

# ComEd Industrial Systems Impact Evaluation Report

Energy Efficiency / Demand Response Plan:  
Program Year 2019 (CY2019)  
(1/1/2019-12/31/2019)

Presented to  
ComEd

**FINAL**

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## ComEd Industrial Systems Impact Evaluation Report

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## 1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's CY2019 Industrial Systems Program. It includes a summary of the energy and demand impacts for the total program broken out by relevant measure and program structure details. The appendix provides the impact analysis methodology and details of the Total Resource Cost inputs. CY2019 covers January 1, 2019 through December 31, 2019.

## 2. PROGRAM DESCRIPTION

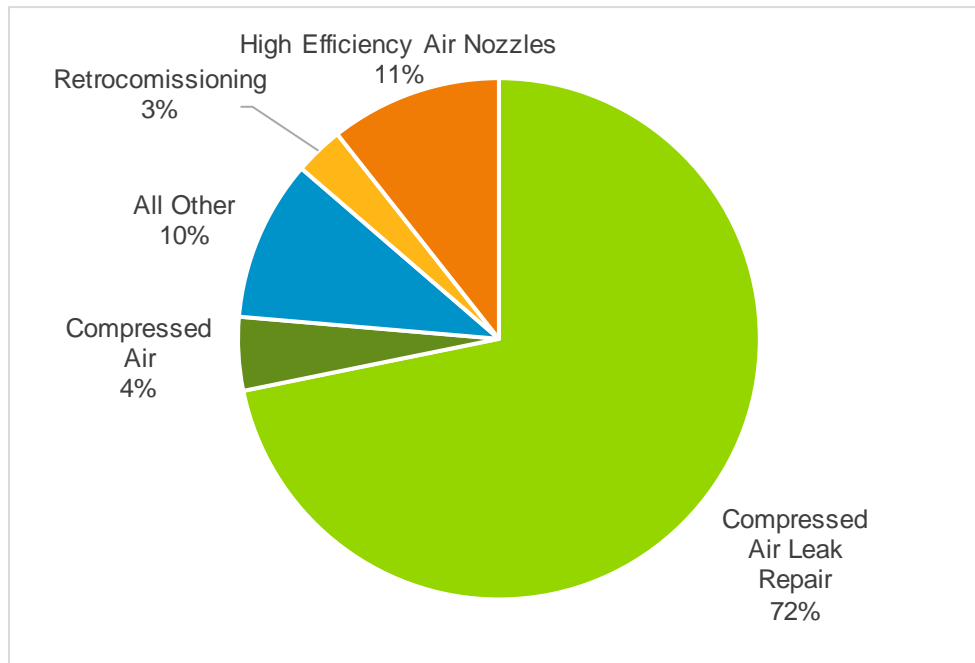
The program had 338 participants in CY2019 and distributed 461 measures across 358 projects, as shown in the following table and graph.

**Table 2-1. CY2019 Volumetric Findings Detail**

Participation	Industrial Systems
Participants	338
Total Measures	461
Number of Measures/Participant	1.36
Installed Projects	358

Source: ComEd tracking data and evaluation team analysis

**Figure 2-1. Number of Measures Installed by Type**



Source: ComEd tracking data and evaluation team analysis

### 3. PROGRAM SAVINGS DETAIL

Table 3-1 summarizes the incremental energy and demand savings that the Industrial Systems Program achieved in CY2019. The evaluation team found no gas savings for this program attributable to ComEd, therefore, the electric CPAS is equivalent to total CPAS.

**Table 3-1. CY2019 Total Annual Incremental Electric Savings**

Savings Category	Energy Savings (kWh)	Non-Coincident Demand Savings (kW)	Summer Peak* Demand Savings (kW)
<b>Electricity</b>			
Ex Ante Gross Savings	43,057,134	NA	6,252
Program Gross Realization Rate	0.94	NA	1.28
Verified Gross Savings	40,404,017	NA	8,021
Program Net-to-Gross Ratio (NTG) <sup>†</sup>	0.77	NA	0.78
Verified Net Savings	31,111,093	NA	6,256
<b>Converted from Gas<sup>†</sup></b>			
Ex Ante Gross Savings	0	NA	NA
Program Gross Realization Rate	0.94	NA	NA
Verified Gross Savings	0	NA	NA
Program Net-to-Gross Ratio (NTG) <sup>†</sup>	0.77	NA	NA
Verified Net Savings	0	NA	NA
<b>Total Electric Plus Gas</b>			
Ex Ante Gross Savings	43,057,134	NA	6,252
Program Gross Realization Rate	0.94	NA	1.28
Verified Gross Savings	40,404,017	NA	8,021
Program Net-to-Gross Ratio (NTG) <sup>†</sup>	0.77	NA	0.78
Verified Net Savings	31,111,093	NA	6,256

NR = Not reported (refers to a piece of data that was not reported, i.e., non-coincident demand savings)

NA = Not applicable (refers to a piece of data that cannot be produced or does not apply)

\* The coincident summer peak period is defined as 1:00-5:00 p.m. Central Prevailing Time on non-holiday weekdays, June through August.

† The evaluation team found no gas savings for this program attributable to ComEd, therefore, the electric CPAS is equivalent to total CPAS.

Source: ComEd tracking data and evaluation team analysis

### 4. CUMULATIVE PERSISTING ANNUAL SAVINGS

Table 4-1 and Figure 4-1 show the measure-specific and total verified gross savings for the Industrial Systems Program and the cumulative persisting annual savings (CPAS) for the measures installed in CY2019. The electric CPAS across all measures installed in 2019 is 31,111,093 kWh (Table 4-1). The evaluation team found no gas savings for this program attributable to ComEd, therefore, the electric CPAS is equivalent to total CPAS.



# ComEd Industrial Systems Impact Evaluation Report

**Table 4-1. Cumulative Persisting Annual Savings (CPAS) – Electric**

End Use Type	Research Category	EUL	CY2019 Verified Gross Savings (kWh)	NTG*	Lifetime Net Savings (kWh)†	Verified Net kWh Savings									
						2018	2019	2020	2021	2022	2023	2024	2025	2026	
Industrial Systems	Compressed Air Leak Repair	3.0	23,069,816	0.77	53,167,356		17,763,759	17,763,759	17,639,839						
Industrial Systems	Compressed Air	15.0	5,253,403	0.77	33,828,386		3,266,864	2,182,966	2,182,966	2,182,966	2,182,966	2,182,966	2,182,966	2,182,966	
Industrial Systems	Other	13.0	3,803,447	0.77	39,920,221		3,070,786	3,070,786	3,070,786	3,070,786	3,070,786	3,070,786	3,070,786	3,070,786	
Industrial Systems	Retrocommissioning	7.5	3,558,777	0.77	23,679,807		3,157,308	3,157,308	3,157,308	3,157,308	3,157,308	3,157,308	3,157,308	1,578,654	
Industrial Systems	High Efficiency Air Nozzles	15.0	2,558,867	0.77	29,554,914		1,970,328	1,970,328	1,970,328	1,970,328	1,970,328	1,970,328	1,970,328	1,970,328	
Industrial Systems	VSD	15.0	828,919	0.77	12,860,135		857,342	857,342	857,342	857,342	857,342	857,342	857,342	857,342	
Industrial Systems	Industrial Refrigeration	15.0	735,127	0.77	8,490,718		566,048	566,048	566,048	566,048	566,048	566,048	566,048	566,048	
Industrial Systems	No Loss Drains	10.0	104,604	0.77	805,452		80,545	80,545	80,545	80,545	80,545	80,545	80,545	80,545	
Industrial Systems	Strategic Energy Management	5	491,057	0.77	1,890,569		378,114	378,114	378,114	378,114	378,114				
CY2019 Program Total Electric Contribution to CPAS			40,404,017		204,197,559		31,111,093	30,027,195	29,903,276	12,263,437	12,263,437	11,885,323	11,885,323	10,306,669	
Historic Program Total Electric Contribution to CPAS‡						17,990,719	17,990,719	17,694,526	11,918,391	11,918,391	11,918,391	11,918,391	11,918,391	11,918,391	
Program Total Electric CPAS						17,990,719	49,101,813	47,721,721	41,821,667	24,181,828	24,181,828	23,803,714	23,803,714	22,225,060	
CY2019 Program Incremental Expiring Electric Savings§								1,083,898	123,919	17,639,839	-	378,114	-	1,578,654	
Historic Program Incremental Expiring Electric Savings‡§								-	296,193	5,776,135	-	-	-	-	
Program Total Incremental Expiring Electric Savings§								-	1,380,091	5,900,054	17,639,839	-	378,114	-	1,578,654

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Industrial Systems	Compressed Air Leak Repair												
Industrial Systems	Compressed Air	2,182,966	2,182,966	2,182,966	2,182,966	2,182,966	2,182,966	2,182,966					
Industrial Systems	Other	3,070,786	3,070,786	3,070,786	3,070,786	3,070,786							
Industrial Systems	Retrocommissioning												
Industrial Systems	High Efficiency Air Nozzles	1,970,328	1,970,328	1,970,328	1,970,328	1,970,328	1,970,328	1,970,328					
Industrial Systems	VSD	857,342	857,342	857,342	857,342	857,342	857,342	857,342					
Industrial Systems	Industrial Refrigeration	566,048	566,048	566,048	566,048	566,048	566,048	566,048					
Industrial Systems	No Loss Drains	80,545	80,545										
Industrial Systems	Strategic Energy Management												
CY2019 Program Total Electric Contribution to CPAS		8,728,015	8,728,015	8,647,470	8,647,470	8,647,470	5,576,684	5,576,684	-	-	-	-	-
Historic Program Total Electric Contribution to CPAS‡		11,918,391	11,918,391	11,918,391	11,918,391	5,901,156	5,901,156	-	-	-	-	-	-
Program Total Electric CPAS		20,646,406	20,646,406	20,565,861	20,565,861	14,548,626	11,477,839	5,576,684	-	-	-	-	-
CY2019 Program Incremental Expiring Electric Savings§		1,578,654	-	80,545	-	-	3,070,786	-	5,576,684	-	-	-	-
Historic Program Incremental Expiring Electric Savings‡§		-	-	-	-	6,017,235	-	5,901,156	-	-	-	-	-
Program Total Incremental Expiring Electric Savings§		1,578,654	-	80,545	-	6,017,235	3,070,786	5,901,156	5,576,684	-	-	-	-

Note: The green highlighted cell shows program total first year electric savings. The gray cells are blank, indicating values irrelevant to the CY2019 contribution to CPAS.

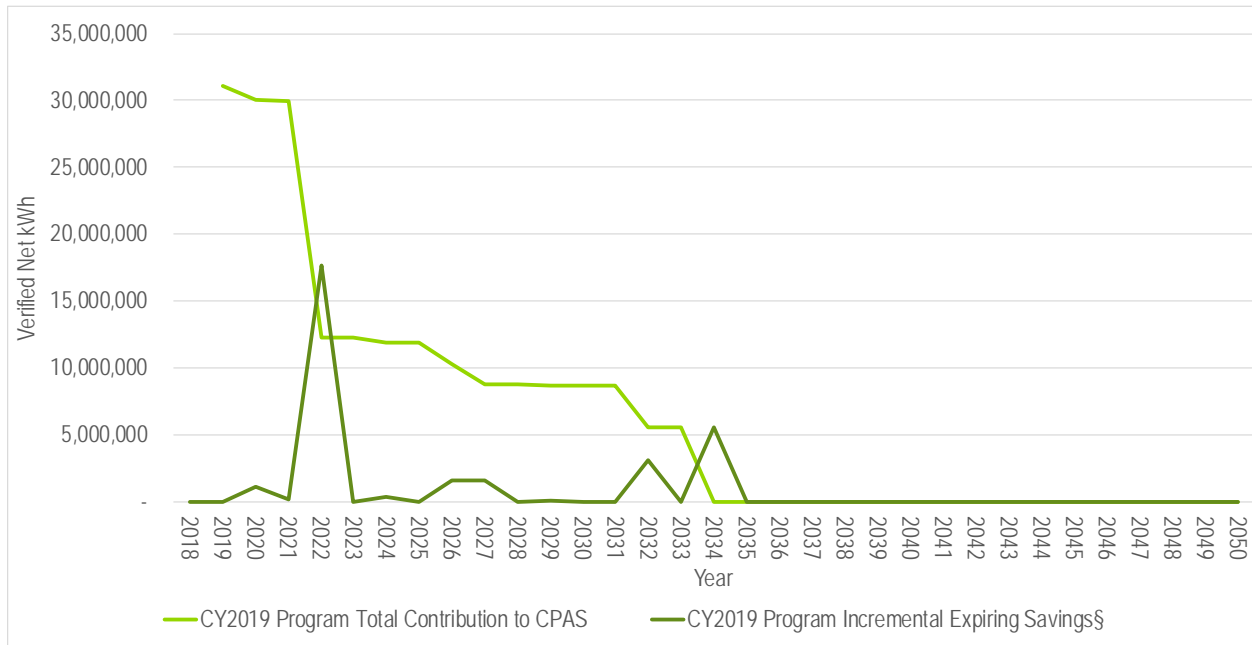
\* A deemed value. Source: is to be found on the Illinois SAG web site here: [https://www.ilsag.info/ntg\\_2019](https://www.ilsag.info/ntg_2019).

† Lifetime savings are the sum of CPAS savings through the EUL.

‡ Historical savings go back to CY2018

§ Incremental expiring savings are equal to CPAS Y<sub>n-1</sub> - CPAS Y<sub>n</sub>

Source: Evaluation team analysis

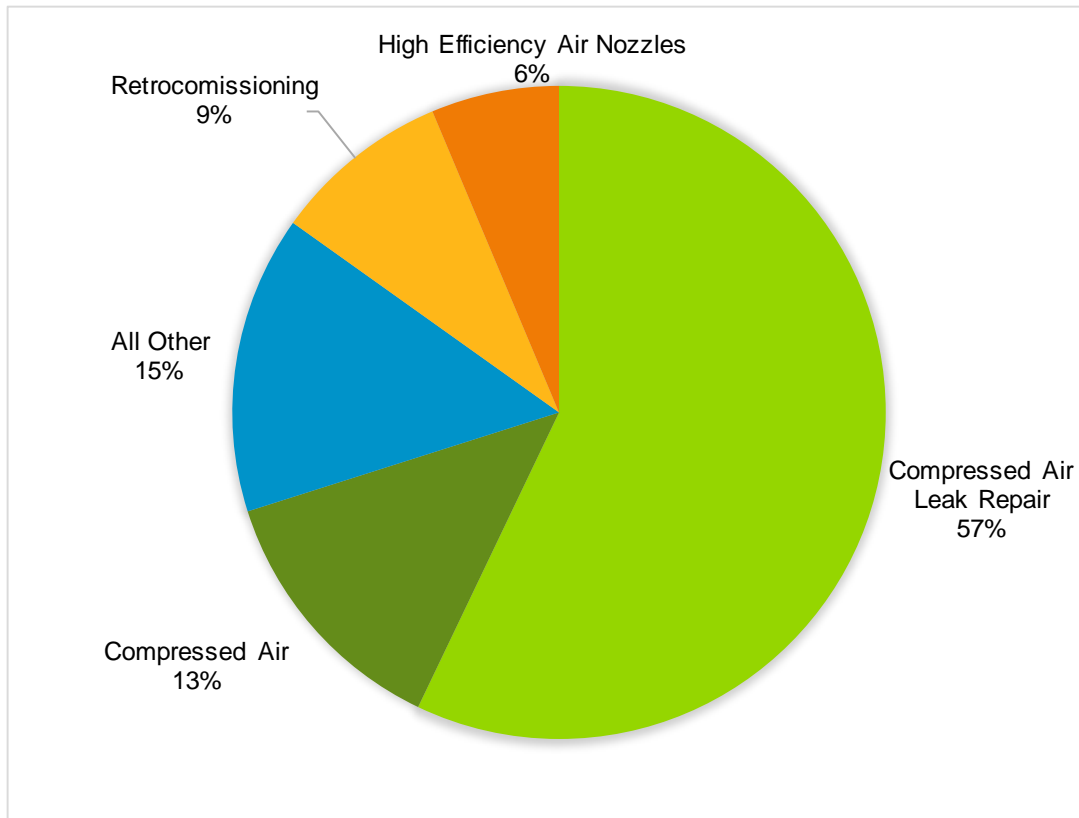
**Figure 4-1. Cumulative Persisting Annual Savings**


\* Expiring savings are equal to CPAS  $Y_{n-1}$  - CPAS  $Y_n$ .

Source: Evaluation team analysis

## 5. PROGRAM SAVINGS BY MEASURE

Figure 5-1 below displays verified net savings by measure type. Compressed Air Leak Repair measures made up over 56% of the verified net savings for CY2019. The “All Other” category includes variable speed drives (VSDs), Industrial Refrigeration, No Loss Drains, and Strategic Energy Management systems, as well as all other one-off measure types.

**Figure 5-1. Verified Net Savings by Measure Type – Electric**


Source: ComEd tracking data and evaluation team analysis

**Table 5-1. CY2019 Energy Savings by Measure – Electric**

End Use Type	Research Category	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTG*	Verified Net Savings (kWh)	EUL (years)
Industrial Systems	Compressed Air Leak Repair	24,584,688	0.94	23,069,816	0.77	17,763,759	3.0
Industrial Systems	Compressed Air	5,598,366	0.94	5,253,403	0.77	4,045,120	15.0
Industrial Systems	Other	4,053,199	0.94	3,803,447	0.77	2,928,654	13.0
Industrial Systems	Retrocommissioning	3,792,463	0.94	3,558,777	0.77	2,740,258	7.5
Industrial Systems	High Efficiency Air Nozzles	2,726,894	0.94	2,558,867	0.77	1,970,328	15.0
Industrial Systems	VSD	883,350	0.94	828,919	0.77	638,268	15.0
Industrial Systems	Industrial Refrigeration	783,399	0.94	735,127	0.77	566,048	15.0
Industrial Systems	No Loss Drains	111,473	0.94	104,604	0.77	80,545	10.0
Industrial Systems	Strategic Energy Management	523,302	0.94	491,057	0.77	378,114	5.0
	<b>Total</b>	<b>43,057,134</b>	<b>0.94</b>	<b>40,404,017</b>	<b>NA</b>	<b>31,111,093</b>	<b>NA</b>

NA = Not applicable

\* A deemed value. Source: is to be found on the Illinois SAG web site here: [https://www.ilsag.info/ntg\\_2019](https://www.ilsag.info/ntg_2019).

Note: The savings in this table includes secondary electric energy (kWh) savings from water supply and wastewater treatment plants for measures claimed by ComEd.

Source: ComEd tracking data and evaluation team analysis



**Table 5-2. CY2019 Summer Peak Demand Savings by Measure**

End Use Type	Research Category	Ex Ante Gross Peak Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Peak Demand Reduction (kW)	NTG*	Verified Net Peak Demand Reduction (kW)
Industrial Systems	Compressed Air Leak Repair	4,166	1.28	5,345	0.78	4,169
Industrial Systems	Compressed Air	656	1.28	842	0.78	657
Industrial Systems	Other	350	1.28	449	0.78	350
Industrial Systems	Retrocomissioning	499	1.28	640	0.78	499
Industrial Systems	High Efficiency Air Nozzles	429	1.28	550	0.78	429
Industrial Systems	VSD	89	1.28	114	0.78	89
Industrial Systems	Industrial Refrigeration	0	1.28	0	0.78	0
Industrial Systems	No Loss Drains	19	1.28	25	0.78	19
Industrial Systems	Strategic Energy Management	44	1.28	56	0.78	44
	<b>Total</b>	<b>6,252</b>	<b>1.28</b>	<b>8,021</b>	<b>NA</b>	<b>6,256</b>

NA = Not applicable

\* A deemed value. Source: is to be found on the Illinois SAG web site here: [https://www.ilsag.info/ntg\\_2019](https://www.ilsag.info/ntg_2019).

Source: ComEd tracking data and evaluation team analysis

## 6. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

### 6.1 Impact Parameter Estimates

The Industrial System Program does not have relevant impact parameters.

### 6.2 Other Impact Findings and Recommendations

The evaluation team developed several recommendations based on findings from the CY2019 evaluation.

**Finding 1.** For project 40209, the evaluation team found that the default values are used when using the templates to estimate the ex ante savings.

**Recommendation 1.** The evaluation team has previously reviewed the implementation team's templates and found that they are reasonable to use. However, the evaluation team recommends that care should be taken when using the default values in the template and site-specific adjustments should be made, whenever applicable.

**Finding 2.** For project 40122, the compressed air template contained a cell reference and formula error on the High Efficiency Nozzles tab.

**Recommendation 2.** The evaluation team recommends that the implementers fix the errors in the template and set up a more rigorous QAQC process to avoid these kinds of errors in CY2020.

**Finding 3.** For project 40179-2, the leak detection survey resulted in about 265 CFM, compared to primary compressor capacity of 210 CFM. It was assumed that the leaks occurred at 120 psig, but most of the leaks were found at regulated pressures as low as 30 psig.

**Recommendation 3.** The compressed air leak repair projects are on the rise every year and for CY2019 they represent around 56% of the total ex ante savings for the entire program. Care

should be taken to ensure that the results from the air leak surveys are reasonable and should be validated when feasible. The Compressed Air Challenge<sup>1</sup> describes several simple tests for determining total system leakage, and it can be used to validate the survey results.

**Finding 4.** For project 40145-2, the CFM data was not normalized in the ex ante calculations to ensure consistency between pre- and post-case operation.

**Recommendation 4.** Consistent with the recommendations from previous years, the pre- and post-case data should be normalized to a common, representative condition. Savings should be normalized for production, weather, or CFM demand whenever applicable. If there is CFM demand reduction as part of the project, it should be clearly defined in the scope of measures. Claimed savings for unspecified CFM demand reduction should be quantified and shown to be related to the project.

## 7. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

### 7.1 Gross Impact (M&V) Sample

Consistent with the evaluation plan, the evaluation team used a stratified random sampling approach to select the gross impact sample of ten projects. The evaluation team sorted projects based on ex ante kWh savings and placed the projects in three strata.

Table 7-1 provides a profile of the gross impact M&V sample for the Industrial Systems Optimization Program in comparison with the program population. The table shows the resulting sample, which consists of ten projects, making up approximately 4.5 million kWh, representing 11% of the ex ante program savings. The table also shows the ex ante-based kWh sample weights for each of the three strata.

**Table 7-1. CY2019 Gross Impact Sample by Strata**

Industrial Systems Population Summary				Sample			
Sampling Strata	Number of Tracking Records (N)	Ex Ante kWh Impact Claimed	kWh Weights	Number of Tracking Records (n)	Ex Ante kWh	Sampled % of Population kWh	
1	15	14,495,223	0.34	4	3,638,335	0.25	
2	47	14,340,084	0.33	3	797,836	0.06	
3	296	14,221,827	0.33	3	89,425	0.01	
CY2019 Total		358	43,057,134	-	10	4,525,596	0.11

Source: ComEd tracking data and Guidehouse team analysis

### 7.2 Roll-Up of Savings

There are two basic statistical methods for combining individual gross realization rates from the sample projects into an estimate of verified gross kWh savings for the population. These two methods are referred to as “separate” and “combined” ratio estimation.<sup>2</sup> In the case of a separate ratio estimator, a separate gross kWh savings realization rate is calculated for each stratum and then combined. In the

<sup>1</sup> Evaluation team will have follow up discussion with the implementation team and provide more information on validation methodologies.

<sup>2</sup> A full discussion and comparison of separate vs. combined ratio estimation can be found in [Sampling Techniques](#), Cochran, 1977, pp. 164-169.

case of a combined ratio estimator, the evaluation team completes a single gross kWh savings realization rate calculation without first calculating separate gross realization rates by stratum.

The evaluation team used the separate ratio estimation technique to estimate verified gross impacts for the Industrial Systems Optimization Program. The separate ratio estimation technique follows the steps outlined in the California Evaluation Framework,<sup>3</sup> which identifies best practices in program evaluation. The evaluation team matched these steps to the stratified random sampling method that they used to create the sample for the program. The evaluation team used the standard error to estimate the error bound around the estimate of verified gross impacts.

## 8. APPENDIX 2. IMPACT ANALYSIS DETAIL

### 8.1 Savings by Project

The Industrial Systems Optimization Program sample consists of ten projects. Table 8-1 provides the ex ante and verified energy savings for all the projects in the sample.

**Table 8-1. CY2019 Energy Savings by Project**

Sampled Application ID	Sample Strata	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTG *	Verified Net Savings (kWh)
IDS-40145-2	1	1,519,216	0.98	1,485,253	0.77	1,143,645
IDS-110	1	787,309	0.99	777,541	0.77	598,707
IDS-40487	1	746,245	1.00	746,245	0.77	574,609
IDS-40122	1	585,565	1.05	611,991	0.77	471,233
IDS-40424	2	385,768	1.00	385,768	0.77	297,041
IDS-79	2	207,199	1.09	225,365	0.77	173,531
IDS-40398	2	204,869	1.00	204,869	0.77	157,749
IDS-40109-2	3	48,457	0.84	40,708	0.77	31,345
IDS-40179-2	3	23,485	0.97	22,838	0.77	17,585
IDS-40209	3	17,483	0.43	7,577	0.77	5,834
<b>Total</b>		<b>4,525,596</b>	<b>NA</b>	<b>4,508,155</b>	<b>NA</b>	<b>3,471,279</b>

NA = Not applicable

\* A deemed value. Source: is to be found on the Illinois SAG web site here: [https://www.ilsag.info/ntg\\_2019](https://www.ilsag.info/ntg_2019).

Source: *ComEd tracking data and Guidehouse team analysis.*

Table 8-2 provides the ex ante and ex post demand savings for all the projects in the sample.

<sup>3</sup> Tec Market Works, "The California Evaluation Framework," Prepared for the California Energy Commission, June 2004. Available at <http://www.calmac.org>

**Table 8-2. CY2019 Demand Savings by Project**

Sampled Application ID	Sample Strata	Ex-Ante Gross Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Demand Reduction (kW)	NTG*	Verified Net Demand Reduction (kW)
IDS-40145-2	1	173	0.99	172	0.78	134
IDS-110	1	118	0.29	34	0.78	27
IDS-40487	1	-	-	-	0.78	-
IDS-40122	1	52	1.80	93	0.78	73
IDS-40424	2	-	-	-	0.78	-
IDS-79	2	-	-	-	0.78	-
IDS-40398	2	30	1.00	30	0.78	23
IDS-40109-2	3	6	1.64	9	0.78	7
IDS-40179-2	3	8	0.86	7	0.78	5
IDS-40209	3	5	0.35	2	0.78	1
<b>Total</b>		<b>392</b>	<b>NA</b>	<b>346</b>	<b>NA</b>	<b>270</b>

NA = Not applicable

\* A deemed value. Source: is to be found on the Illinois SAG web site here: [https://www.ilsag.info/ntg\\_2019](https://www.ilsag.info/ntg_2019).

Source: ComEd tracking data and Guidehouse team analysis.

The evaluation team has provided ComEd with site-specific M&V reports for each verified project. These site-specific impact evaluation reports summarize the ex ante savings in the end of year summary submitted, as well as the ex post M&V plan, data collected at the site, and all the calculations and parameters used to estimate savings. Table 8-1 and Table 8-2 above summarize the results for each project. The evaluation team uncovered issues in five of the ten projects, which resulted in energy or demand realization rates with a discrepancy of greater than 10% from a realization rate of 1.0. Some key observations from these site-specific evaluation results are discussed below for each project that had large differences in energy savings.

- Project IDS-40109-2: This project involved the repair of compressed air leaks throughout the facility. The savings were reduced because the ex ante analysis claimed almost year-round operation of the compressor, assuming 8,700 hours per year. The evaluation team found that the compressor only operated 4,437 hours per year, which reduced the savings.
- Project IDS-40209: The ex ante calculations used a TRM approach to calculate savings related to the installation of a VSD compressor. As this is a custom program, the evaluation team accounted for site-specific conditions like Compressed Air and Gas Institute (CAGI) specification performance curves, operating pressure, and flow rates which were not factored into the ex ante calculations.

## 9. APPENDIX 3. TOTAL RESOURCE COST DETAIL

Table 9-1 shows the Total Resource Cost (TRC) cost-effectiveness analysis inputs available at the time of finalizing this impact evaluation report. Additional required cost data (e.g., measure costs, program level incentive and non-incentive costs) are not included in this table and will be provided to the evaluation team later.

**Table 9-1. Total Resource Cost Savings Summary**

End Use Type	Research Category	Units	Quantity	EUL (years)*	ER Flag†	Verified Gross Electric Energy Savings (kWh)	Verified Gross Peak Demand Reduction (kW)	Verified Gross Gas Savings (Therms)	Gross Heating Penalty (kWh)	Gross Heating Penalty (Therms)	NTG (kWh)	NTG (kW)	NTG (Therms)	Verified Net Electric Energy Savings (kWh)	Verified Net Peak Demand Reduction (kW)	Verified Net Gas Savings (Therms)	Net Heating Penalty (kWh)	Net Heating Penalty (Therms)
Industrial Systems	Compressed Air Leak Repair	Measures	331	3.0	No	23,069,816	5,345.39	0	0	0	0.77	0.78	0.77	17,763,759	4,169.40	0	0	0
Industrial Systems	Compressed Air ‡	Measures	21	15.0	No	5,253,403	841.78	0	0	0	0.77	0.78	0.77	4,045,120	656.59	0	0	0
Industrial Systems	Other	Measures	8	13.0	No	3,803,447	448.92	0	0	0	0.77	0.78	0.77	2,928,654	350.16	0	0	0
Industrial Systems	Retrocommissioning	Measures	14	7.5	No	3,558,777	640.09	0	0	0	0.77	0.78	0.77	2,740,258	499.27	0	0	0
Industrial Systems	High Efficiency Air Nozzles	Measures	49	15.0	No	2,558,867	550.45	0	0	0	0.77	0.78	0.77	1,970,328	429.35	0	0	0
Industrial Systems	VSD	Measures	6	15.0	No	828,919	113.55	0	0	0	0.77	0.78	0.77	638,268	88.57	0	0	0
Industrial Systems	Industrial Refrigeration	Measures	3	15.0	No	735,127	0.00	0	0	0	0.77	0.78	0.77	566,048	0.00	0	0	0
Industrial Systems	No Loss Drains	Measures	18	10.0	No	104,604	24.70	0	0	0	0.77	0.78	0.77	80,545	19.26	0	0	0
Industrial Systems	Strategic Energy Management	Measures	11	5.0	No	491,057	55.94	0	0	0	0.77	0.78	0.77	378,114	43.63	0	0	0
<b>Total</b>				<b>7.2</b>		<b>40,404,017</b>	<b>8,021</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>31,111,093</b>	<b>6,256</b>	<b>0</b>	<b>0</b>	<b>0</b>

\* The total of the EUL column is the weighted average measure life (WAML), and is calculated as the sum product of EUL and measure savings divided by total program savings.

† Early Replacement (ER) measures are flagged as Yes, otherwise a No is indicated in the column.

‡ The EUL for this measure varies over time. See the CPAS tables (Table 4-1).

Source: ComEd tracking data and evaluation team analysis