, new equipment, measures implemented during off peak periods, or other changes that may impact whole building usage .

The relative frequency of negative demand savings claims in 2019 is expected and within the bounds of reasonability as compared to program year 2018.

CEI Demand Savings Data

Parameter	2018	2019
Total Projects	57	115
Negative Demand Savings Projects	14	28
% Negative Demand Savings Projects	25%	24%

Source: Guidehouse analysis of PY2018 and PY2019 ex ante tracking data.

CEI Program Customer Feedback

A telephone survey was conducted with ten CEI participants to gather their thoughts and insights regarding the program. The survey, conducted in January-February 2020 also supported impact evaluation project verification.

Finding: Overall, participants are pleased with the program:

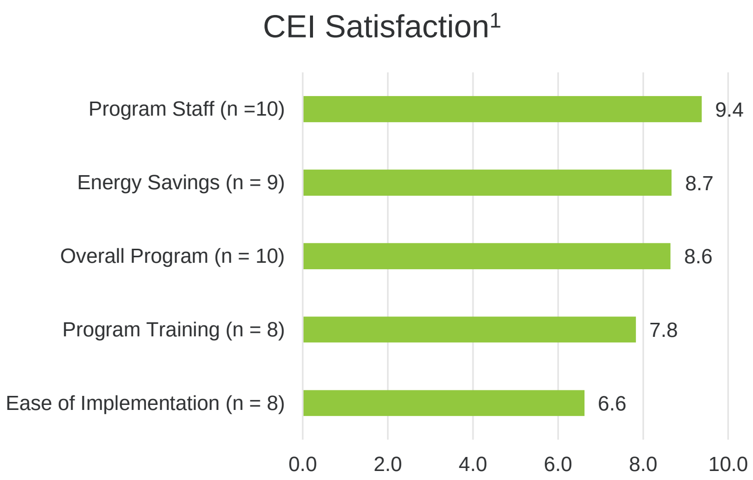
- **Ninety percent** of interviewees would recommend the program to others.
- **Seven** interviewees returned as members of the alumni cohort.

As mentioned in the past, the time commitment for CEI participation and individual company constraints continue to be the biggest drawbacks for the program.

Finding: Participants appreciate the benefits of group trainings and onsite visits.

- Compressed air continues to be a topic that manufacturing participants appreciate learning more about, as one of the higher site end-uses.
- Participants are interested in learning about newer technologies, such as heat exchanger applications (to capture useable waste energy in both cooling and heating processes) that can be implemented in their facilities.
- Program onsite visits are valued by participants to identify projects; and helping the site to save energy and money.
- Two participants (or 20% of participants) suggested having annual onsite visits to assist identifying additional projects – especially after the low-cost, no-cost projects have been installed.

CEI Program Customer Feedback



Satisfaction Findings: Overall, participants were very satisfied with the program. Communication with program staff received the highest satisfaction rating while the ease of implementing recommended measures received a slightly lower satisfaction score.

- Participants are very satisfied with their interactions with the CEI program staff, rating their average satisfaction as a **9.4**.
- Participants ranked their overall satisfaction with the program an average of **8.6**.
- Participants were happy with the savings the CEI program provided their facility, rating their average satisfaction with energy savings as an **8.7**
- Participants were pleased with program trainings, indicating they were a beneficial learning opportunity. They rated their average satisfaction as a **7.8**.
- Participant satisfaction with implementing the recommended measures received the lowest rating, giving it an average satisfaction rating of **6.6**. While common reasons for implementation issues were related to their particular facility constraints, the CEI program could consider developing support tools for facility champions to engage decision makers and promote their projects.

Source: Guidehouse CEI participant telephone survey.

[1] "Don't Know" responses were removed from this analysis. As a result, the 'N' may vary slightly by program aspect.

CEI Program Customer Feedback

Finding: The CEI program provided customers with financial benefits:

- Over **70 percent** of CEI participants noticed lower energy bills. Those who did not see reductions, attributed the lack of savings to an expansion of their facility or operations.
- Two participants felt their savings were more than expected.
- Four thought the savings were about what they expected.
- Two felt that the savings were less than they expected.

"I like the low cost/no cost aspect of it. We have been in the program so long, it's harder to find things. But from a cultural perspective, it's an easy thing to train new employees on the concept of low cost/no cost. And, participation in the program is a nice way to show upper management we are continually trying to reduce our costs."

Customer

"I think it was a good partnership with AEP Ohio on how we can save on our energy usage by educating and coaching us. I felt we let them down by not doing our part due to internal time and resource constraints."

Customer

[A benefit of the program is] "…the ability to have an adviser to help with any energy concerns and learning from others in your industry; including both their success and mistakes to avoid making the same mistakes in your own area."

Customer

"The CEI program is a great opportunity that everybody should take advantage of. One of the best programs we have ever had, it has changed a lot of the things here."

Customer

Source: Guidehouse CEI participant telephone survey.

CEI Program Recommendations

FINDING #1

CEI-1. CEI participants give the program high satisfaction generally, and specifically to the networking opportunities and knowledge exchange during first year trainings.

RECOMMENDATION #1

Continue to coordinate with alumni participants to host group cohort visits at various sites.

FINDING #2

CEI-2. Participants value AEP Ohio and IC on-site visits to assist identify and prioritize projects. An annual onsite visit (currently available to limited, specific customer groups) could help alumni participants continue to identify additional projects – particularly after low-cost / no-cost projects have been completed.

RECOMMENDATION #2

Consider offering onsite walk-throughs to all alumni cohorts on an annual basis.

FINDING #3

CEI-3. Participants view implementation of larger projects, combined with the CEI program time commitment requirements as barriers to success.

RECOMMENDATION #3

Consider providing additional support to facility champions to assist with implementation of energy efficiency projects, including:

- Project identification
- Cost justification
- Project planning

FINDING #4

CEI-4. Participants are interested in learning about newer technologies that can be implemented in their facilities (for example: waste heat capture and reuse).

RECOMMENDATION #4

Consider additional subject matter expert presentations at group cohort events on the latest energy efficiency technologies to discuss specific participant opportunities.

Data Center Program

Findings & Recommendations: Data Center Program

The Data Center (DC) program targets customers with data centers of all IT load levels interested in reducing the energy intensity of their IT and cooling infrastructure. The DC program provides incentives for energy efficiency improvements that may cover up to 50 percent of project costs.

PROCESS EVALUATION ACTIVITIES	
Program Manager Interviews	✓
Implementation Contractor Interviews	✓
Participant Telephone Surveys	-
Tracking Database Analysis	✓

2019 DC Program Project Size

Data center projects up to 10,000 square feet are classified as small to mid-size. Based on this project size definition, tracking data indicate the program is primarily serving 'mega or utility-size data centers'.

This data reveals that the program did not succeed in targeting more small data center projects this program year. Compared to 2018, the program included fewer localized data centers and server rooms, and more enterprise and utility-scale data centers.

DC Project Size Data			
AEP Ohio Description[1]	**Sq. Ft.**	**#2018 Projects**	**#2019 Projects**
Server closets or rooms	< 500	1	2
Localized data centers	500-5,000	5	0
Enterprise data centers	5,000-10,000	2	3
Mega or utility-scale data centers	> 10,000	7	13
Total Projects		15	18

Source: Guidehouse analysis of PY 2018 and PY2019 tracking data.

[1] Description definitions from AEP Ohio program manager. Number of projects based on database reported sq.ft.
Source: Guidehouse analysis of PY 2018 and PY2019 tracking data.

2019 DC Program Contractor & Time Analysis

Contractor information was a source of data incompleteness in the DC program; this includes ‘Contractor’ field left blank or filled out as “Multiple Contractors” with no specific contact information. The database does not address whether projects designated “Multiple Contractors” were conducted by customer in-house staff or a contractor.

Time analysis for the Data Center program reflect that the elapsed time between major touch points range widely, but on average have reasonable timelines. Customer total participation in the program lasts 295 days on average from pre-application date to incentive payment.

DC Contractor Data

Contractor	Count	Savings (kWh)	% of Program Savings (kWh)
Self Performed	1	1,430,851	5%
Multiple Contractors	12	24,475,006	93%
Contractor A	2	158,269	1%
Contractor B	2	113,590	0%
Contractor C	1	248,405	1%

Source: Guidehouse analysis of PY2019 tracking data, n=18

DC Time Data

Touchpoint 1	Touchpoint 2	Min Time Elapsed (Days)	Max Time Elapsed (Days)	Average Time Elapsed (Days)
Application submitted	Actual project complete	(96)[1]	346	8
Pre-application submitted	Incentive paid	109	494	295
Actual project complete	Incentive paid	47	163	101

[1] Values in red parenthesis indicate negative values.

DC Program Recommendations

FINDING #1

DC-1. Program did not achieve 2019 goal of expanding service to include more smaller size data center projects.

RECOMMENDATION #1

DC-1a. Leverage AEP Ohio's in-house outreach team to identify smaller size data center opportunities in strategically important economic sectors, such as college / universities and schools.

DC-1b. Promote benefits and services available to smaller data centers through a combination of IC and non-program subject matter experts and the contractors who directly influence customer decisions.

FINDING #2

DC-2. Tracking database 'Contractor' field does not contain sufficient data to support messaging to key program stakeholders. Some of the largest projects list 'multiple contractors' with no name or contact details.

RECOMMENDATION #2

DC-2. Require completion of key data fields, including contractor name and contact information as a prerequisite to issuing incentive payment. Allow input of multiple contractors and contact information per measure.

Guidehouse observes that collecting contractor information would support DC-1b recommendation implementation.

Efficient Products for Business, Process Efficiency, and Self Direct Programs

Findings & Recommendations:

Findings and Recommendations for EP4B, PE, and SD programs are presented together reflecting implementation by a single IC, a common application form, and other customer and marketing synergies.

Efficient Products for Business

EP4B helps fund a wide variety of energy-saving improvements for existing buildings. The program provides prescriptive incentives that may cover up to 50% of project costs.

Process Efficiency

PE is tailored to businesses seeking incentives for improving the energy efficiency of large or custom measures and processes specific to their unique business application. The program provides assistance with technology evaluation and savings projection verification. Incentive payments are customized to project results.

Self Direct

SD is designed for the unique needs of large-scale or mercantile C&I customers that could benefit from energy efficiency credits for projects completed over a retrospective rolling 3-year period. Eligible customers have annual usage exceeding 700,000 kWh or the customer must be part of a national or regional account with multiple facilities in one or more states.

PROCESS EVALUATION ACTIVITIES	EP4B	PE	SD
Program Manager Interviews	✓	✓	✓
Implementation Contractor Interviews	✓	✓	✓
Participant Telephone Surveys	✓	-	-
Tracking Database Analysis	✓	✓	✓

2019 EP4B, PE, and SD Time Analysis

Average elapsed time between customer touchpoints varies across programs. Duration of average elapsed time may be reflective of program efficiency.

Finding: EP4B exhibits the largest range between customer touchpoints, but on average elapsed times are reasonable. On average, SD has the highest elapsed time between crucial touchpoints.

In some cases, steps appear to be conducted out of the program's normal order of operations, as indicated by negative values shown in red.

Touchpoint 1	Touchpoint 2	Min Time Elapsed (Days)[1]	Max Time Elapsed (Days)	Average Time Elapsed (Days)
EFFICIENT PRODUCTS FOR BUSINESS[2]				
Final Application Received	Final Application Review	(358)	150	7
Actual Project Complete	Final Application Received	(282)	730	44
Final Application Received	Payment Approval	(316)	250	28
Actual Project Complete	Payment Approval	(313)	790	72
PROCESS EFFICIENCY				
Actual Project Complete	Final Application Received	(52)	515	69
Final Application Received	Payment Approved	(298)	217	57
Payment Approved	Payment Mailed	0	367	9
SELF DIRECT				
Actual Project Completion	Final Application Received	19	936	361
Final Application Received	Payment Approval	11	404	116

Source: Guidehouse analysis of PY2019 tracking data.

[1] Red parenthesis indicate negative values.

[2] Midstream projects only had Paymentmaileddate and IncentivesPaidDate included; other project status dates were not provided for Midstream projects. As such, Midstream projects are not included in the date analysis.

2019 PE Program End Uses

Finding: Over 98% of PE end uses were initially mapped to "custom" by the program implementation contractor. Often these custom end uses can be mapped to more specific end uses with increased data granularity to more accurately capture program impacts and guide future management and promotional activities.

To illustrate, Guidehouse manually mapped the "Custom" end use to more granular end uses shown in the table, based on project description.

PE Custom End Use Disaggregated Data

End Use	Project Count	Savings (MWh)
Process	7	25,037
Custom	5	2,708
Refrigeration	2	2,623
Compressed Air	7	2,585
EMS	10	1,945
Controls	2	1,673
VFDs	4	1,257
HVAC	6	690
Motors	4	288
Food Service	2	222
Lighting	7	168

Source: Guidehouse analysis of PY2019 tracking data.

2019 EP4B Program Customer Feedback

One hundred EP4B customers participated in a telephone survey conducted in January 2020 with program participants who completed projects in 2019.

Survey goals included:

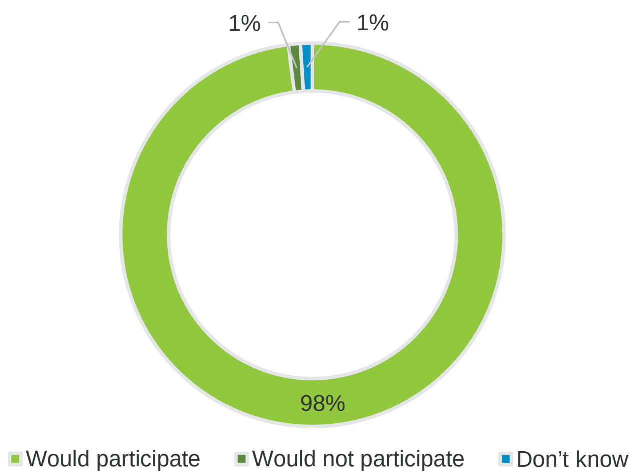
- Understanding program awareness and customer participation motivations.
- Assessing program satisfaction.
- Identifying primary benefits and barriers of participation.
- Identifying areas for program improvement.

Finding: Customers are pleased with the program, and **98 percent** of the participants surveyed stated that they would participate in the program again.

The two percent of respondents who indicated they would not participate in the program again for the following reasons:

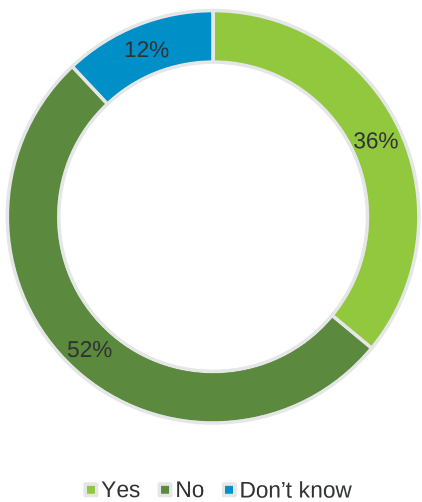
- Program staff were not responsive to our needs
- Did not receive the rebate

Would you participate in the AEP Ohio program again?



2019 EP4B Program Customer Feedback

Did you receive assistance from AEP Ohio staff to complete the pre-approval application?



Finding: EP4B participants had assistance with the application process, easing their level of effort to enroll and participate in the program. Thirty-six percent (n = 36) of respondents indicated they received assistance completing the pre-approval application.

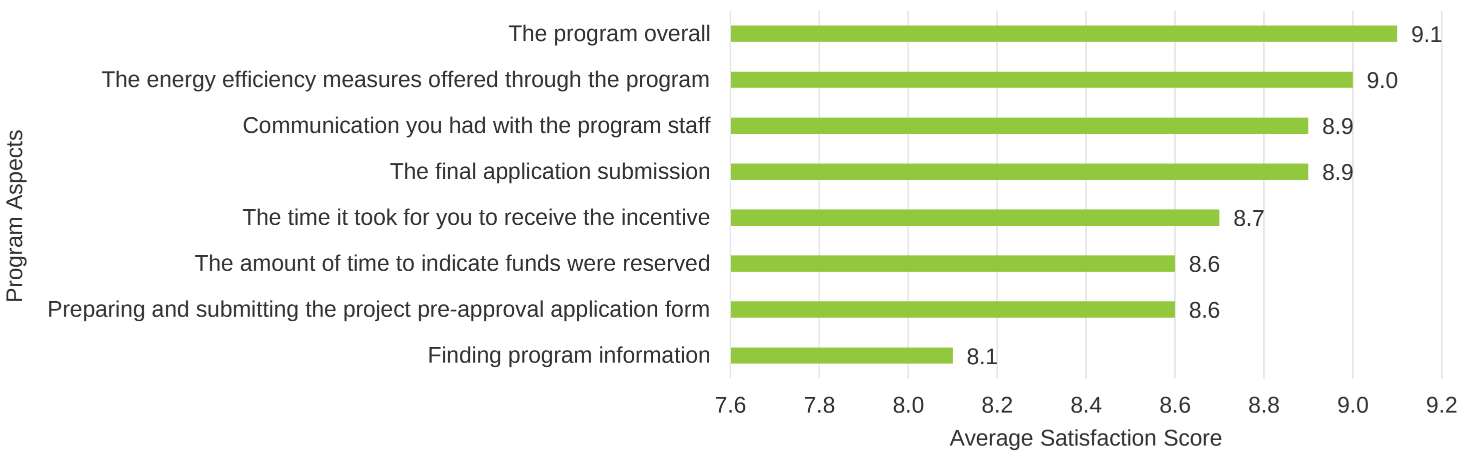
Of the participants that received assistance with the application, 25 percent (nine percent of total survey respondents) indicated they would not have participated in the program if they did not receive assistance.

2019 EP4B Program Customer Feedback

Finding: EP4B participants are very satisfied with aspects of the program.

All areas received high satisfaction. The lowest satisfaction rating was “finding program information.” There is an opportunity to increase the information that is easily accessible to customers.

How would you rate your satisfaction with the following program aspects?[1]



[1] “Don’t Know” responses were removed from this analysis. As a result, the ‘N’ may vary slightly by program aspect. The question was asked on a 0 to 10 scale with 0 being extremely dissatisfied and 10 being extremely satisfied.

2019 EP4B Program Customer Feedback

Finding: Participants were pleased with the quality of the products offered through the program.

	Lighting	Refrigeration	Motors &Drives	HVAC	Food Storage
*On a scale of 0 to 10, with 0 being very poor quality and 10 being very high quality, how would you rate the quality of **old** equipment at your facility?*	**5.4**	**2.0**	**6.5**	**5.2**	**2.0**
Sample size (n)	85	1	8	5	1
*On a scale of 0 to 10, with 0 being very poor quality and 10 being very high quality, how would you rate the quality of **new** equipment at your facility?*	**9.4**	**10.0**	**9.3**	**9.0**	**9.0**
Sample Size (n)	87	2	6	6	1

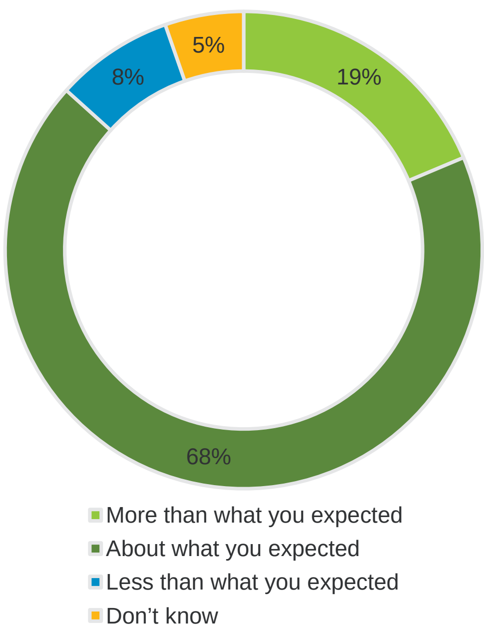
Note: “Don’t Know” responses were removed from this analysis.

2019 EP4B Program Customer Feedback

Finding: Participants are recognizing energy savings resulting from their program participation.

- **Sixty-eight percent** of respondents indicated their electricity bills are about what they expected and **19 percent** indicated savings are more than what they expected.
- **Eight percent** of the respondents have not noticed lower electricity bills and **five percent** do not know.

Would you say your bill savings are...



2019 EP4B Program Customer Feedback

Respondents reported **helpful** aspects of the EP4B program were:

Pre-approval application: “AEP Ohio took care of it pretty much. They assisted and filled out the form, the whole nine-yards. We really didn't have to do anything.”

Customer

Reservation of funds: “I thought it was rather quick from the time the paperwork was sent in and received word that it was approved.”

Customer

Program measures: “I thought personally that the energy efficiency measures were excellent.”

Customer

EP4B program aspects AEP Ohio could **improve** included:

Program Information: “I didn't think there's a very good understanding of what's available to the end user in the program and where contacts are...”

Customer

Program Awareness: “…we didn't even know it was even out there, you have to go out and look for it.”

Customer

Source: Guidehouse customer survey analysis.

2019 EP4B, PE, SD Program Recommendations

FINDING #1

EP4B-1: Most participants indicated they learned about the program though a program representative, stressing they would not have known the program existed if they did not receive a visit from a representative. Customers expressed a genuine interest in increasing awareness for other businesses. This finding is consistent with Express feedback.

RECOMMENDATION #1

EP4B-1: Consider increasing program awareness through other means to increase participation and diversify the means by which people learn about the program. Consider publishing additional program details for customers to more easily find information about the program.

FINDING #2

EP4B-2: While the new Midstream track only delivers 8% of program savings, Midstream projects have a high percentage of small office, large office, and medical-hospital participants compared to the standard delivery track. This delivery track serves economic segments with less participation in the historical prescriptive delivery track.

RECOMMENDATION #2

EP4B-2: Continue to support economic segments not traditionally served by the EP4B program and increase participation from selected end uses by expanding the Midstream track.

FINDING #3

EP4B-3: Customers are satisfied with the program, view the measures installed as improving the quality of their equipment, and are recognizing energy savings from their participation.

RECOMMENDATION #3

EP4B-3: AEP Ohio should consider EP4B's favorable customer satisfaction metrics as an indirect benefit to current operation, and a potential goal for future operation.

FINDING #4

PE-1: Process Efficiency tracking data does not provide granular industry standard end use data within all the "Custom" measure designations.

RECOMMENDATION #4

PE-1: Provide a drop down list of acceptable industry standard end use designations in the program application to ensure project end uses are designated appropriately.

Express Program

Findings & Recommendations: Small Business Express Program

The Small Business Express program (EXP) is a direct install program providing incentives that may cover up to 80 percent of project cost. Twelve-month zero-interest financing is available for qualifying businesses.

The Express program was originally designed for businesses using less than 200,000 kWh/year, or < 100 kW demand annually. In 2019, the program expanded to include businesses using up to 400,000 kWh / year.[1]

PROCESS EVALUATION ACTIVITIES	
Program Manager Interviews	✓
Implementation Contractor Interviews	✓
Participant Telephone Surveys	✓
Tracking Database Analysis	✓

[1] The program definition of small business changed from 200,000 kWh/yr. or less to 400,000 kWh/year or less starting November 1, 2019.

2019 Express Program Time Analysis

Finding: The Express program's average time elapsed are quite short relative to other programs, highlighting a fast project turn-over rate and overall program efficiency.

- Time analysis for the Express program shows that the minimum time elapsed was 0 for all evaluated touchpoints.
- Number of projects that achieved zero days, proposal to work begin = 1
- Number of projects that achieved zero days, work begin to complete = 106
- Number of projects that achieved zero days, work complete to invoice = 10

Express				
Touchpoint 1	**Touchpoint 2**	**Min Time Elapsed (Days)**	**Max Time Elapsed (Days)**	**Average Time Elapsed (Days)**
Proposal signed	Work begin	0	158	30
Work begin	Work complete	0	113	5
Work complete	Invoice	0	176	13

Source: Guidehouse analysis of PY2018 and PY2019 ex ante tracking data.

2019 Express Program Contractor Information

Express Contractor Data			
Average savings per project			6%
Contractor	**Project Count**	**Savings (kWh)**	**% Energy Savings**
Contractor A	122	3,109,336	25%
Contractor B	95	1,753,872	14%
Contractor C	62	1,433,289	12%
Contractor D	44	1,125,885	9%
Not Provided	63	1,123,464	9%
Contractor E	61	784,159	6%
Contractor F	65	589,703	5%
Contractor G	23	444,540	4%
Contractor H	20	345,224	3%
Contractor I	29	338,791	3%
Contractor J	14	298,644	2%
Contractor K	16	242,038	2%
Contractor L	12	222,715	2%
Contractor M	4	136,207	1%
Contractor N	9	123,294	1%
Contractor O	11	115,766	1%
Contractor P	5	74,809	1%

Source: Guidehouse analysis of PY2019 ex ante tracking data.

Finding: Contractor information was a source of data incompleteness in the Express program.

- Contractor information was left blank for 63 projects.

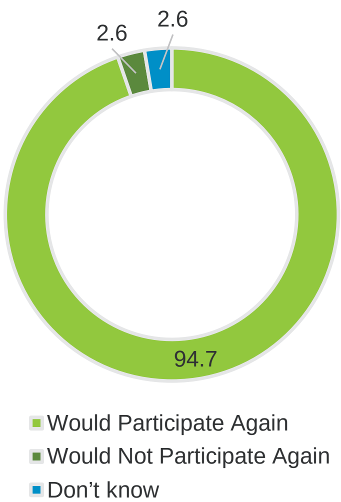
Finding: Three contactors provided over 50 percent of program savings.

- On average, contractors in the Express program brought in six percent of savings, highlighting the high involvement and reliance on the three top performing contractors.

An individual project was identified by a unique project ID, regardless of a repeat premise IDs.

2019 Express Program Customer Feedback

Would you participate in the program again?



Source: Guidehouse customer survey analysis.

Seventy-six Express program customers participated in a telephone survey conducted in January 2020 with customers whose projects were completed in 2019.

The goal of the survey effort included:

- Understanding program awareness and customer motivations to participate
- Assessing program satisfaction
- Identifying primary benefits and barriers of participation
- Identifying areas for program improvement

Finding: Customers are satisfied with the program.

Ninety-five percent of respondents stated they would participate in the program again.

- **Five percent** of respondents indicated they would not participate in the program again because their "company does not have any building plans in the foreseeable future."

Customers primarily participated in the program to lower their utility bills. Most customers, **39 percent**, reported utility savings were about what they expected or more then they expected, **14 percent**. They also reported high satisfaction for the equipment they received through the program.

Some customers reported savings were less than expected (**13 percent**), but there could be confusion about how energy savings materialize (energy savings compared to dollar savings).

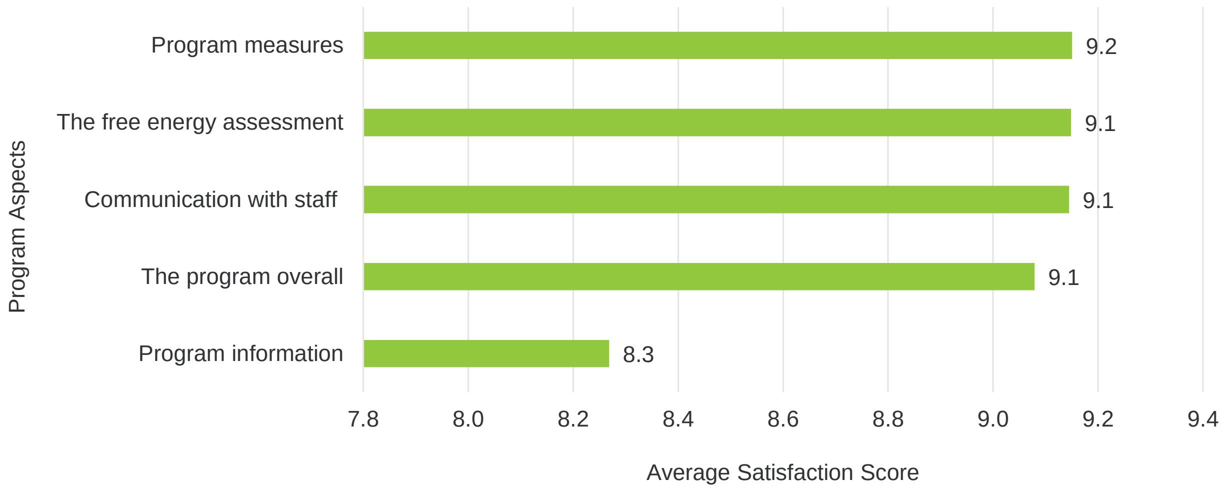
2019 Express Program Customer Feedback

Finding: Customers are satisfied with the program, and products installed. Customers were asked to rate their satisfaction on a 0 to 10 scale, where 0 represented very dissatisfied and 10 represented very satisfied.

Overall, various program aspects received very high satisfaction, with four out of five program aspects receiving above a 9.0 average satisfaction score.

Satisfaction with program measures was rated the highest; ease of finding information the lowest.

How would you rate your satisfaction with the following program aspects?[1]

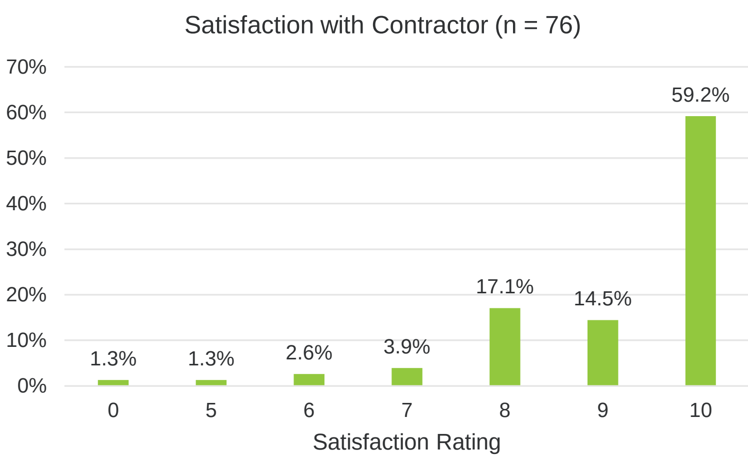


Source: Guidehouse customer survey analysis"

[1] Don't Know" responses were removed from this analysis. As a result, the 'N' may vary slightly by program aspect. The question was asked on a 0 to 10 scale with 0 being extremely dissatisfied and 10 being extremely satisfied.

2019 Express Program Customer Feedback

Using a 0 to 10 scale where 0 is very dissatisfied and 10 is very satisfied, how would you rate your satisfaction with the expertise of the contractor?



Source: Guidehouse customer survey analysis.

Finding: Overall, respondents expressed **high satisfaction for contractor expertise** and were pleased with the **onsite assessment**.

- **Ninety one percent** of respondents rated contractor expertise an 8 or higher on a 0 to 10 scale, with 10 being the highest ranking.
- **Ninety two percent** of respondents would recommend the contractor, while seven percent would not. One percent don't know.

Some customers were dissatisfied with contractors due to performance issues. Of the 7 percent of the respondents who would not recommend the contractor again, respondents indicated that the contractor:

- Was disruptive and did not act professionally
- Worked past business hours

Most customers were pleased with the assessment reports they received. They found the following information to be beneficial:

- Estimated annual cost savings
- Estimated annual energy savings
- Explanation of the equipment the contractor would install

Customers recommended incorporating the following information into the assessment report:

- The time to perform the installation
- An explanation of AEP Ohio's involvement and contact information

2019 Express Program Customer Feedback

Finding: Participants are very pleased with the lighting equipment offered through the program, indicating that the quality of their lighting equipment was greatly improved through their participation. Customers were also satisfied with the refrigeration equipment installed.

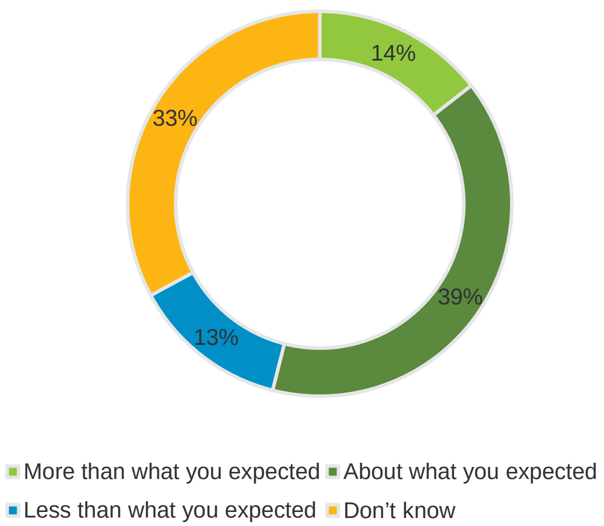
	Lighting	Refrigeration
*On a scale of 0 to 10, with 0 being very poor quality and 10 being very high quality, how would you rate the quality of **old** equipment at your facility?*	5.6	5.2
Sample size (n)	73	6
*On a scale of 0 to 10, with 0 being very poor quality and 10 being very high quality, how would you rate the quality of **new** equipment at your facility?*	9.4	9.4
Sample Size (n)	74	7

Note: "Don't Know" responses were removed from this analysis.

Source: Guidehouse customer survey analysis.

2019 Express Program Customer Feedback

Would you say your bill savings are...



Finding: A majority of participants are recognizing monetary savings from the program. Many drivers could affect this perception, however, including rate changes, better management of customer expectations, and other effects.

- **Fourteen percent** of respondents indicated bills savings are more than what they expected, which is three percent higher compared to 2018 (8.2 percent).
- **Thirty nine percent** of respondents indicated their electricity bills are about what they expected (PY2018: 48.2 percent).
- **Thirteen percent** of the respondents have not noticed lower electricity bills, a reduction of 20 percent compared to PY2018 (32.9 percent).
- **Thirty three percent** do not know if they have recognized savings as a result of their participation (PY2018: 10.6 percent).

Source: Guidehouse customer survey analysis.

2019 Express Program Customer Feedback

Finding: The Express financing option has encouraged customer participation, making it financially feasible for businesses to pursue energy efficiency upgrades. **Sixteen percent** of participants would not have participated in the program if the financing option had not been included.

Would you have decided to participate in the program if the loan was not offered as part of the program?

Responses	Percent
Yes	41.7%
No	50.0%
Don't Know	8.3%
Total Percentage	100.0%
Total Respondents	N = 24

- **Eighty-four percent** of respondents (n= 64) indicated they were offered the 12-month interest-free financing option through the program.
- Of those participants, **37.5 percent** chose the financing option.
- Of those 37.5 percent, **50 percent** indicated they would not have participated in the program if the financing option was not available, signifying the financing option is attractive to customers.

Source: Guidehouse customer survey analysis.

2019 Express Program Customer Feedback

What could AEP Ohio do to improve the program?[1]

Responses	Percent
Nothing	30%
Greater Publicity	20%
Better communication / Improve program information	20%
Higher Incentives	9%
Don't Know	9%
More Measures	5%
Longer time period to complete projects	3%
Better contractor selection	3%
Simplify application process	1%
Total Percentage[1]	124%
Total Respondents	N = 94

Finding: Customers are satisfied with the program, but some participants have recommendations for improvement.

Customers would like improved communication and information as well as greater publicity of the program. They would like other businesses to take advantage of the program.

- **Twenty percent** of respondents recommended improving program information and communication.
- **Twenty percent** of respondents also recommended greater publicity, indicating they would not have learned about the program if someone did not visit their business. Guidehouse acknowledges some alignment with this finding and program's marketing strategy. This as an opportunity to promote the strategy to potential customers. Let customers know the program is designed for unique customer types, and they have been identified as an excellent candidate these energy efficiency improvements.

Source: Guidehouse customer survey analysis

[1] This was a multiple response question, meaning customers could select multiple options. Because of that, percentages sum to over 100%. Some responses were rounded to display whole numbers. Participants who selected "Nothing" were unable to select additional options, as this was a mutually exclusive option.

2019 Express Program Customer Feedback

Finding: Overall, customers are pleased with the program, as indicated by their verbatim responses.

"It was a very efficient process, very educational, very informative, and the follow through was very good."

Customer

"I feel that it is really good for small businesses, helps them a lot, because they can't compete with bigger businesses with more money, because it helps them be more energy efficient."

Customer

"Financially, what we were responsible for, the energy savings or cost savings offset that, so there was not a lot out of pocket necessary."

Customer

Finding: Some respondents indicated the energy assessment could be improved.

"I think it was a little bit strictly focused on lighting and did not delve into the other areas of opportunity we had for saving energy. I think it was restricted towards electrical usage and not overall energy usage. We were interested in energy savings, not just electricity cost savings.

Customer

Source: Guidehouse customer survey analysis.

2019 Express Program Recommendations

FINDING #1

EXP-1: Ninety-five percent of Express program participants are satisfied with the program and their measures installed. Participants indicate the program improves the quality of equipment in their facilities. More participants are reporting bill savings compared to 2018.

RECOMMENDATION #1

EXP-1: Continue supporting small businesses with energy efficient equipment incentives and one-on-one support. Continue setting expectations of energy savings with customers to maintain customer satisfaction.

FINDING #2

EXP-2: Most participants indicated they learned about the program though a program representative, stressing they would not have known the program existed if they did not receive a visit from a representative. Customers expressed a genuine interest in increasing awareness for other businesses. [This finding is consistent with EP4B feedback.]

RECOMMENDATION #2

EXP-2: Consider increasing program awareness across small businesses to increase participation and diversify the ways in which people learn about the program. Consider options such as promotion through organizations supporting small businesses and bill stuffers directed at small businesses.

FINDING #3

EXP-3: Overall, customers were satisfied with the contractor performance, but some customers expressed dissatisfaction with the contractor who installed the equipment.

RECOMMENDATION #3

EXP-3: Contact customers after the installation to assess contractor performance. Provide each contractor with an annual performance review and incentivize them to perform well.

2019 Express Program Recommendations

FINDING #4

EXP-4. Customers were satisfied with the assessment report they received, but they expressed opportunities to enhance and improve the reports to provide greater value to customers.

RECOMMENDATION #4

EXP-4. Consider including the amount of time it will take to schedule and complete the installation, and an explanation of AEP Ohio's direct involvement. Customers sleuthed for additional information about those topics and indicated it would be helpful to include it in the assessment report.

FINDING #5

EXP-5. Thirty-seven percent of participants used the financing option, 16 percent of Express program participants would not have completed the project were it not for the financing option.

RECOMMENDATION #5

EXP-5. Continue to offer and promote a financing option to reduce first-cost barriers.

FINDING #6

EXP-6. Express tracking data contains 63 projects with blank contractor information fields.

RECOMMENDATION #6

EXP-6. Require this field to be completed for incentive payment to ensure complete data capture.

FINDING #7

EXP-7. All refrigeration measures contributed to 4.8 percent of total program savings, a decrease from 16 percent in 2018. The refrigeration measures included anti-sweat controls, compressors and fan management, EC motors and refrigerated case lighting.

RECOMMENDATION #7N

EXP-7. Seek opportunities to increase refrigeration measures; consider additional measures such as strip curtains and screw compressors to diversify the portfolio of measures.

Non-Residential New Construction Program

Findings & Recommendations: Non-Residential New Construction Program

The Non-Residential New Construction (NRNC) program provides efficiency options for new construction and major renovation projects. The program serves the needs of building owners, architects/designers, and engineers looking for energy efficiency recommendations and incentives.

PROCESS EVALUATION ACTIVITIES	
Program Manager Interviews	✓
Implementation Contractor Interviews	✓
Participant Telephone Surveys	-
Tracking Database Analysis	✓

2019 NRNC Program Data Gaps

Finding: NRNC program data provided to Guidehouse included only minimal contact date data points for customer interaction.

- Provided data indicate on average, AEP Ohio's programs capture four time-related data points. NRNC only captures two customer touchpoints, highlighting time data as a potential tracking data gap.

Finding: Provided NRNC program tracking data does not capture key project stakeholder information, such as designer, architect, mechanical or electrical engineers, etc.

- All other programs in the portfolio (with the exception of CEI where work is typically conducted by in-house staff) capture key project stakeholders, typically the installing contractor.
- Key stakeholders can be used to track participation, communicate project questions, and manage program changes.

NRNC				
Total Records	173			
Touchpoint 1	**Touchpoint 2**	**Min Time Elapsed (Days)**	**Max Time Elapsed (Days)**	**Average Time Elapsed (Days)**
Eligibility reviewed	Incentive Paid	24	656	105

Source: Guidehouse analysis of PY2018 and PY2019 ex ante tracking data.

2019 NRNC Program Recommendations

FINDING #1

NRNC-1. The NRNC program tracking data captures two time related data points. Program managers and evaluators do not have transparency into the time customers spend in particular program activities, and where customer experience could be improved (to streamline activities).

RECOMMENDATION #2

NRNC-1.Record additional customer touchpoints to manage and improve program processes. Consider capturing dates for:

- Application received
- Design team meeting
- Project plans received
- Project complete
- Project inspection complete

FINDING #2

NRNC-2. Between 2018 and 2019 the program saw a shift in economic segments served, including a dip in small office participation and a spike in industrial / manufacturing and medical - hospital segment participation.

RECOMMENDATION #2

NRNC-2. Continue to pursue industrial / manufacturing and medical-hospital projects, but also aim to recapture the small office economic segment.

- Consider reaching out to 2018 small office project design team members to enquire about, and potentially enroll open projects.

FINDING #3

NRNC-3. The NRNC program tracking data does not capture stakeholder information.

RECOMMENDATION #3

NRNC-3. Include and collect tracking data fields to track stakeholder participation and performance.

04
Appendix

Acronyms

Acronym	Definition
AVG	Average
C&I	Commercial and Industrial
CC	Cross-Cutting
CEI	Continuous Energy Improvement
CRM	Customer Relationship Management
DC	Data Center
DI	Direct Install
EP4B	Efficient Products for Business
EM&V	Evaluation Measurement and Verification
EXP	Express
HVAC	Heating, Ventilation and Air Conditioning
IC	Implementation Contractor
NEB	Non-Energy Benefit
NRNC	Non-Residential New Construction
PE	Process Efficiency
PM	Program Manager
PY	Program Year
SD	Self Direct
SP	Solution Providers
VFD	Variable Frequency Drive

Business Sector:
Historical MWh Comparison Data-Table 1

Historical Energy Savings (MWh)

Program Name	2014	2015	2016	2017	2018	2019
EP4B	110,836	120,242	132,171	157,452	168,107	117,144
DC	11,895	11,292	21,399	27,799	34,270	26,426
NRNC	42,908	32,213	44,151	42,844	33,115	35,292
EXP	5,253	9,246	9,124	9,403	8,813	12,262
CEI	39,298	18,810	42,768	25,549	18,019	20,452
PE	85,254	50,360	43,003	48,939	8,325	39,637
SD	6,127	18,746	19,223	6,362	3,087	4,017
Total:	**301,571**	**260,909**	**311,839**	**318,348**	**273,736**	**255,230**

Source: Guidehouse analysis of program tracking databases.
Notes:
[1] 2014 – 2018 savings are ex post. 2019 savings are ex ante.
[2] 2014 – 2016, Efficient Products for Business was called the Prescriptive Program and Process Efficiency was the Custom Program.

Business Sector:
Historical MW Comparison Data-Table 2

Historical Demand Savings (MW)

Program Name	2014	2015	2016	2017	2018	2019
EP4B	17.4	17.2	17.2	22.8	26.2	23.2
DC	1.4	1.2	2.7	3.2	4.2	3.1
NRNC	6.4	7.0	8.3	7.6	5.2	5.0
EXP	1.6	1.7	1.3	1.4	2.3	2.5
CEI	1.6	0.0	1.8	2.8	1.2	-0.8
PE	7.8	4.25	3.9	3.7	1.0	2.3
SD	0.7	2.1	2.5	0.9	0.6	0.7
Total:	**36.8**	**33.45**	**37.8**	**42.2**	**40.8**	**36.0**

Source: Guidehouse analysis of program tracking databases.
Notes:
[1] 2014 – 2018 savings are ex post. 2019 savings are ex ante.
[2] 2014 – 2016, Efficient Products for Business was called the Prescriptive Program and Process Efficiency was the Custom Program.
[3] In historical reports, Demand Savings is oftentimes referred to as the Coincident Peak Reduction.

EP4B: Business Type by Delivery Method Comparison Data - Table 3

Business Type	Prescriptive Savings (kWh)	B4E Savings (kWh)	Midstream Savings (kWh)	Grand Total Savings (kWh)
UNDEFINED	-	-	133,647	133,647
Assembly / Meeting Place	3,053,801	-	118,091	3,171,893
College/University	5,622,221	1,603,829	99,764	7,325,813
Conditioned Warehouse	1,189,235	2,284,391	48,832	3,522,458
Exterior Sports Field	256,276	-	69,465	325,741
Government/Municipal	3,385,002	586,462	186,553	4,158,016
Grocery	3,712,692	96,517	13,841	3,823,050
Hotel/Motel	839,813	328,551	114,854	1,283,219
Industrial/Manufacturing	15,470,971	5,328,002	147,703	20,946,676
Large Office	3,912,912	742,149	1,263,174	5,918,235
Large Retail/Service	13,338,441	7,589,750	322,754	21,250,946
Medical- Hospital	3,557,398	1,030,734	1,048,337	5,636,469
Medical- Nursing Home	1,513,259	-	109,751	1,623,010
Miscellaneous	5,503,676	417,287	790,759	6,711,722
Multifamily	1,871,558	-	-	1,871,558
Multifamily - Interior Dwelling	-	-	853,244	853,244
Refrigerated Warehouse	847	-	-	847
Restaurant	1,152,282	39,263	184,463	1,376,008
School	11,983,768	1,026,792	147,162	13,157,721
Small Office	1,353,866	-	3,037,530	4,391,396
Small Retail/Service	6,707,482	-	273,412	6,980,894
Unconditioned Warehouse	1,004,231	1,616,892	60,396	2,681,519
Grand Total	**85,429,730**	**22,690,619**	**9,023,734**	**117,144,083**

Source: Guidehouse analysis of program tracking databases.

Business Sector Total Results
PY 2019 Economic Segments: Sub-Segment Roll-Up

Different programs use slightly different and sometimes more granular terms to describe economic segments. The evaluation team rolled up sub-segments as indicated for portfolio comparison.

Assembly	**Medical- Hospital**
Assembly	**Medical- Nursing Home**
Religious	**Multifamily**
College/University	**Office**
Data center	Small Office
Government/Municipal	Large Office
Grocery	**Outdoor Sports Complex**
Grocery	**Restaurant**
Food(s)	Full Service Restaurant
Hotel/Motel	Fast Food
Industrial/Manufacturing	**Retail/Service**
Industrial/Manufacturing	Auto Related/Automotive
Plastics	Small Retail
Construction	Large Retail
Glass Manufacturing	**School**
Industrial Equipment	**Warehouse**
Steel Fabricators	Conditioned Warehouse
Wood Products	Unconditioned Warehouse
Steel Foundry	Refrigerated Warehouse
Chemical	**Miscellaneous**
Small Product Manufacturing	Exterior
Thermal Component Testing	Garage
	Financial
	Research
	Nutraceutical

Source: Guidehouse analysis of program tracking databases.

APPENDIX S

AEP Ohio Utility Energy Efficiency Savings Summary

1 Incremental Savings from Programs in Year 2019

	Ex Ante Gross Savings			Realization Rate		Actual Expenditures			Participation		Weighted Program Measure Life	TRC Test Ratio	PAC Test Ratio	Notes
	A	B	C	D	E	F	G=F/A	H=F/C	I	J	K=C/A	L	M	
	First Year Annual Energy Savings	First Year Peak Demand Savings	Lifetime Savings	Energy Savings (Ex PostGross/Ex Ante Gross)	Demand Savings (Ex Post Gross/Ex Ante Gross)	Program Costs	Ex Ante First Year Cost Per First Year Annual Savings (F/(A*1000))	Ex Ante First Year Cost per Lifetime Savings (F/(C*1000))	Participation Number	Description (Units Description is provided in the PSR)	Years	By Program	By Program	
	MWh	MW	MWh	%	%	$	$/kWh	$/kWh				C/E Ratio	C/E Ratio	
Residential Programs														
Efficient Products	134,588	24.0	2,153,405	100%	100%	12,967,640	0.10	0.0060	4,693,394	Units	16	2.7	5.1	
Intelligent Home & DR	1,510	1.4	1,510	102%	179%	1,737,346	1.15	1.1507	63,721	Units	1	0.1	0.1	
Appliance Recycling	24,697	4.0	197,572	100%	100%	2,929,189	0.12	0.0148	18,230	Units	8	1.8	2.2	
Home Energy Reports	94,550	12.3	94,550	107%	107%	1,411,187	0.01	0.0149	524,337	Participants	1	2.6	2.6	
Residential New Homes	6,455	2.9	161,373	100%	110%	2,414,762	0.37	0.0150	1,866	Participants	25	1.0	2.2	
Manu. New Homes	304	0.1	5,476	88%	104%	331,161	1.09	0.0605	51	Participants	18	0.4	0.6	
e[3] *smart* SM	3,011	0.4	45,166	108%	107%	978,276	0.32	0.0217	25,313	Units	15	1.4	1.4	
Community Assistance	2,672	0.4	37,401	97%	104%	5,489,628	2.05	0.1468	4,150	Participants	14	0.2	0.2	
Total Residential	**267,786**	**45.5**	**2,696,454**			**28,259,189**	**0.11**	**0.01**	**5,331,062**		**10**	**1.9**	**3.0**	
Business Programs														
Efficient Products for Bus.	117,144	23.2	1,640,017	110%	88%	13,527,051	0.12	0.0082	3,091	Projects	14	1.1	3.9	
Process Efficiency	39,637	2.3	673,828	79%	105%	2,999,502	0.08	0.0045	66	Projects	17	1.3	6.2	
Bus. New Construction	35,292	5.0	529,385	95%	94%	3,827,610	0.11	0.0072	173	Projects	15	1.3	4.2	
Express	12,262	2.5	171,664	72%	93%	3,702,247	0.30	0.0216	655	Projects	14	1.0	1.5	
Self Direct	4,017	0.7	36,154	98%	120%	399,890	0.10	0.0111	42	Projects	9	0.7	3.0	
Demand Response	0	0.0	-	N/A	N/A	-	N/A	N/A	0	Projects	0	0.0	0.0	
Retro-Commissioning	0	0.0	-	N/A	N/A	-	N/A	N/A	0	Projects	0	N/A	N/A	
CEI	20,452	-0.8	102,260	104%	97%	2,176,960	0.11	0.0213	115	Projects	5	1.4	1.4	
Data Center	26,426	3.1	475,670	101%	110%	2,269,110	0.09	0.0048	18	Projects	18	1.4	6.0	
Combined Heat & Power	37,602	4.2	752,045	N/A	N/A	796,510	0.02	0.0011	1	Projects	20	1.4	17.3	
Total Business	**292,832**	**40.2**	**4,381,023**			**29,698,882**	**0.10**	**0.01**	**4,161**		**15**	**1.2**	**4.4**	
Other Programs														
Education & Training	0	0.0	0			83,392			0		0			
Targeted Advertising	0	0.0	0			2,945,445			0		0			
Research & Development	0	0.0	0			1,564,041			0		0			
Community Energy Savers	0	0.0	0			-			0		0			
Total Other	**0**	**0.0**	0			**4,592,877**			0					
Portfolio Total	**560,618**	**85.7**	**7,077,476**			**62,550,948**	**0.1116**	**0.009**	**5,335,223**		**13**	**1.5**	**3.9**	

2 Information Relative to Statutory Targets for Year 2019

3 year baseline retail normalized (mercantile, weather, opt-out, etc.) sales. (MWh)	37,954,987
2019 Annual Benchmark Target (%)	1.00%
2019 Savings (MWh)	560,618
2019 T&D & Gridsmart & USF (MWh)	33,044
2019 Achievement (%)	156%

3 Banked Savings in Year 2019

2019 Excess Savings Banked Toward Future Compliance (MWh)	157,179
Total Banked Savings Remaining After 2019 (MWh)	1,648,930

4 Opt Out - Three year baseline in 2019

Total Opt Out load (MWh)	5,740,748